Addendum Synthesis report possible impacts on water quality by future Alcolea dam

Date
1 September 2021

Number of pages
1 of 4

Contact person
Miguel Dionisio Pires

Direct number
+31(0)88 335 7720

E-mail
Miguel.Dionisio@deltares.nl

This document is an addendum to "*Synthesis report on the possible impacts on water quality by the future Alcolea dam*" produced by Deltares (reference: 11206708-002-ZWS-0002). The report, produced for the Junta de Andalucía, received after being made public external comments from two organizations. In this addendum we clarify and make adjustments as a response to these comments, when necessary, to certain calculations and conclusions that were made in the above-mentioned report.

Scope of work

Deltares was asked by the Junta de Andalucía (the client) to analyze specific information that was provided by the client with the aim to see in a quick analysis if an increase in pH could occur in the future Alcolea reservoir as an indication for an improved water quality whereby using the reservoir of Sancho as a supporting reference. This has been done to the best of our knowledge but depended on the quality on the available information and data. The latter may require to be more explicit about uncertainties on some topics in our report.

Conclusions and recommendations

In general, based on the results of this quick analysis and the information provided by the Junta de Andalucía, it is obvious that the water quality in the future reservoir of Alcolea will improve in comparison to the water quality upstream. Our study however was a quick assessment and based on limited data and literature. This comes with some uncertainties in our estimations. Whether a improved water quality is good enough to be used for agriculture or other purposes was not considered in our report. To be able to answer that question requires a more detailed study in which additional information needs to be considered. This was also highlighted in a WWF and FNCA report (Corominas et al. 2020).

We therefore recommend to:

- Improve monitoring of the water quality, preferably using continuous measurements.
- Perform a water quality modelling study for a more complete assessment
- Implement sedimentation dikes and DAS
- To compare to estimated water quality improvement to threshold values for different uses such as agriculture

Data and literature used

The documents that we received to review and use for our estimations on the future water quality in the Alcolea reservoir are:

1. 01_Estaciones_pH.pdf
2. A21 Calidad de las Aguas.pdf:
3. Ap01 A23_DIA Presa Alcolea.pdf
4. Argumentario Alcolea.pdf
5. Informe AYESA a MAGRAMA 04-07-2012.pdf
6. INFORME CALIDAD AGUAS EMBALSES DHTOP FAJA PIRÍTICA firmado.pdf
7. INFORME RIESGO HIDROLÓGICO PRESA DE ALCOLEA FINAL firmado.pdf
8. NOTA SOBRE LA INTERPRETACIÓN DE LOS VALORES PH CUENCA DEL RÍO ODIEL firmado.pdf

The report provides descriptions about the contents of these 8 documents. Furthermore, the Junta provided an excel sheet with data on water quality for 36 monitoring stations.

The scope of the assignment to Deltares was restricted and therefore did not allow us to do an intense literature review and very detailed calculations based on a dynamic water quality modelling. Neither it was asked to assess the suitability for different purposes such as irrigation. As such, care should be taken with the interpretation of the results. This was one of the major comments that we received and therefore we make some adjustments in this addendum to our report. Below we reply in more detail to the most important comments that we received.

Answers to the main comments

Calculation of pH in general
In our report, the pH of the reservoir is estimated as the mixture of different waters, taking into account only the protonic acidity, but not the fact that Al, Fe and other elements hydrolyze upon precipitation and release new protons into the medium, and therefore bringing some limitation to this simplified estimation. We consider our estimation correct, but it has some uncertainty because the release of new protons was not considered. In acidic waters with metals, the net acidity has to be considered for a more precise estimate of the pH, taking into account the protons and also the acidity resulting from the precipitation of metals. As such, the calculation of the average metal concentrations and the pH must be done together, as the precipitation of Al, Fe and other metals will produce protons, affecting the pH although it is unclear if this will be significant. We recommend to perform a complete calculation of the pH taking these considerations into account.

Contribution from other mines
A comment was made that contributions from other mines than those mentioned in the report should also be included. We relied on the information provided by the client. The exact information on which mine is still in operation and is contributing to the pollution of the rivers was not provided to us. The Junta requested to make the calculations using the information that was provided by them to simplify the analysis. In case other mines would make a significant contribution then this may cause a bias in the analysis.

Estimation of pH: dilution considering contribution from mining basins
The estimation of the contribution of the mines from the precipitation over the mining areas is a simplification and has uncertainties. It should be emphasized that the results obtained in this way can be subject to errors. We also wrote that permanent flows coming from mines have lower flows than water flows in the main river during precipitation. During periods of precipitation however, the loads from the flows of mines will increase also which could (temporarily) lead to increased acidification in the main river. How much exactly was not possible to calculate with the information provided by the client.

Calculation of pH increase in the reservoir of El Sancho and extrapolation to Alcolea
The calculation of the increase in pH of 0.91 is mentioned in a second report available at the Junta (Water quality analysis of the Sancho reservoir). The reason for the assumption of a 1.3 increase in Alcolea is due to the input (aportación):volume ratio which is about 1.3 (in Sancho it is 0.9, information given by client). The question if in the future Alcolea reservoir the pH will rise more than in the reservoir of Sancho, based on the larger volume of the Alcolea reservoir, is debatable but not unlikely. Therefore, although we expect that the pH in the reservoir of Alcolea will rise, the mentioned pH of 5.59 (and 6.39) contains several uncertainties. This is why we recommended in the report that a more intensive monitoring program should be part of the project. Also, the amount of the real effect of DAS and sedimentation dikes is difficult to predict, and the effectiveness of these measures need to be monitored as well.

pH 4.29 and metals
On page 27 of the report we wrote "*A pH of 4.29 would allow all the iron compounds to precipitate and a large part of the Aluminum, Copper, Zinc, Manganese and other compounds to precipitate, greatly favoring the increase in water quality*". This is not correct. For Iron it is still correct, but the other metals start to precipitate at higher pH levels as can be seen in the figure below (from the document "A21 Calidad de las Aguas.pdf").

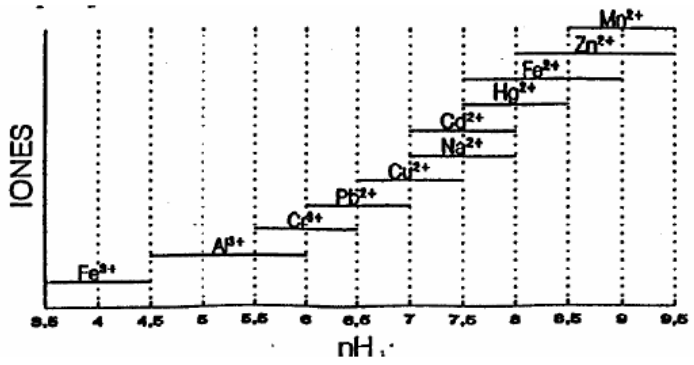

Figura 5.- pH típicos a los que precipitan algunos iones metálicos.

Therefore, at a pH of 4.29 only precipitation of Iron (Fe^{3+}) may occur but other metals may remain in solution and therefore not contribute to an improved water quality.

Relationship with precipitation (Estimation of pH: dilution considering average contribution from mines)
A comment was made that no variation of discharges was taken into account for the calculation of the pH in this section of the report. We acknowledge that considering the variation in high and low water discharges would improve the calculations but nevertheless, in that case more detailed spatio-temporal data on the concentrations of metals, pH etc, at different locations and time are needed as input for a dynamic water quality modelling. The water quality parameters are only monitored a couple of times each year and in some years no monitoring has been done. Since these data is not available it is incorrect to try to relate a set of frequently measured data (precipitation) with a set of scarcely measured data (water quality). This is why we looked at value averages. Of course, our conclusions then have to be careful. For instance, during high discharges (especially during the so called "First flush") the input of contamination coming from the mining areas may increase.
This lack of detailed spatio-temporal data is one of the reasons why we suggested to improve monitoring, preferably with continuous measurements.

pH 5.59
The value of pH 5.59 in the section "*Estimation of pH: dilution considering contribution from mining basins* was not mentioned in the conclusions but should have been so since there is at the moment no justification to mention the value of 6.39 only.

Measures
Sedimentation dikes are in our report considered to be a useful measure to retain metals from the water column because a fraction of these metals is adsorbed to suspended solids and may sink to the bottom. However, a fraction of the metals will not be adsorbed to suspended solids and these will therefore not be retained by the dikes and eventually reach the reservoir. Yet, it is still worth to implement sedimentation dikes even if it is only partly effective.

Other literature
Although it was not part of our assignment, we performed a small and quick survey on self-purification in reservoirs. The literature that we found at the time of elaboration of the report did not mention problems with acidification but did suffer mostly from organic pollution. An external comment mentioned that dynamics of metals in reservoirs has been studied and documented for the reservoir of El Sancho (e.g. Sarmiento et al. 2008, Torres et al. 2013), which we did not screen in our survey. These studies mention that although precipitation of elements occur, oxidation of the sediments during turnover periods also occurs, which releases toxic elements back into the water column. This means that although an improvement due to precipitation may take place, upward diffusion of metals during de-stratification (mixing) of the water column may lead to an increase of the metal concentrations in the water column of the reservoir. However, the water quality monitoring in the reservoir of El Sancho is not adequate enough to show these dynamics and should therefore be intensified to be able to draw such conclusions.