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Hydrology and Earth System Sciences
Discussions

Interactive comment on "A comparison of interpolation methods on the basis of data obtained from a bathymetric survey of Lake Vrana, Croatia" *by* A. Šiljeg et al.

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Anonymous Referee #1: This work conducted a complete bathymetric survey on Lake Vrana, and produced the contour map of this lake as well as calculated its surface area and volume. In addition, the authors compared the efficiency of 16 different interpolation methods to discover the most appropriate one. This work was done in a very detailed way, and nice results were obtained finally. It should have some merits to the similar studies in the future.

Author Response: Thank you.

Anonymous Referee #1: However, from the structure of the entire text, presentation of the results and many other aspects, I felt this paper was far not enough good to be considered to publish in HESS.

Author Response: We respect the opinion of the reviewer, though we feel that the comment is in contradiction with the aforementioned one ("This work was done in a very detailed way, and nice results were obtained finally. It should have some merits to the similar studies in the future"). The handling editor's opinion is that the research is well-structured and that it should be further processed.

Anonymous Referee #1: Some specific comments listed as follows: 1. The paper is in a bad organization of the text, some parts are redundant and meaningless to a scientific paper. Section 2.1 could be largely condensed by cutting most of the paragraph, just to show the catchment setting, simple description of the equipment and data compilation.

Author Response: Of course, certain parts can be shortened or left out. In the chapter 2.1. the authors briefly present: 2.1.1) features of the researched area (based on this, the reviewer concluded the following - Anonymous Referee #1: This lake is a large, shallow lake with relatively high fluctuation of annual lake level (âĹij193cm) and high percentage coverage of aquatic vegetation), 2.1.2) the aim and the purpose of the research (the reviewer mentioned that the model can be used for the purpose of managing and future researches), 2.1.3) used equipment (there are several types of research equipment and the reader should be aware of specific features of the research technology), 2.1.4) time frame (there were numerous limiting factors that needed to be taken into consideration, since those affected the results) and 2.1.5) data processing (a demanding and time-consuming process that requires experience, and the research shows the basics).

IMPORTANT: the data gathering phase is an extremely important part of the model development, which has been pointed out by many authors (Weibel & Heller 1991, Hutchinson & Gallant 2000 Hengel at al. 2003, Oksanen 2006, IHO 2005, Erdogan

2009). The accuracy of the model, as well as data derived from DTM depend on the data gathering phase.

Anonymous Referee #1: 2. Too many unnecessary figures used in the paper. Fig. 1, 2, 3, 7 are not really useful in a scientific paper. However, a complete map of the whole catchment of this lake was not presented. As “the waters of lake Vrana are a specific and complex system” and the lake is characterized by several features, why not show all these components and their relations within the drainage by using an composite map?

Author Response: The reviewer considers that the authors should present the catchment map of the researched area, that the figures 1, 2, 3 and 7 are unnecessary, and that the chapter 2.1 is too long. We are not sure if the reviewer has properly understood the main aims of this research. Surely the analysis of the technology and data gathering/processing in the context of DTM development (consisting of 5 phases; 1 – data gathering, 2 – model development, which includes testing interpolation methods and choosing spatial resolution, 3 – analysis and visualization, 4 - interpretations and 5 – application) are more important than the representation and description of the catchment area? We repeat, the accuracy of the model, but also of any DTM-derived data, depends on the data gathering phase.

Anonymous Referee #1: 3. This lake is a large, shallow lake with relatively high fluctuation of annual lake level (âĹij193cm) and high percentage coverage of aquatic vegetation. In this case, it is almost not possible to obtain precise bathymetric data. Also, the surface area and volume are always changeable during different seasons, what is the real meaning to do such precise calculation? It could be useful in lake management, but not really worthful in scientific research.

Author Response: Indeed, the level fluctuation od 193 cm is one of the problems and the reasons that the DTM was developed and can be used as a managing tool (it is already used). In order to develop an adequate model which can be used in the

managing, it is necessary to gather data and find out the optimal model in a scientific manner. In order to develop a model, it is necessary to test deterministic and geostatistical interpolation methods and choose the most appropriate method of interpolation and spatial resolution. Since there have been no previous bathymetric researches in the Republic of Croatia, the specific features of Lake Vrana were unknown. After this research, however, those features are known, and this is something worth discussing. Many questions can be formulated now, even such as why is the depth only 3,71 meters at the water level of 0,43. It is difficult to simply assume certain things in a scientific work.

(Anonymous Referee #1: In this case, it is almost not possible to obtain precise bathymetric data.)

This statement brings into question the work of all scientists who work on the DTM development. Is it possible to precisely measure and represent the entirety of Earth’s surface? Why do we use ellipsoids? Why do we use models? What are models actually? Why do people continue to work on the data gathering methods? There are technologies which enable the development of a DTM with up to 90% precision. But such model is only 90% “real” relative to an ellipsoid that was used to represent the model of Earth. The research explained why a single-beam echo sounder was used and what its main features are. It is correct that the surface area and the volume of the lake constantly change. Such significant yearly oscillation causes many problems (dying of fish, increased salinity and temperature etc.), which was also the reason why this bathymetric research was done. Why are such detailed measurements necessary? Firstly, in order to deal with the aforementioned problems. Now, one can measure the volume and the surface area of the lake in any given moment, and certain situations can be predicted. The statement “It could be useful in lake management, but not really worthful in scientific research” causes some misunderstandings. Does that mean that scientific researches should not be applicable?

Anonymous Referee #1: 4. I could not find the substantial value of the comparison of

16 different interpolation methods.

Author Response: Similar researches have been done in many relevant scientific works (Erdogan, 2009, Chaplot at al. 2006, Aguilar at al. 2005, Webster & Oliver 2007, Li & Heap 2008). If such works have no value, then we agree that this one has no value as well. The results showed that all the tested interpolation methods performed equally well due to small vertical roughness, but such conclusion could not had been formulated a priori and required validation. The small measure of vertical roughness was proven only after the bathymetric survey. Also, the model in this research could not have been developed based solely on a single set of elevation data because a problem with extrapolation at the edges of the researched area appeared. Many scientists seem to overlook this problem in the process of DTM development (eg Erdogan 2009). So, in order to compensate and avoid extrapolation, we used elevation data from aerophotogrammetric gathering and stereo-restitutional processing. Using two sets of data showed that the results of the comparison of interpolation methods were significantly different. The research states the reasons for this. The paper also features a comparison of manually and automatically defined parameters in relation to the output results of interpolation methods.

Anonymous Referee #1: 5. There is several presentation of the lake area of the lake but obviously they are not consistent. In P.6 L.5-10, the entire area of the catchment is 29865; P.10 L.10-15, northern part of the lake is 14351; P.22 L.10-15, the surface area of the lake is 29865; P.33 table 6, the surface area is 30.815 (all the above data are in a unit of square kilometre). However, in table 7, ha is used instead of square kilometre. All these things are quite confused and obviously some of them must be wrong.

Author Response: Results are definitely not wrong. As you said, the surface of the lake constantly changes and it is relative to the water level. In ideal circumstances (when there is no vegetation at the edges of the lake), it would be possible to determine the exact surface at a given moment by using remote measuring technology. However, the situation in this research was much more complicated. Since we did not have

access to such technology (which could penetrate thick vegetation and detect the exact border between water and land), we decided to use interpolation methods. By using such methods, the border within the thick vegetation was approximated. This was possible because we used two different sets of elevation data. This way it is possible to, for example, set the water level at 3 meters and calculate the surface area. The developed model for approximation was tested in the field. During the survey, the water level was 0,4 meters. Interpolation methods at such water level showed the resulting surface area of 29,865 m2 (in case of the best interpolation method). Although this was approximated, it is nevertheless the most reliable calculation since the water level was extremely low and the water was not significantly within the thick vegetation area. At the mean water level (0,81 meters) the surface of the lake amounts to 30,815 m2. This is an approximated value as well. The surface of 14,351 m2 relates to the surface we managed to survey in a single day.

Anonymous Referee #1: 6. When the authors talked about water level changes of this lake, they used “cm” and “mnm” to show the fluctuation within a year (P.18 L.0-15 and Table 6). However, what is the relation between “cm” and “mnm”? What does the “mnm” mean? Actually, as the authors pointed out, the lake level is changeable with large annual oscillation, how could you get the water level with such a precision (e.g., 0.003mnm, in the table it was 0.03mnm)? Do you think it is really meaningful?

Author Response: Mnm is a Croatian acronym which means elevation above sea level (a translation error made by the lector). Cm stands for elevation in relation to national coordinate system. There is a difference between these two. The paper shows both of these values. It is correct that the different values cause confusion for the reader. During the data gathering, the referential plane was that of the national coordinate system. The water level was 0,43 meters.

Anonymous Referee #1: 7. As the authors pointed out, 4.6 % of the lake’s surface area is covered in dense vegetation, please indicate how to calculate and better to show where the 4.6 % of vegetation covered areas are located in this lake.

Author Response: For the purpose of this paper, we performed a field research of the area covered in vegetation. We also used a map of the habitat, scale of 1:5000, made by Sven Jelaska (biologist). This map was done for the purposes of the Lake Vrana Nature Park and it was a result of a precise field research.

Anonymous Referee #1: 8. In table 1, 2, 4 and Fig.8, 11, abbreviation was used to describe the interpolation methods, these are meaningless for the readers. The authors must give their whole name and even interpret them simply.

Author Response: We partially agree with these statements. The paper's introduction can provide the full names of interpolation methods. As for the tables, due to practical reasons the methods are abbreviated, in a manner similar to other researches.

Anonymous Referee #1: 9. In fig. 8 and 15, the bathymetric maps were not shown enough explicitly. Contour maps with isolines of water depth could be better

Author Response: Representation with isolines is less comprehensible than the used one. We tried to visualize output results in many ways for the purpose of this paper, but the current way seemed the clearest and therefore the most appropriate.

Anonymous Referee #1: 10. There are so many interpolation methods were used in this study, however, they were not fully introduced. The most important one could be "ordinary cokriging", but several times the other terms were mentioned, e.g., "ordinary kriging", "simple kriging", "simple cokriging". Are they different methods or similar? The authors need to specify them in detail to clarify each method.

Author Response: Ordinary kriging, simple kriging and simple cokriging are different methods. Of course, all three are mentioned in the research paper. However, the output results of those methods depend on the input data and parameters. We assumed that the paper would be read by a reader who is already familiar with the differences in interpolation methods. The differences can, of course, be explained, but it would also be necessary to extend the paper to 5 pages in that case. How necessary would

it be? The paper also already references other relevant researches which explain interpolation methods in detail.

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