Black: Comments of RC

Red: comments of the authors

Word by word citations including in the manuscript

Brown: omitted after conversion of the final manuscript version

RC1

Thank you very much for your constructive comments.

The manuscript describes an interesting phenomenon -- but doesn't explore plausible explanations. One may expect that the water temperature in the Class A pan is influenced by sediment at the bottom of the pan, and by having waterplants that limit water circulation. The temperature at the water surface will influence evaporation. Even measurements of surface water temperature for a relatively short period could help quantify such effects. One expects the temperature differential to be highest under full-sun conditions and lowest with an overcast sky. So plotting the temperature differential to environmental conditions could give some indication of the mechanism involved.

The statistical toolbox used is rich -- but one wonders how replicable results might be under conditions beyond those of the experiment if there is no mechanistic understanding of the process. The 'machine learning' methods are deemed successful in 'fitting', but results are not presented in a way that allows others to use them in new settings.

Finally, according to answer of RC 6, this section has been omitted from the final manuscript version. Instead, another discussion was added. See also RC6's comments. Dear Reviewer,

The macrophytes seeded in the pans probably hinder the water circulation and the radiation penetration into the deeper water layers. This is the reason why the surface water temperature in seeded pans is higher than in empty A pan. This summer, water temperature layering was also detected in A pan. We plan to complete the manuscript with this new result. Comparison in temperature layering between seeded and empty pans highlights the macrophyte modified circulation patter.

Surface water temperature (Tw) of A pans was sensed with thermocouples (Delta Ohm HD-226-1) at 10-min intervals in 2015-2020.
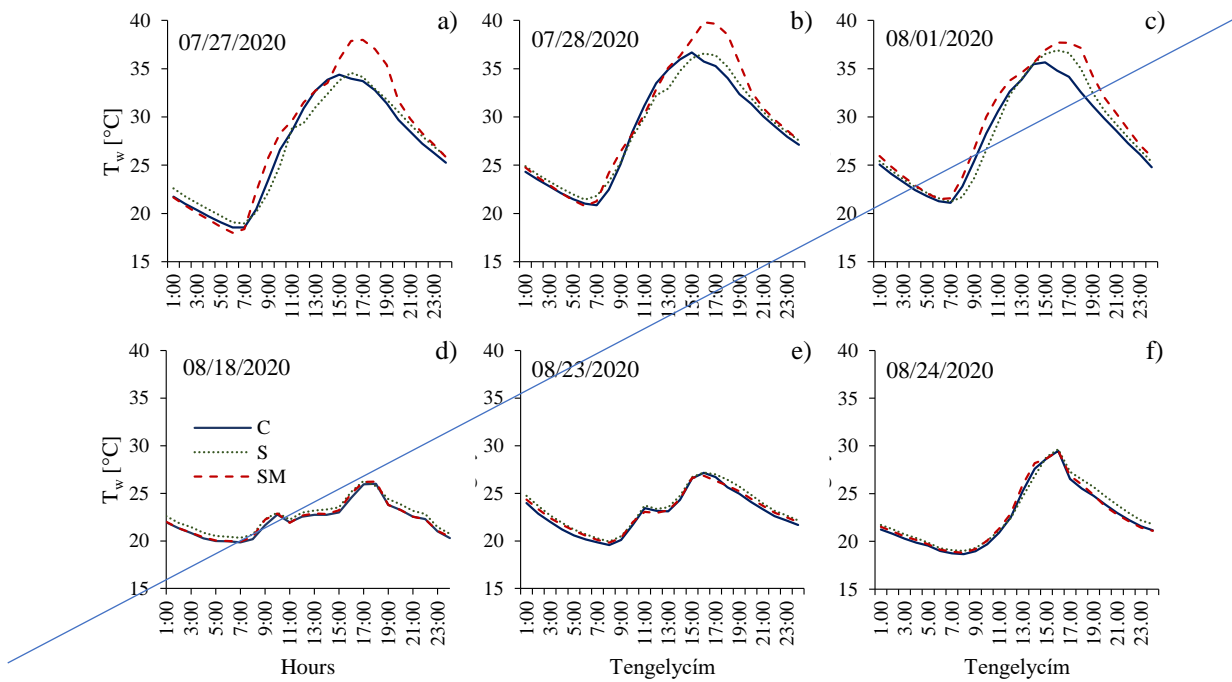
al., 2012) than that of in comparison to empty pans. In the case of natural waters containing submerged macrophytes, the plants restrain the radiation transfer to the deep water and reduce it to 0 at a depth of 1 m (Wang et al., 2019).

Coates, M.J., Folkard, A. (2009): The effects of littoral zone vegetation on turbulent mixing in lakes. Ecol. Model., 220, 2714–2726.

Golosov, S.; Kirillin, G.A. parameterized model of heat storage by lake sediments. Environ. Model. Softw. 2010, 25, 793–801.

Sharip, Z., Hipsey, M.R., Schooler, S.S., Hobbs, R.J. (2012): Physical circulation and spatial exchange dynamics in a shallow floodplain wetland. Int. J. of Design & Nature and Ecodynamics. 7,3, 274–291.

Wang, Y., Ma, Q., Gao, Y., Hao, X., Liu, S. (2019): Simulation of the Surface Energy Flux and Thermal Stratification of Lake Taihu with Three 1-D Models. Water, 11(5), 1026.

Thank you very much for your constructive comments.

Minor:

sipctatum ==> spicatum

Done. Thank you!

Sincerely,

Brigitta Simon-Gáspár et al.

RC2

Dear Reviewer,

we thank the reviewer for appreciation of work and for the comments. We believe the current comments can greatly help improve the quality of the paper. Please find our responses in the attached file.

General comments

The authors used FAO-56 Penman-Monteith equation (FAO56-PM), multiple stepwise regression (MLR) and Kohonen self-organizing map (K-SOM) techniques to estimate daily pan evaporation (Ep) in three treatments. And in an six-season experiment. The 10 modelling approach included six measured meteorological variables were compared and evaluated. The results showed that the MLR method provided close compliance with the observed pan evaporation values, but the K-SOM method gave better estimates than the other methods.

I really appreciate the huge work made by the authors. However, I have some questions about the innovation of the research method and the purpose of this study. First, the ,methods of FAO-56 Penman-Monteith equation (FAO56-PM) (Allen et al., 1998), Kohonen self-organizing map (K-SOM) techniques (Kohonen, 1982) and multiple stepwise regression (MLR) are classic, but also relatively old methods. Predecessors have done a lot of research and published a lot of relevant papers on the comparison of these methods. If only a few traditional, classical methods are compared and discussed, I think that there is not enough innovation in terms of methodology to be published in HESS, and there are already many ready-made papers on comparative studies of evaporation calculation methods. In addition, the authors said that "there is little information in the literature on how submersed macrophytes affect the evaporation of a lake" in Introduction (Lines 64). Is this statement supported by the literature? (Wang, J.H. 1994. Effects of aquatic plants on water surface temperature and evaporation. Arid Land Geography, 17(2), 3. doi: CNKI:SUN:GHDL.0.1994-02-009). This article is not available in any traditional datanbase (scimago, google scholar, Sci-hub. se). Only the Journal name was found here: http://english.egi.cas.cn/pub/alg/. But even in the search window, the article is missing.

"The aim of the study was to investigate the effect of littoral sediment and macrophytes on lake evaporation and not an introduction of a new method in pan evaporation estimation. The previous results in FAO-56 Penman-Monteith equation (Allen et al., 1998), Kohonen self-organizing map techniques (Kohonen, 1982) and multiple stepwise regression are classic methods, highlighted widely by citations in the study. They are the tools in analysing the effect of sediment and macrophytes in pan (lake) evaporation estimation only. The novelty of the paper is the way how the evaporation estimation is carried out."

The second main aim of this paper was to estimate daily Ep using FAO-56 Penman-Monteith (FAO56-PM), Kohonen self-70 organization map (K-SOM) and multiple stepwise linear regression (MLR) methods. Since this purpose is only the comparison and evaluation of several traditional methods, and I personally still feel that the innovation is not sufficient for HESS.

This work's novelty is not the use of a new statistical method. We complete the new aim of the article as follows: "**To our best knowledge, there are no studies attempting to project the lakes evaporation using traditional A pan measurements, taking the macrophytes- and sediment-related factors into account. Lake evaporation study is missing under such climate conditions as our experimental site.**"

Specific Comments

1. English language needs to be modified. I found several unclear sentences that make it difficult to understand the analysis and results carried out.

Thank you for your comment. Although, this manuscript was corrected by an English native speaker. Correcting the paper, we repeat this process. It would be useful to know which are those unclear sentences.

2. The description at the beginning of the Abstract is too simple and empty, two to three sentences should be used to focus on the shortcomings of the current study and the innovation of this study.

The Abstract will be completed to highlight the main novelty and the mechanical impact of seeded macrophytes on the pan evaporation.

"The results showed that the MLR method provided close compliance (R^2=0.58-0.62) with the observed pan evaporation values, but the K-SOM method (R^2=0.97-0.98) yielded by far the closest match to observed evaporation estimates for all three pans.

To our best knowledge, no similar work has been published previously using the three modelling methods for seeded pan evaporation estimation.

The current study differs from previous evaporation estimates by using neural networks even with those pans containing sediments and submerged macrophytes. Their evaporation will be treated directly by K-SOM, in which the modelling is more than the simple Ep of a Class A pan filled with clean tap water."

3. Some of the references in the Introduction are too old. It is suggested that the author update some relevant studies recently published.

We added 25 new references to the Introduction. See in the reference list

4. The font resolution in Figure 1 is too low to see the relevant text clearly. I suggest the author to redraw it.

Done.

5. The numeric font in equation 2 is suggested to be Times New Roman, and the rest of the formula is the same.

Done. Thank you for your comment.

6. In Materials and methods, it would be better to give specific steps about the experimental design of this study, the current presentation is relatively sketchy.

We complete the materials and methods with more exact steps of the experimental design as follows:

"The used sediment was psammal/psammopelal (Ø > 6 μm - 2 mm, sand/sand with mud) with the following composition: quartz, calcite, aragonite, dolomite, muscovite, chlorite, feldspar, smectite, kaolinite and pyrite (Anda et al., 2016). One Class A pan was treated with a 0.02 m thick sediment–covered bottom.

Macrophyte samples were gathered from lake Balaton (Keszthely Bay) with similar water depth (0.6–0.8 m) each year. The amount of crop density was controlled monthly without variation in the green mass weight of crops between natural habitat and ''seeded'' US Class A pans. In the experimental area three species of submerged, freshwater aquatic macrophytes: Potamogeton perfoliatus, Myriophyllum spicatum and Najas marina was colonized.''

7. The Results and Discussion session. I found some good results from this study, but unfortunately the authors' description of these results is too brief (Both in Figures and Tables)and suggest a more specific analysis and evaluation of the results. And the discussion was not in-depth enough and was only a brief description of the Results. It is recommended to fully evaluate and discuss the results obtained by several different methods used in this study in terms of the mechanism of influence.

The results will be analysed in more detail accounting the following:

We plan to extend the description of the results with weather conditions of the studied six seasons using Thornthwaite index, TI (). In the next step, the evaporation will also be analysed based on TI. We discuss differences in pan evaporation based on actual weather conditions.

A more specific analysis and evaluation of the missing discussion of pan evaporation related to thermal layering and surface water temperature will also be added. These basic observations in terms of the mechanism of influence will be completed to Abstract as well.

8. The content of the conclusion should not be a simple retelling of the results and discussion, but also a more in-depth explanation of the scientific significance and potential application value of the study, rather than the kind of formulaic statement in the last paragraph of the conclusion.

"**Potential application value of the study is validating presence of littoral sediments and macrophytes in evaporation estimation, the amount of lost water by lakes that can easily be accounted in the prediction of wetland performance. Results from the study may also be contributed to the protection of aquatic plants and environmental management of lakes in other regions of the world. Management strategies aiming to estimate accurate water budget terms including evaporation can be a realistic aim for preventing further inaccurate water loss projections.''**

9. I am not quite sure if the current hess format requires line numbers to be marked every five lines, which causes some reading difficulties, if not required by the journal format, it is recommended that authors mark all line numbers.

The authors used the Copernicus_word_template format recommended by HESS.

Sincerely,

Brigitta Simon-Gáspár et al.

RC3

This paper discusses a way of modeling pan evaporation using 3 methods: the Penman-Monteith equation, multiple step-wise regression, and the Kohonen self-organising map. The novel element to this work appears to be the fact that the pan evaporation was measured with 3 class A pans but two contained sediment and one contained submerged macrophytes on top of sediment. To me, this is the part that sets the paper apart and is important, because the authors are trying to create more realistic conditions for the observational experiment before using the data for a modelling study.

Thank you for your understanding!

I liked the part of the discussion lines 248-250 where the authors discuss the low winds in this study and in earlier studies. I think that the fact that they honestly state a kind of negative result is helpful and proper.

Thanks again!

1. I was disappointed that the methods were not discussed in more detail, in particular, the Kohonen self-organising map method. I can see that proper citations are given, and that this method has been applied to evaporation modelling before. However, I think that the paper would benefit greatly from an introduction to the Kohonen method. Then all 3 methods could be explained to the reader alongside the relevance to the physical process being studied. Why were these methods chosen in the first place? What are the pros and cons to these methods?

"K-SOM provides an indirect method for the estimation of pan evaporation, that seems necessary to get evaporation of natural ecosystems including lakes. In other words, applying an indirect method, in which the pan evaporation is estimated from other, easily measurable meteorological parameters such as sun radiation, air temperature and relative humidity has of primary importance. This approach has widely been used for pan evaporation projection among others by Kisi et al. (2016) and Lin et al. (2013). Kisi et al (2016) compared the soft computing model K-SOM and multiple linear regression (MLR). The authors demonstrated the superiority of K-SOM over MLR even in the model performance.

The Penman-Monteith model is considered as the international standard for computing potential evapotranspiration and predicting crop water requirement. Penman-Monteith equation (FAO-56) may also be proper method to get pan evaporation with submerged macrophytes. Wang et al. (2021) reported that actual evaporation is important for hydrological research due to its direct impact on the hydrologic processes (water cycle, water resources management). The above authors concluded that to estimate pan evaporation, it is essential to find the proper formulation of Penman-Monteith equation. It may be especially true even in pans with seeded macrophytes. In accordance with composition of lake ecosystems, this is the method in evaporation estimation that implies living organism."

"To our best knowledge, no similar work has been published previously using the three modelling methods for seeded pan evaporation estimation." (This last sentence goes to Introduction)

Added references:

Kisi, O., Genc, O., Dinc, S., Zounemat-Kermani, M.: Daily pan evaporation modeling using chi-squared automatic interactiondetector, neural networks, classification and regression tree, Comput. Electron. Agr., 122, 112-117, DOI: 10.1016/j.compag.2016.01.026, 2016.

Lin, G.F., H.Y. Lin and M.C. Wu Development of a support-vector-machine-based model for daily pan evaporation estimation. Hydrol. Process., 27 (22) (2013), 3115-3127

Wang, L., Hang, S., Tian, F., Comparison of formulating apparent potential evaporation with pan measurements and Penman methods, J Hydrology, 592, January 2021, 1258162021, https://doi.org/10.1016/j.jhydrol.2020.125816

2. Figure 5 should be explained. I can see that this is related to figure 3 but the links are not made clear. The x and y axes are not labelled in either figure. How do the hexagons map to the inputs or outputs? I can't figure this out from reading the manuscript. Also, I found no definition for "importance" in the caption. This is part of the lack of time spent discussing and explaining the relevance of the methods used in the study.

These are not traditional Fig. with x and y axis. The Fig. 3 is a schematic layout of correlations, the winning nodes, and their neighbourhood.

To Fig. 3: "**As similar input patterns could have different outputs, to determine the best output for a given input pattern is to use the mean output value as the clustered input patterns to the correspondent neuron, and then the closest (most similar) neuron would be directly used for the given input pattern (Chang et al., 2010, Kohonen, 1990).**"

Description of Fig. 5 can be found in lines 215-220.To Fig. 5: "**Superimposed on K-SOM patterns of input meteorological variables, radiation, air temperatures including minimum and maximum, relative humidity, wind speed could be captured revealing their co-variability with the pan evaporation.**"

To References

Kohonen, T., 1990. The self-organizing map. Proceedings of the IEEE 78 (9), 1464–1480.

F-J. Chang, L-C. Chang, H-S. Kao, G.-R. Wu, Assessing the effort of meteorological variables for evaporation estimation by self-organizing map neural network. Journal of Hydrology, 384, 1–2, 118-129, 2010, https://doi.org/10.1016/j.jhydrol.2010.01.016

3. Tables 1 and 2 are very large and comprehensive. While I think that the information is critical to explaining the conclusions of the paper, I do not think that the information in them is easy to make sense of. Is there any way that the tables could be re-organised or even some of the information could be turned into figures to display the information in a clearer way? One suggestion for table 2 is to keep information for the correlation values only in the tables, but to put all the statistics (max, min, mean, std. dev.) in a figure with sub panels. Are all the statistics relevant? Perhaps the authors could be a bit more selective? I agree that information on the full, training and testing data should be presented.

The Table 1 is important. We keep it in its original form. In case of Table 2 some elements will be omitted (CV, max and min).

4. Figure 1 was not displayed with very high resolution. Could the authors provide a higher quality figure?

Yes

5. Figure 4 box plot whiskers and circles are not clearly defined. Software packages which compute these types of diagrams are not all the same. Please could the range (and meaning) of the box lenghth, whiskers and circles be stated explicitly.

Completed the title of the Fig: "**The lower and upper ends of the box indicate the 25th and 75th percentiles of the variances, respectively, while the horizontal bar within the box indicates the median. The two horizontal bars indicate the range that covers 90% of the variances. Outliers are indicated with circles.**"

6. Table 1 has three lines at the bottom saying "Based on observed means" but I don't know what these lines are referring to. Is it the full, training and testing data sets?

We correct it

Minor corrections

In figures with multiple panels, the sub-panels should be labeled with letters (a, b, c,...) in order to make the discussion of the results clearer in the body of the paper and make it easier to clarify the definitions in the captions.

We clarify where it is necessary

L167 "displays a regular pattern" does not make sense to me. Can the authors make clearer what the Relative humidity and global radiation statistics are exhibiting and why it is important to notice this?

The last two sentences will be omitted from the manuscript.

We plan to extend the description of the results with weather conditions of the studied six seasons using Thornthwaite index, TI. In the next step, the evaporation will also be analysed based on TI. We discuss differences in pan evaporation based on actual weather conditions. See also answers of Ref 2.

L178 Where is F defined? I could not find it.

Completed

L241 Please change "few" to "little"

Done

L247 Please change "researches" to studies"

Done

L273 Please change neural network to "a neural network approach".

Done

L290 the range or tuple presented is unclear. Is "(-0.42-0.44)" really (-0.42 to -0.44) or (-0.42, -0.44)? Also, it seems strange to put the larger number -0.42 in front of -0.44 if indeed they both are negative.

Clarified

L296 Please change "has high priority" to "is superior to". I'm not sure about the phrase "prediction precision" precision sounds like a computational error here. Are you talking about skill? High correlation or low RMSE? Is there a better way to phrase this?

Modified as accuracy in prediction

Sincerely,

Brigitta Simon-Gáspár et al.

RC4

Thank you very much for your constructive comments.

Reviewers' comments:

In this paper, K-SOM and other methods are used to improve the estimation of lake evaporation, which is conducive to accurately estimate the total lake evaporation and improve the climate effect of the lake under the background of climate change. I recommend publication of the paper in HESS after revision.

Thank you!

Major comments

Has this article been studied by simulation at Keszthely, Hungary. However, how do you consider the effect of the evaporation of non-uniform underlying surfaces, such as mountains, and grass?

The use of class A pan to measure evaporation is controlled by WMO Guide including its placement, pan dimensions, time, and frequency of measurements etc. The aim of these strict restrictions is the comparability of evaporation measurements under different environmental conditions. The goal of the study was to detect the effect of littoral sediment and macrophyte on evaporation rate. The seeded and empty pans were set up on the same place on the Agromet. Research Station of Keszthely, allowing comparison of standard and seeded pan's evaporation rates. Finally, the impact of macrophytes and sediments on (lake) evaporation rates were discussed.

This paper improves the calculation method of lake evaporation, and further analysis of lake evaporation and its climate effects are needed on the Lake Balaton in the future.

Thank you!

Minor comments

Figure 1 should be topography.

Corrected

L.47 The unsupervised NNs, including Kohonen Self Organizing Maps (K-SOM), has several advantages (Kohonen, 1982). Full name should be given for the first occurrence 'NN'.

Completed

L.16-20 Performances of the different models were compared using statistical indices, which included the root mean square error (RMSE), mean absolute error (MAE), scatter index (SI) and Nash-Sutcliffe efficiency (NSE). The results showed that the MLR method provided close compliance with the observed pan evaporation values, but the K-SOM method gave better estimates than the other methods. Overall, K-SOM has high accuracy and huge potential for Ep estimation for water bodies 20 where freshwater submerged macrophytes are present. This section need to be rewrite.

Performances of the different models were compared using statistical indices. The results showed that the MLR method provided close compliance (R^2=0.58-0.62) with the observed pan evaporation values, but the K-SOM method (R^2=0.97-0.98) gave better estimates than the other methods. Although, we plan to re-write the whole Abstract.

L.84 (latitude: 46°44′N, longitude: 17°14Ê¹E, elevation: 124 m above sea level) 'above sea level' Can be abbreviated as a.s.l.

Done

L.231 From the figure, it can be observed that most of the estimated daily Ep values are close to the observed daily Ep values for all three pan treatments.

Which figure?

In Fig. 6. We complete the text.

Many researchers have conducted research with neural networks aimed at the estimation of Ep as a function of meteorological variables (Keskin and Terzi, 2006). Several of these researchers found better results in Ep estimation with neural network than those obtained from the Priestley-Taylor and the Penman methods (Rahimikhoob, 2009; Malik et al., 2020). Consistent with other studies, this study demonstrated that modelling of Ep is possible through the use of K-SOM technique in addition to the 275 FAO56-PM and MLR methods. The comparison results indicated that, in general, the K-SOM model was superior to the FAO56-PM and MLR methods. Chang et al. (2010) used different methods to estimate pan evaporation, including also the KSOM and the FAO56-PM. According to the results of Chang et al. (2010), K-SOM was the best of the studied methods, and it was found that the Penman-Monteith method is also likely to underestimate evaporation. Malik et al. (2017) used four heuristic approaches and two climate-based models to approximate monthly pan evaporation, where the K-SOM model performed better than the climate-based models. The regression line in scatter plots has R2 as 0.937 for K-SOM model at Pantnagar and Ranichauri (India), respectively. In the study of Malik et al. (2017), RMSE values were 0.685 and 1.126 for K-SOM, when 50% of the total available data was used in the testing of models in two stations. This section should be put in the introduction.

We don't think so. This paragraph contains our results in the light of other author's ones dealing with the same topic as this study.

Line 280 The regression line in scatter plots has R2 as 0.937 for K-SOM model at Pantnagar and Ranichauri (India), respectively. 'Respectively' can be deleted.

Deleted

Can the confidence of the correlation coefficient pass the significance test?

Yes, all p levels are below 0.001. We indicate them on Fig. 6 as well.

Sincerely,
Brigitta Simon-Gáspár et al.

RC5

Thank you very much for your constructive comments.

In this manuscript, the authors use three methods to calculate daily evaporation during summer months (Jun to Sep) at a experimental site in Hungary. The three methods are the FAO Penman Monteith (PM) method, multiple stepwise regression and Kohonen self-organizing (SOM) maps. All methods are provided with observed meteorological time series for the years 2015 to 2020 as input. Simulated values are then compared to the observed evaporation estimates of three evaporation pans. The difference between the three pans is that one is a standard open water pan, one pan is partly filled with sedimentes and one with water living plants. Overall, the Kohonen self-organizing maps yield by far the closest match to observed evaporation estimates for all three pans.

The topic of evaporation estimates is fundamental to land-surface hydrology. For example, the PM method is frequently used to estimated potential evaporatin in hydrologic models. Errors in the PM methods will bias any subsequent hydrologic modeling. Despite the fact, that the topic of the manuscript is of general importance, the structure of the manuscript is poor and needs to increase substantially. One important issue is that I could not find that all findings listed in the abstract and the conclusions mentioned in the abstract are supported by the main text. Additionally, the methods part does not provide all details to follow what the authors did exactly. This does concern the PM method and the SOM method. The re-phrasing of the mentioned sections is in process and see also answers of RC2 and RC3. To complete the M&M section based on the answer of RC3 is as follows:

"**K-SOM provides an indirect method for the estimation of pan evaporation, that seems necessary to get evaporation of natural ecosystems including lakes. In other words, applying an indirect method, in which the pan evaporation is estimated from other, easily measurable meteorological parameters such as sun radiation, air temperature and relative humidity has of primary importance. This approach has widely been used for pan evaporation projection among others by Kisi et al. (2016) and Lin et al. (2013). Kisi et al (2016) compared the soft computing model K-SOM and multiple linear regression (MLR). The authors demonstrated the superiority of K-SOM over MLR even in the model performance.**

The Penman-Monteith model is considered as the international standard for computing potential evapotranspiration and predicting crop water requirement. Penman-Monteith equation (FAO-56) may also be proper method to get pan evaporation with submerged macrophytes. Wang et al. (2021) reported that actual evaporation is important for hydrological research due to its direct impact on the hydrologic processes (water cycle, water resources management). The above authors concluded that to estimate pan evaporation, it is essential to find the proper formulation of Penman-Monteith equation. It may be especially true even in pans with seeded macrophytes. In accordance with composition of lake ecosystems, this is the method in evaporation estimation that implies living organism."

"To our best knowledge, no similar work has been published previously using the three modelling methods for seeded pan evaporation estimation." (This last sentence goes to Introduction)

Added references:

Kisi, O., Genc, O., Dinc, S., Zounemat-Kermani, M.: Daily pan evaporation modeling using chi-squared automatic interactiondetector, neural networks, classification and regression tree, Comput. Electron. Agr., 122, 112-117, DOI: 10.1016/j.compag.2016.01.026, 2016.

Lin, G.F., H.Y. Lin and M.C. Wu Development of a support-vector-machine-based model for daily pan evaporation estimation. Hydrol. Process., 27 (22) (2013), 3115-3127

I am convinced that the comparison of evaporation estimation methods for the three pans (in particular Figure 6) are valuable findings that should be reported, but the manuscript needs to be substantially improved. Thank you!

Most importantly, the authors should decide what their main focus of the study is. Is it the effect of macrophytes on evaporation or is it the different estimation methods? At the moment, this is not clear. I would suggest the former to be the more interesting subject.

The content of the study aim is also under consideration. But the macrophyte's effect in pan evaporation is in the focus. We complete the new aim of the article as follows: "**The aim of the study was to investigate the effect of littoral sediment and macrophytes on lake evaporation and not an introduction of a new method in pan evaporation estimation. The previous results in FAO-56 Penman-Monteith equation (Allen et al., 1998), Kohonen self-organizing map techniques (Kohonen, 1982) and multiple stepwise regression are classic methods, highlighted widely by citations in the study. They are the tools in analysing the effect of sediment and macrophytes in pan (lake) evaporation estimation only. The novelty of the paper is the way how the evaporation estimation is carried out. Up to our best knowledge, there are no studies attempting to project the lakes evaporation using traditional A pan measurements, taking the macrophytes- and sediment-related factors into account. Lake evaporation study is missing under such climate conditions as our experimental site.**"

Abstract:

L. 14ff: I don't think that the statement regarding the correlation of RH is supported by the findings of this study. See my comment below regarding L. 218ff.

We omit the word "stronger"

The conclusion mentioned in the abstract on line 19f is not given anywhere else in the manuscript. It is unclear how the authors come to this conclusion or what they mean with "potential".

We mean potential as possibility. The word potential will be changed in possibility

Introduction:

Section starting at line 52 is a collection of statements that do not follow a apparent logical structure. It is not clear to me what the authors wish to express here.

Re-written Introduction part is: "**Evaporation of open water surfaces is usually measured by means of pans endowed with unrealistic properties. These pans are filled with clean tap water and the evaporated water is also replaced with tap water that is not the case in natural ecosystems. In nature, however, there may also be submerged macrophyte living in the open water. These plants presence is essential and affects the chemical and physical water properties including its quality (Yan et al., 2019). Furthermore, the species that are rooted in the sediment can stabilize the sediment by inhibiting its resuspension (Madsen and Cedergreen, 2002; Vymazal, 2013).**

Changes in the heat regime of a water body had been reported to result in alterations of macrophyte community composition (Barko et al., 1982), which may affect the temporal appearance and spatial distribution of macrophytes in the future. As a result, due to global climate

change, it is important to examine submerged macrophytes in all aspects, including their effect on evaporation. "

Methods:

L. 110f: The data described in Section 2.1 is not sufficient to apply the Penman-Monteith equation. Section 2.1 states that global radiation R_s is measured but Penman-Monteith equation requires net radiation and ground heat flux. How are the latter two derived?

We complete the M&M: "**Rn was estimated from global radiation, mean daily temperature, the mean daily vapor pressure, the site latitude and elevation after Allen et al. (2005). A fixed value of 0.23 was applied for the common reed albedo. It was assumed that soil heat flux density was G= 0 on a daily basis. Detailed description of the process can be read in Soós and Anda (2014)."**

References:

Allen, R.G., Clemmens, A.J., Burt, C.M., Solomon, K., O'Halloran, T., 2005. Prediction accuracy for projectwide evapotranspiration using crop coefficients and reference evapotranspiration. J. Irrig. Drain. Eng. ASCE 131 (1), 24–36

Anda, A., G. Soos, J. A. Teixeira da Silva, V. Kozma-Bognár 2015. Regional evapotranspiration from a wetland in Central Europe, in a 16-year period without human intervention, Agric. Forest Meteor. 205: 60-72, DOI: 10.1016/j.agrformet.2015.02.010

Soós, G., Anda, A, A methodological study on local application of the FAO-56 Penman-Monteith reference evapotranspiration equation, GEORGIKON FOR AGRICULTURE: A MULTIDISCIPLINARY JOURNAL IN AGRICULTURAL SCIENCES 18, 2, 71-85, 2014.

Results:

L. 187f: There are only four lines describing the results of table 2. This is not well balanced. Either the text needs to be expanded or the table shortened.

To the text completed with: "**There was statistically significant difference in evaporation rates of full datasets as well as in case of training and testing datasets between the seeded and classic Class A pan."**

Table 2 will also be re-structured by omitting some of the lines (CV, max and min)."

L. 206f: I am not an expert in self organizing maps. I don't know how to interpret characteristics shown in table 3 and the authors only describe the last two lines in this table.

We add the following to Table 3 explanation: "**These are the usual parameter table for K-SOM. The inputs were normalized, the code book is generated, the map size is the dimensions of the component planes (Figure 5), the neighbouring function of the pixels is Gaussian, the shapes of component planes are sheets, the lattices in planes are hexagonal."**

L. 218ff: "Thus, the correlation..." This sentence is confusing to me. First, it should state observed values and not modeled values. Second, it is shown in table 2 that RH is negatively correlated with E_p which is expected. Here, the authors state that red colors in Figure 5 show high correlation. For RH, the values are substantially higher than for any other variable suggesting a higher impact. This suggests to me that the SOM algorithm is not able to reproduce the relationships reported in table 2.

The Fig. 5 is in accordance with results in Table 2. In the two component planes of Fig. 5 (Ep and RH), the red areas of hexagons are on the opposite sides that indicate the negative correlation as it was

stated in L218ff. That is in the text: "**The component planes also visually confirm the negative correlation between RH and Ep, with high values of the RH resulting in low values of the Ep**"

L. 231: I disagree with this statement. How can the authors state that all three methods are close to observed values, when coefficient of determination varies from 0.11 for Penman-Monteith method to 0.97 for self-organizing maps. I think it is fair to state that the Penman-Monteith method is not able to reproduce the observed values. It is not clear to me whether the authors did apply the Penman-Monteith equation correctly because not all details are provided in the manuscript (see comment above).

This sentence will be omitted. The asked information was completed in M&M. See above

Discussion:

L. 256f: There are results reported in the discussion section. This should be moved to the results section and is not a clear manuscript structure.

We move L 256f to the results

L. 271ff: This section lists findings of other studies but does not provide a discussion of these results against the findings of the present study.

It demonstrates previous results that existed before this study. The conclusion contains the new findings of this study.

Minor comments:

L. 9: There is a misleading typo here: the A should not be capital.

Thank you!

L. 110f: Which equation was used to derive e_s and e_a from RH?

"The Tetens equation (Monteith and Unsworth, 2008; Allen et al., 1998; Tetens, 1930) was used for calculating saturation vapor pressure (e_s) as follows:

$e_s=0.6108*exp(17.27T_a/(T_a+237.3))$**, where T_a is the air temperature in ^oC. The vapor pressure, e_a was calculated from the relative humidity (RH):**

$e_a=(RH/100) *e_s$

References:

Allen RG, Pereira LS, Raes D, Smith M. Crop Evapotranspiration-Guidelines for Computing Crop Water Requirement, Rome, Food and Agriculture Organization of the United Nations, 1998.

Tetens O. Über einige meteorologische Begriffe. Z. Geophys., 1930; 6. 297-309.

Monteith, J.L., and Unsworth, M.H. 2008. *Principles of Environmental Physics*. Third Ed. AP, Amsterdam.

L. 118ff: Section 2.4 is not understandable to readers who are not familiar to SOM. It needs to be rewritten using an easier language. Figure 3 is also very confusing. Also, E_p is mentioned in Figure 3 as input variable, but this cannot be correct. I guess that observed E_p is used during training to compute an error measure.

According to answer RC3, the description of K-SOM will be extended.

Thank you for your suggestion, the observed Ep was used during the training. The Fig. 3 is only schematic representation of K-SOM network architecture. We correct the input of Fig. 3 by omitting the Ep.

L. 139: The sentence regarding the splitting of the data is incomplete.

We complete the sentence

L. 184: Table 1 can be moved to the appendix because it is not central to the goal of the manuscript.

Thank you!

Sincerely,

Brigitta Simon-Gáspár et al.

RC6

The comment "Most importantly, the authors should decide what their main focus of the study is. Is it the effect of macrophytes on evaporation or is it the different estimation methods? At the moment, this is not clear. I would suggest the former to be the more interesting subject." gives relevant advice to the authors.

In revising the manuscript, authors may challenge the concept that there is a single 'potential evaporation' metric that applies to all vegetation or open-water surfaces: the presence of water plants in Class A pans will influence surface temperature (hopefully you have some data on this) and hence evaporation. Clarifying the physical basis of this effect will be more relevant for future authors than a comparison of 'interpolation techniques' within the existing data set (with little confidence in using results elsewhere.

According to the RC-6 reviewer's advice (this is his second term), the clarified physical basis of the pan with submerged macrophyte was added to the manuscript. See below. At the same time, we omit the Fig. provided in the answer of RC1. Instead, the analysis below completes the manuscript.

The aim of the study will be clarified as previous answers present it.

To M & M

In the last vegetation period, to detect vertical T_w profiles, four fastened thermistors of Delta Ohm HD-226-1 (accuracy: 0.3ºC) collected the temperature data at 0.05, 0.10, 0.15 m depth from the pan bottom and on the water surface, at 10-min intervals. Hourly averaged T_w values were used in the analysis. To present diurnal variation in T_w and stratification, sample days were selected for clear-sky, calm, and cloudy weather conditions.

To Results

On the basis of daily variation of T_w in different depth, two time-periods were distinguished (Fig. 1); daytime (7:00 – 18:00 h, LMT) and nighttime cooling (19:00 – 6:00 h, LMT).
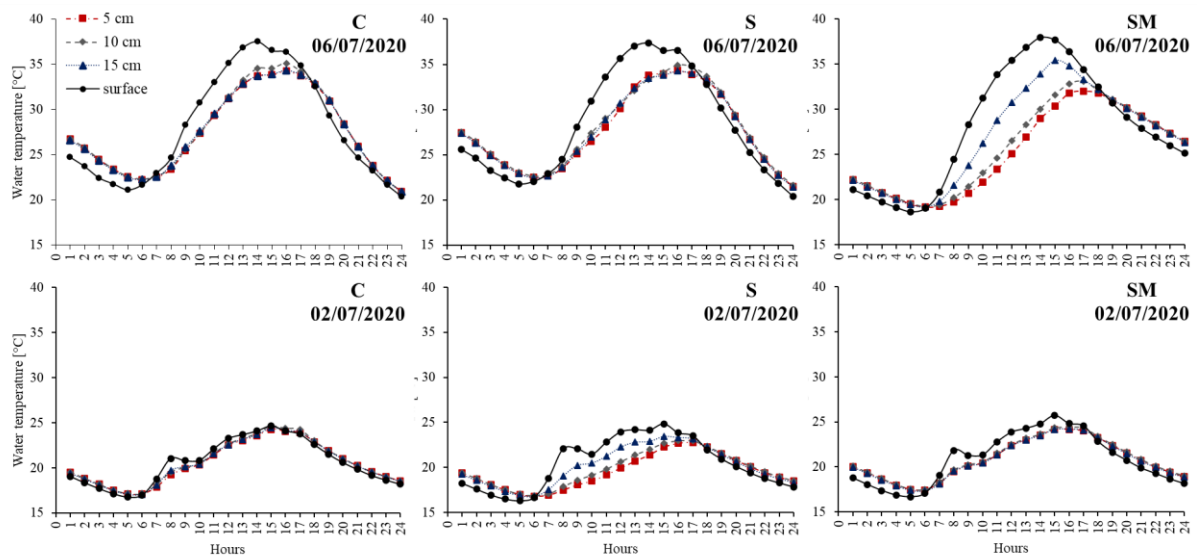
Fig. 1 Water temperature of different pan treatments (C – Class A pan/control; S – Class A pan with sediment covered bottom; SM – Class A pan with submerged macrophyte) in clearsky and cloudy sample days

On clear sky conditions, the surface T_w peaked at 14:00 h, irrespective to treatment. The magnitudes of surface T_w in daytime (between 07:00 and 14:00 hours) increased from 21.6 to 37.5ºC in C, from 23.0 to 37.4ºC in S, and from 19.8 to 38.0ºC in SM. Then, with declining solar radiation, the T_w slightly decreased during the nighttime cooling to 21.2, 21.8 and 18.7ºC in C, S and SM, respectively, until sunrise. In deeper water depth, a similar pattern of T_w with slightly smaller magnitudes was measured with time lag of 1-to-2-hours from the surface T_w. In classic A pan, the T_w in deeper depth from the surface did not reduce as rapidly as T_w in seeded pans. On cloudy days, insignificant T_w differences less than 1ºC (p=0.059 - 0.969) between the neighbouring layers were observed in every treatment.

To Discussion

Daily mean T_w increases were 5.4 and 4.5ºC in S and SM, respectively, compared to C during clear-sky conditions. Despite the less intense stratification on overcast days, T_w of seeded pans was 5.4ºC higher than that of daily mean T_w of C.

Increased stratification was evident in daytime, but the number of layers strongly depended on macrophyte presence. More moderate T_w layer differences were also present at night. The stratification was the most intense with 3 significantly different layers (p<0.001) in seeded pans, during clear-sky daytime. At the same time, the number of layers with varied T_w was only 2 (p<0.001 – p=0.012) in classic A and sediment covered pans. Results in the study were confirmed by Andersen et al. (2017) concluding that shallow lakes colonized by submerged macrophytes strongly stratify the water body, mainly during the daytime. The reason of this stratification is the dissipating turbulent kinetic energy and absorbing heat (Vilas et al., 2018). The plants may act as a barrier to seeded pans water mixing, attenuating underwater light, thereby enhancing the thermal stratification inside the pan's water column.

The strength of stratification, the daily mean T_w differences between the surface and bottom water were 2.5 (p=0.005), 3.0 (p<0.001) and 6.5°C (p<0.001) in C, S and SM, respectively, on cloudless days. At night-time cooling, variation in T_w between different layers was less pronounced, remaining below 1°C (p<0.001 – p= 0.005).

In addition to stratification, the macrophytes have strengthened the daily variation of T_w in different depth. A 0.3°C increase in daily mean surface T_w of seeded pans related to C was obtained during daytime, with variation ($T_{max} - T_{min}$) of 18.4 and 19.3°C in C and SM, respectively. On the bottom, an opposite trend in daytime mean T_w was detected; the seeded pans T_w in 0.05 m depth was 3.1°C (p=0.040) cooler than that of the T_w of C. Probably the macrophyte presence resulted in insufficient downward heat transport, maintaining the more stratified water body of seeded pans. Herb and Stefan (2004) also found reduced turbulent mixing in shallow Otter Lake, Minnesota, with rooted macrophytes. The authors observed that T_w fluctuations at 20 cm depth were 3°C in open water and 4.5°C in lake water with macrophyte cover. Evapotranspiration functions of SM fitted to surface T_w evolution; the higher the surface T_w, the more intense the E_p rate was measured in SM related to E_p of classic A pan.

To Conclusion

Macrophyte induced thermal stratification in water bodies (lakes/evaporation pans) emerge only in the vegetation period, during macrophytes development. One less layer in Classic A pan compared to macrophyte seeded pans was probably due to modified T_w stratification causing changed water column stability. Wider T_w values induced dynamics presented in the macrophyte seeded pans demonstrated the possibility of developing a more heterogenous environment for aquatic ecosystems. Macrophyte induced modified thermal stratification with higher surface T_w could explain the increased E_p in seeded pans. Modified E_p of seeded pan made those values closer to the E_p of natural lakes with submerged macrophytes. While T_w stratification trend in SM was similar to that of natural shallow lake's one, it may also provide a new consideration for routine hydrometeorological management. T_w distribution in macrophyte covered lakes impacts other physical properties such as nutrient cycling, dissolved oxygen etc. When treating E_p from a pan to that from a vegetated surface including lakes or other aquatic habitats, to improve evaporation estimation, multidimensional approximation is necessary offering simple methods for end-users including hydrologists, meteorologists, or any other specialists.

To References

Vilas M.P., C. L. Marti, C. E. Oldham, M. R. Hipsey, 2018. Macrophyte-induced thermal stratification in a shallow urban lake promotes conditions suitable for nitrogen-fixing cyanobacteria. Hidrobiologia, 806:411–426, https://doi.org/10.1007/s10750-017-3376-z

Andersen, M. R., K. Sand-Jensen, R. Iestyn Woolway & I. D. Jones, 2017. Profound daily vertical stratification and mixing in a small, shallow, wind-exposed lake with submerged macrophytes. Aquatic Sciences 79: 395–406.

William R. Herb & Heinz G. Stefan (2004) Temperature Stratification nand Mixing Dynamics in a Shallow Lake With Submersed Macrophytes, Lake and Reservoir Management, 20:4, 296-308, DOI: 10.1080/07438140409354159

Sincerely,

Brigitta Simon-Gáspár et al.