RC: This paper shows a comprehensive investigation of Milan – Po Plain aquifers in Italy, including detailed geology and stratigraphy, hydrochemistry, human factors, etc. The authors did a lot of field works, collected many data and conducted a huge hydrogeological model. However, in my opinion, the manuscript needs to be improved to be published on HESS. The paper structure is well-organized, but some sections remain unclear.

AC: We thank the reviewer for this general statement and comments.

RC: The introduction is vague and too focused on general aspects.

AC: We believe that the introduction should provide a background and an analysis of the state of the art to identify existing shortcomings of the subject matter. In particular, the paper discusses the relevance of a robust investigation and modelling of aquifers in urban areas. Because of the specificities of the setting, we believe it is appropriate to introduce general problems and the different approaches adopted in the literature. This is addressed as follows:

Lines 27-34 provide background information about groundwater rebound resulting from decreasing industrial withdrawals in urban areas, summarizing the major consequences and providing examples.

Lines 43-50 describe how climate changes may alter the hydrological cycle. We believe that this is particularly relevant because potential impacts of global climate changes on the groundwater are largely unknown, especially for densely populated areas where groundwater is heavily exploited for public and industrial supply. Available studies about the impacts of climate changes on groundwater resources show site-specific results and are cited.

Lines 51-59 explain why an approach employing all the available data, in order to develop a comprehensive hydrostratigraphic model based on an exhaustive parametrization, and to build a robust hydrogeological numerical model, is needed.

Lines 60 - 73 introduce the reader to the study area (i.e. the Milan Metropolitan Area) and explain why studying it is within the above mentioned scopes. The state of the art about the study area and what is the original contributions of the research with respect to the existing literature are clearly stated.

RC: The structure of this manuscript is more like a hydrogeological survey report or groundwater modeling summary, not a research article.

AC: We believe that the presented manuscript follows the typical structure of a scientific paper, including: i) an introduction to the problem, ii) the presentation of the settings, the data and the methods, iii) a summary of the results, iv) a thorough discussion showing advancements and improvements with respect to the existing literature, and v) the conclusions.

RC: Motivation is not clearly stated and the objectives are vague and of weak scientific interest. Why did you do this study and what scientific questions are answered?

I recommend fixing the main significant scientific objective, as in my opinion, the multi-dimensional approach used for the reconstruction of aquifer geometry.

AC: In our opinion, the aims of the research are clearly stated in the abstract and in the introduction, as well as the motivation for this research

The groundwater rebound in urban/agricultural/industrial areas is a serious problem in many cases, and may be boosted/buffered by climate change and consequent changes in urban and societal development.

To complete a robust analysis: (1) the aquifer geometry needs to be reconstructed, then (2) a reliable groundwater flow model based on comprehensive aquifer parametrization must be developed. The latter will allow to understand the present day conditions and to simulate future scenarios, taking into account climate change, population growth, and industrial and agricultural activities. The importance of such future-scenario simulations is self-explaining, in our opinion.

Building such models (i.e. hydrostratigraphic and flow model) for any alluvial aquifer requires the description of the aquifer heterogeneities and the spatial distribution of hydraulic parameters (lines 54-57). These analyses generally involve detailed data and significant computational efforts, as required, for example, by stochastic simulations. Thus, the proposed approach which employs available data to estimate and assign hydraulic parameters over different "homogenous" units of a 3D numerical model can be useful for these kind of analyses. A sedimentological analysis of the stratigraphic data is required to avoid simplified and unreliable approaches and to help grouping lithological layers in significant hydrostratigraphic units. The attribution of hydraulic parameters following the qualitative description of single layers as from the drilling phases is often affected by the subjectivity in the description. Recognition of specific sedimentological and stratigraphic sequences adds meaning and robustness to this work. We present a complete approach that can be followed and replicated by other researchers in this and in similar areas. Therefore, we consider this an important scientific point addressed in this manuscript.

RC: Note that the objectives of this paper are differently stated in the abstract and in the Introduction.

AC: We agree that the objectives of the paper are structured in different way in the abstract and in the introduction. For sake of simplicity, we decided to modify the objectives in the introduction to fit the corresponding aims in the abstract.

RC: The objectives and conclusions do not represent a relevant advance to scientific knowledge related hydrogeological characterization. I encourage the authors to address the scientific issues, restructure the manuscript and resubmit the paper. Because it is a research article instead of a report, the authors are expected to explain why Milan - Po Plain aquifers are important and interesting to study in a scientific point of view, not only for the need of groundwater managing purposes. These aspects have to be clarified and illustrated in the manuscript.

AC: In the following we try to answer to the reviewer questions but it is possible that, because of language problems, we do not fully understand his/her observations and comments.

Since the importance of studying the Milan – Po plain aquifer (and in general alluvial aquifers beneath large cities affected by groundwater rebound) seems to be somehow hidden in the paper, some aspects are not better explained in the introduction.

Rising groundwater levels in large cities due to a decline in groundwater exploitation is a serious problem with significant social, environmental and economic implications, and glacial outwash deposits are important sources of groundwater in various areas surrounding alpine chains. This is quite relevant for the areas around the European Alps where very large cities developed with an enormous social and economic value. Accordingly, we believe that the proposed approach could be adopted for designing models aimed at regional groundwater management purposes.

The methods and general approach are illustrated for the aquifers of the Milan Metropolitan area. These represent an important groundwater resource for a very large population (ca. 5 million people, half the population of Lombardy region) and a highly industrialized area (listed as the fourth European city for GDP). Nevertheless, a groundwater flow model capable to capture the overall groundwater dynamics (both in steady and transient state) based on a comprehensive aquifer reconstruction and parametrization is still lacking (lines 66-74).

RC: The authors used a great proportion of the words in this manuscript to introduce and describe the field works and data collections, data treatment, conceptual model description and model results.

AC: Sorry we do not understand this statement. Field work is not described in the manuscript. On the contrary, we clearly present the available and used datasets and explain all the methods to make the approach understandable as well replicable, as requested for a scientific study.

RC: Again, I would recommend the authors to focus on the discussion of main significant scientific objective, i.e. the reconstruction of aquifer geometry and how this can be assessed by means of groundwater modeling.

AC: The discussions, which is quite a relevant part of the paper, is focused on the different objectives of the research, as listed in the introduction: hydrostratigraphic modeling (lines 470-500), hydraulic

parametrization and groundwater model design (lines 501-551), groundwater flow modeling and processes identification (lines 552-599), and finally future scenarios (lines 600-613). For each of these topics, we clearly state the problems, advantages and disadvantages of the methods and discuss the results.

In our opinion, the exhaustive hydraulic parametrization and its implementation into the 3D finite element model, the comprehensive budget analysis, and the simulations of future scenarios are significant to accomplish the established scientific objectives including the validation of a method for the hydrostratigraphic reconstruction and the groundwater model setting.

RC: The Results and Discussion sections are too long and show repeated information and the resulting redaction is unclear. These sections have to be rewritten and shortened.

AC: We will try to clean the discussion by deleting possible duplications. We believe that the results section is clear and concise, whereas the discussions section explores the significance of the results of the work and analyses the significance of the findings in terms of paper topics, approaches and methods.

For example, section 5.3 (results) describes the numerical results of the groundwater flow model. First describes the quality of the steady-state numerical model in terms of residual errors (lines 416-423), the validation results (lines 423-426), and the resulting budget (lines 428-441). Then, in similar way the results of transient numerical model and future scenarios are described (lines 442-461).

In section 6.4 (discussions), the significance of the modelling results is stressed in relation to paper topics (i.e. groundwater rebound, effect of withdrawals and recharge changes).

RC: The Discussion Section is a description of how the numerical model was constructed and performed, and how this is supported by the literature. The rest is a general overview of the results of the model versus measurements (heads, river outflows, recharge . . .) and also the result of the future scenarios simulations.

AC: The model construction is reported in the methods not in the discussion. In our opinion, the discussion section explores all the produced outcomes from the hydrostratigraphic reconstruction to the future scenario simulations results, not only the model construction. Each discussions subsection is more speculative with respect to the results subsections. Anyway, as said above, some parts will be shortened to make the text crispy and keep the focus on discussing the results and methods, as well as the differences with respect to previous studies.

Section 6.1 describes how the multi-dimensional approach allows the aquifer geometry reconstruction. The differences with previous hydrogeological models are stressed.

Section 6.2 describes both advantages and limitation of methodologies used for the aquifer parametrization. Then the section explains how the results can be implanted into the 3D groundwater model to define nearly-homogenous subunits.

Finally, suggestions for the adoption of the hierarchical classification jointly with the hydraulic parametrization (i.e. empirical equations) for geostatistical or stochastic simulations are presented (lines 252-533).

Section 6.3 explores the significance of the estimated Transimissivity-Specific Capacity relationships (equations 7 and 8). Then criteria and precautions are suggested for the adoption with both equations in the hydraulic parametrization of alluvial aquifers. Unfortunately, such type of relationships are still required at many places because of the incomplete investigation techniques adopted in the past for aquifer parametrization.

Section 6.4 explores the obtained groundwater modeling results. This section describes what numerical model results tell us about aquifer processes and the implications on both groundwater level and quality. We will delete the most general statements from the discussion following the suggestions by the reviewer. Differences and similarities, with respect to previous published groundwater models, are stressed as well.

Section 6.5 explores the results of the scenarios simulations. This is significant because hydrogeological studies generally show very site-specific results.

RC: Section 4.4 (Model Calibration) is weak. No relevant comments about the methodology used for calibration.

AC: Section 4.4 clearly states how model calibration is achieved (i.e. by means of inverse procedure and by using observation points). It is largely known that the calibration of a groundwater flow model is performed by varying the values of one or more parameters (i.e. hydraulic conductivity, storativity) until simulation results and measured values agree. The results of the calibration in terms of quality of the results is reported (lines 418-422 and 449-455 for steady and transient model, respectively).

RC: No relevant comments are focused to justify the obtained model calibration statistics.

AC: We will add some comments about obtained calibration values.

RC: No comparison between the initial (conceptual model) and calibrated parameters (K, Ss, Recharge, etc.). No comparison between initial groundwater budget derived from conceptual model statement (in the whole or in a certain period) respect the obtained by modeling. Some of these issues are weakly illustrated in some parts of the text and in some figures, but I consider that an integrative and detailed explanation is needed.

AC: The comparison between initial and calibrated parameters is shown in Table 4. Recharge has not been calibrated, hence no comparison is required in the discussions section.

No sensitivity analysis of the parameters used in the model is commented.

We agree with the reviewer. No sensitivity analysis is presented. It could be interesting to stress the sensitivity of hydraulic parameters even if not a major scientific aim. We will add some sentences in the results section.

RC: It is interesting to state any trends of hydrochemistry data variation along time, related to changes in land uses and anthropogenic factors. And a specific discussion of the effect of contamination/pollution/human factors to data is desired.

AC: This is not the aim of the paper. For details about hydrogeochemical characterization of the study area see https://doi.org/10.1016/j.jhydrol.2017.02.025

Some sentences about the possible effects of groundwater rebound on groundwater quality in urban settings are presented in the introduction and re-discussed in the discussions. Actually, this is part of a forthcoming work.

RC: Authors have to explain how the reconstruction of aquifer geometry can be assessed by means of groundwater modeling and justified by means of a sensitivity analysis.

AC: See comments above. In any case the need for a robust hydrostratigraphic reconstruction cannot be by-passed by simply looking at model sensitivity.

RC: Conclusions are too general and obvious. The authors do not need to mention the results of the numerical model in the conclusion part.

AC: The conclusions section describes the progress with respect to the available research and the critical elements of the proposed investigation, including the most relevant results. This is what commonly accepted in the writing of scientific papers. Accordingly, the comparison between historical groundwater level pattern and future scenarios (i.e. lines 625-629) in our opinion can be considered a critical element.

RC: Authors could use the last section of the paper to extend their discussion to make clear the new contributions that the manuscript supports. Include important implications of your work on the scientific community and also for local groundwater management.

AC: We agree with the reviewer. We will modify the conclusions section by including some general implications for the scientific community and for local groundwater management. In any case, we consider the discussions different from the conlcusions.