nature portfolio

Peer Review File

Rapid decline of Caspian Sea level threatens ecosystem integrity, biodiversity protection, and human infrastructure

Corresponding Author: Dr Simon Goodman

This file contains all editorial decision letters in order by version, followed by all author rebuttals in order by version.

Attachments originally included by the reviewers as part of their assessment can be found at the end of this file.

Version 0:

Decision Letter:

** Please ensure you delete the link to your author home page in this e-mail if you wish to forward it to your coauthors **

Dear Dr Goodman,

Your manuscript titled "Rapid Caspian sea level decline requires dynamic spatio-temporal conservation planning to keep biodiversity protection measures relevant" has now been seen by our reviewers, whose comments appear below. In light of their advice we are delighted to say that we are happy, in principle, to publish a suitably revised version in Communications Earth & Environment.

We therefore invite you to revise your paper one last time to address the remaining concerns of our reviewers. At the same time we ask that you edit your manuscript to comply with our format requirements and to maximise the accessibility and therefore the impact of your work.

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We hope to hear from you within two weeks; please let us know if you need more time.

Best regards,

Alice Drinkwater, PhD
Associate Editor
Communications Earth & Environment
@CommsEarth

REVIEWERS' COMMENTS:

Reviewer #1 (Remarks to the Author):

The topics discussed in the submitted manuscript are very interesting because it aims to assess to value the negative effects of sea level decline on marine ecosystems and human ecosystems in the Caspian Sea.
The introduction is complete and represents a good background for the entire manuscript.
The methodology is correcty and well detailed in data analysis.
Results and Discussions are clearly developed about the resulting data and well supported by figures and tables.
The conclusions are consistent with the contents of the paper being of great interest for international readers and, also, for the whole scientific community.
Figuers and tables are informative and well inserted in the text.
The references are appropriate and detailed.

Specific Comments
- Pag. 9 Line 1: in Figure 2, it is necessary to enlarge frame e) for a better comprehension of the scripts inside the frame.

Reviewer #2 (Remarks to the Author):

The article is well written and engages the reader, even for those located far from the Caspian Sea.

The decline of the Caspian Sea level (CSL) is not inherently new information, but the innovation lies in a comprehensive examination of alterations in biodiversity, the condition of protected areas, and the anticipated deterioration in human well-being resulting from the decline of CSL and subsequent biodiversity loss. Therefore, there is no question that the paper will be interesting to a wide spectrum of readers and hopefully will affect the field of knowledge, especially of those involved in strategic decisions.

The authors' primary practical conclusion is that “Addressing CSL decline impacts on biodiversity will require adaptive, temporally dynamic approaches to spatial conservation planning. Rather than having fixed spatial boundaries, protected areas will need to track shifting species ranges and ecosystems over time.”

This is a sound and well-grounded conclusion. However, while the title suggests a focus on "spatio-temporal conservation planning" in relation to biodiversity protection strategies, the article actually covers broader topics, including the impact of CSL decline on "human infrastructure and activity." The paper does not specifically emphasize these aspects, but environmental circumstances and biodiversity do indeed influence human well-being. Thus, these features have only an indirect bearing on the title (which only regards measures of protection of biodiversity). In other words, either the title is too narrow or the offered content is too broad. It is advisable to maintain the content in its current form while considering a more suitable title.

The work is methodologically sound and acceptable with minimal revisions.

Minor note: Alongside their comprehensive literature analysis, I would recommend the latest study by Lahijani, H.A., Ghaffari, P., Leroy, S.A., Beni, A.N., Yakushev, E.V., Abtahi, B., Saleh, A. and Behravesh, M., 2024. A note on the silent decline of the Caspian environment. Marine Pollution Bulletin, 205, p.116551.

Reviewer #3 (Remarks to the Author):

This study is important and timely. Desiccation of Northern-Eastern and Northern part of the Caspian Sea can, indeed,

poses problems as for nature conservation so for human economic activities now and in the future. Focus of the study is a response of important biodiversity areas of different types, including marine and coastal areas, protected areas and areas of charismatic species like Caspian seal and sturgeon and of infrastructure objects, like ports, oil/gas extraction fields to changes in the Caspian Sea level (CSL). The paper is written in clear language, gives a lot of quantitative information and has nice Figures. Russian abstract is a very good idea, because it will widen the auditorium of the paper.
We certainly recommend this paper for publication in “Communication Earth and Environment”. Further comments and suggestions are directed for improvement of the manuscript.

General comments/suggestions
Scenario of 18 meters decline of CSL in the next 75 years (appr. 25 cm a year) looks a bit of extreme and alarmistic. Water extraction in the Caspian Sea basin is now decreasing and only two of CIMIP5 and CIMIP6 models demonstrate such a radical climate change over South Eastern Europe under most extreme emissions scenarios and socio-economic scenarios (Koriche et al., 2021). We suggest to show at response Figures not only extreme scenario decline in CSL, but as well modest emissions scenario (RCP 4.5/SSP2) CSL decline in 2100. Generally, having (may be) graph (even simplified) with timing of CSL future change would help.
There is a plea for international cooperation to cope with negative consequences for CSL decline in Discussion. We think that it will be good to have (may be in Supplement?) also response Figures for biodiversity areas and infrastructure by countries, so national authorities (first of all In Kazakhstan and Russia) would be informed on emergency of situation.
The part on observed recession of shoreline in 2001-2022 is falling out structurally from the paper. One can see in results that Komsomolsky Bay biodiversity area disappeared and that a Caspian seal moulting aggregation moved from here approximately 5-7 km westwards in one year. However, it is unclear 1) how it is related to the next part of the paper (future changes) and 2) if this recession had an impact to number of Caspian seal population. Is decline of population of sturgeon registered somehow due to the recession in the last two decades?

Minor comments

Page 5 line 7. It is not clear what is typical ice coverage at Figure 1. Is it a light violet?

Page 7 lines 33-35 “The first cloud-free image closest to the 15th 33 day of each month was selected for analysis. In QGIS, for each image, within a polygon with bounds 47.12° N, 53.43° E to 45.27° N, 52.05° E, the coastline was digitised manually to distinguish separate land and water polygons”. Digitalization procedure should be described in Supplement and uncertainties of digitalization should be estimated.

Line 29 in References has a typo.

We wish all the best to the authors
Sergey Berdnikov and Sergey Venevsky, Southern Scientific Centre of Russian Academy of Sciences

Review for the paper

"Rapid Caspian sea level decline requires dynamic spatio-temporal conservation planning to keep

biodiversity protection measures relevant"

Court et.al.

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We wish all the best to the authors

Sergey Berdnikov and Sergey Venevsky, Southern Scientific Centre of Russian Academy of Sciences

Response to reviewers – Court et al. COMMSENV-24-3770-T

We thank each of the three reviewers for their overall positive evaluation of the manuscript and enthusiasm for the quality and novelty of the work – it is much very much appreciated to receive such supportive comments.

Reviewer #1

Specific Comments

- Pag. 9 Line 1: in Figure 2, it is necessary to enlarge frame e) for a better comprehension of the scripts inside the frame.

Response: We agree – we have now revised Fig 2 by:

i) Adding data for 2023-24
ii) Adding an extra row within the figure, with the plot element now extending across 2 columns – this increase in size should make the axis numerals more legible.
iii) In addition, we have included additional satellites images for 2023 and 2024 since further rapid costal regression occurred in these years.
iv) To balance the layout, we added an additional photograph of seal moulting aggregations in reed beds from ground level.
v) We checked that the text of the figure is legible when printed sized for A4 pagination in landscape orientation. The full resolution electronic version of the figure is twice this size.

Reviewer #2

"…title suggests a focus on "spatio-temporal conservation planning" in relation to biodiversity protection strategies, the article actually covers broader topics, including the impact of CSL decline on "human infrastructure and activity." The paper does not specifically emphasize these aspects, but environmental circumstances and biodiversity do indeed influence human well-being. Thus, these features have only an indirect bearing on the title (which only regards measures of protection of biodiversity). In other words, either the title is too narrow or the offered content is too broad. It is advisable to maintain the content in its current form while considering a more suitable title."

Response: We thank the referee for this comment, and agree it is appropriate to broaden the title. Consequently, we suggest modifying the title to: "**Rapid decline of Caspian Sea level threatens ecosystem integrity, biodiversity protection, and human infrastructure**"

Minor note: Alongside their comprehensive literature analysis, I would recommend the latest study by Lahijani, H.A., Ghaffari, P., Leroy, S.A., Beni, A.N., Yakushev, E.V., Abtahi, B., Saleh, A. and Behravesh, M., 2024. A note on the silent decline of the Caspian environment. Marine Pollution Bulletin, 205, p.116551.

Response: Done - we are happy to add this reference.

Review #3

Scenario of 18 meters decline of CSL in the next 75 years (appr. 25 cm a year) looks a bit of extreme and alarmistic. Water extraction in the Caspian Sea basin is now decreasing and only two of CIMIP5 and CIMIP6 models demonstrate such a radical climate change over South Eastern Europe under most extreme emissions scenarios and socio-economic scenarios (Koriche et al., 2021). We suggest to show at response Figures not only extreme scenario decline in CSL, but as well modest emissions scenario (RCP 4.5/SSP2) CSL decline in 2100.

Response: We suggest that the referees may be misinterpreting our results, since the maps and graphs already do show the outcomes for the range of sea level decline (-2.5m to -18m) estimated by recent studies (Koriche et al., 2021; Nandini-Weiss et al., 2019; Samant & Prange, 2023) for the modest emission scenarios. The maps use colour shading to indicate bathymetry contours in 2.5 decline increments -2.5m to -18m, while the graphs explicitly give reduction values for these increments. We are not presenting results only for the -18m scenario, and do not imply a final definitive outcome of -18m. Nor do we tie the results to specific climate/emissions scenario due to uncertainties over future emission trajectories.

Our intention was not to be alarmist, and feel that we already adequately highlight areas of uncertainty and discuss the results in terms of both expected maximum declines under extreme scenarios, and declines which are suggested as most likely under currently anticipated moderate scenarios. For instance, we introduce the range of decline projections at p4 lines 34 to 37 and p6 lines 28-36, and discuss our results in this context, p11 line 35 to p12 line 11.

Generally, having (may be) graph (even simplified) with timing of CSL future change would help.

Response: We did consider this possibility when drafting the original manuscript. However, due to the uncertainty in the current climate models, and the sensitivity of Caspian Sea Level decline rates to the trajectory of emission scenarios (the outcomes of which depend on uncertain future international governmental action on emission reduction), we feel that at this time it is not possible to reliably forecast decline timelines, and there is a danger of providing potentially misleading/uncertain information to policy makers. We are therefore not comfortable to include such a graph at this time, but we do make a comment about timelines (p12 lines 3-11) and their uncertainty in the discussion. Hopefully as model uncertainty is reduced in future work, it will be possible to provide more robust predictions on sea level reduction timelines.

There is a plea for international cooperation to cope with negative consequences for CSL decline in Discussion. We think that it will be good to have (may be in Supplement?) also response Figures for biodiversity areas and infrastructure by countries, so national authorities (first of all In Kazakhstan and Russia) would be informed on emergency of situation.

Response: Thanks for this suggestion. We have now added a table of total reductions in EBSA and MPA coverage by country to the main manuscript (see Table 1), and appropriate comments in the main text p7 lines 31-33, p8 lines 20-22. Further detail was also previously given in the Supplementary information.

The part on observed recession of shoreline in 2001-2022 is falling out structurally from the paper. One can see in results that Komsomolsky Bay biodiversity area disappeared and that a Caspian seal moulting aggregation moved from here approximately 5-7 km westwards in one year. However, it is unclear 1) how it is related to the next part of the paper (future changes) and 2) if this recession had an impact to number of Caspian seal population. Is decline of population of sturgeon registered somehow due to the recession in the last two decades?

Response: We feel that the evaluation of coastal recession in the northeastern Caspian is a foundational part of the story we tell in this paper. We included this component to demonstrate that CSL reduction is already driving impacts on ecosystems (e.g. loss of reed beds), displacement of species and elimination of ecologically significant areas (e.g. the Komsomol Bay EBSA) – in our view it foretells what can be expected in future as CSL progresses. The rest of the paper is then projecting

the consequences of further declines. We have made some minor edits to the text to try and make this link more explicit where appropriate.

Unfortunately linking coastal recession to impacts on Caspian seal numbers and declines in sturgeon is beyond the scope of the current paper, but it will be important to explore this in future work.

Page 5 line 7. It is not clear what is typical ice coverage at Figure 1. Is it a light violet?

Response: No, the pink polygon is the Caspian Seal Breeding IMMA, and is included to highlight to the reader the seal breeding habitat on the winter ice sheet. The definition of this polygon is given in the legend to Figure 1.

Page 7 lines 33-35 "The first cloud-free image closest to the 15th 33 day of each month was selected for analysis. In QGIS, for each image, within a polygon with bounds 47.12° N, 53.43° E to 45.27° N, 52.05° E, the coastline was digitised manually to distinguish separate land and water polygons". Digitalization procedure should be described in Supplement and uncertainties of digitalization should be estimated.

Response: Done. The coastline digitisation was done by manually creating water and land polygons in QGIS by identifying the land-sea boundary in the satellite image. We have added methodology for measurement error estimation and report the results. We made replicate measurements for each image, and evaluated the mean percentage difference to quantify measurement error. The mean error was 3.6%, which is acceptable given that the pixel resolution of the images is 250m.

Line 29 in References has a typo.

Response: This was a formatting feature of the reference style used in the bibliography which indicated a contracted the author list. The bibliography is now updated to the Communications Earth and Environment house style.