



DOLORS LOPEZ GODALL, jefa de la Secretaría de Estudiantes y Docencia de la Facultad de Biología de la Universitat de Barcelona,

HACE CONSTAR:

Que **Álvaro Javier Moyano Salcedo**, con NIE Y8850958C y pasaporte AW861067, ha cursado y finalizado el **programa de Doctorado en Ecología, Ciencias Ambientales y Fisiología Vegetal**, desarrollado en el marco del Espacio Europeo de Educación Superior (EEES), en la Facultad de Biología de la Universitat de Barcelona.

Que el citado programa establece como lenguas oficiales de docencia y comunicación científica el **catalán**, el **castellano** y el **inglés**.

Que el doctorando **optó por desarrollar íntegramente su doctorado en inglés**, incluyendo la totalidad de los siguientes elementos:

1. **Elaboración y redacción completa de su tesis doctoral en inglés**, bajo el título:

“Causes, effects, and management of river salinization in Spain with special attention to wastewater treatment.”

2. **Defensa pública de la tesis en inglés**, realizada el 15 de enero de 2025, ante un tribunal internacional compuesto por:

Presidenta – Dra. Eugenia Martí Roca (CEAB–CSIC)

Secretario – Dr. Francesc de Paula Sabater Comas (UB)

Vocal – Dr. Juan David González (Universidad Nacional de Colombia)

3. El doctorando recibió la calificación de **“Sobresaliente cum laude”** y solicitó formalmente la **Mención Internacional**, para la cual presentó todos los requisitos exigidos, entre ellos:

Una **estancia internacional de investigación documentada**. El doctorando realizó una **estancia global de investigación de seis meses**, repartida entre **Australia, Alemania y Estados Unidos**, en instituciones académicas y de investigación de reconocido prestigio. Se adjuntan a esta certificación los documentos acreditativos de dichas estancias, presentados previamente ante esta Secretaría como parte del expediente académico del doctorando.

Dos informes favorables emitidos por evaluadores externos internacionales, en inglés. Se adjuntan los informes favorables emitidos por investigadores internacionales expertos.

Participación de al menos un evaluador internacional en el tribunal de defensa de la tesis.

4. Durante cada año del programa, y como requisito para la continuidad académica, el doctorando presentó **informes anuales escritos y exposiciones orales** de avance del plan de tesis ante una **comisión de seguimiento internacional**, compuesta por:

Portavoz: Núria Bonada (Universitat de Barcelona, España)

Vocal 1: Sujay Kaushal (University of Maryland, EE. UU.)

Vocal 2: Lorenzo Proia (Universitat de Vic, España)

Todos los informes, presentaciones y comunicaciones administrativas con la comisión se realizaron en inglés. Se adjunta el informe final de la comisión de seguimiento.

5. El doctorando cuenta con una sólida producción científica en inglés, resultado de su tesis doctoral, incluyendo la publicación de tres artículos en revistas científicas indexadas en el cuartil Q1 (Scimago o JCR) y presentaciones en cuatro congresos internacionales, todos en dicho idioma.

A efectos de acreditar el idioma utilizado en el desarrollo de su doctorado, y a petición del interesado, se expide la presente certificación.

Barcelona, 23 de enero de 2025



Dolors Lopez Godall

Jefa de la Secretaría de Estudiantes y Docencia

Facultad de Biología

Universitat de Barcelona

Programa de Doctorado en Ecología, Ciencias Ambientales y Fisiología Vegetal

Certificado: University of Canberra, Canberra Australia



Canberra, September 05, 2023

Professor Ben Kefford of the University of Canberra, Australia, certifies that Alvaro Javier Moyano Salcedo has carried out a research internship at our institution from 14 to 26 July 2023, as part of the project called "GlobSalt", which aims to model global river salinization. Alvaro participated in a series of meetings where discussions focused on river dynamics in Australia. He presented a seminar on his work related to temporary river salinization and the effects of salinization in interaction with other pollutants (e.g., nutrients) on aquatic communities.

In addition, he was actively involved in data collection, processing and database development, including physicochemical parameters of rivers at the Australian scale and macroinvertebrate community data. These efforts were highly relevant to the achievement of the project objectives.

We hereby certify that Alvaro Javier Moyano Salcedo has successfully completed his research internship at our institution and that his contributions have been instrumental in the development of our GlobSalt project.

We wish Alvaro Javier Moyano Salcedo all the best in his future academic and professional endeavors.

Signed:

Ben Kefford
Professor
University of Canberra
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ABSENDER



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To whom it may concern

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Research Visit Certificate

Landau

07.09.2023

Ihr Zeichen

Ihre Nachricht vom

Unsere Nachricht vom

Unser Zeichen

I hereby certify that Alvaro Javier Moyano Salcedo has carried out a research internship at our institution from 28 Augst to 1 September 2023, as part of the project "GlobSalt", which aims to model global river salinization. Alvaro participated in meetings where discussions focused on river dynamics in Germany and worldwide. In addition, he was actively involved in data collection of physicochemical parameters of rivers in Germany.
We wish Alvaro Javier Moyano Salcedo all the best in his future academic and professional endeavors.

Dr. Elisabeth Berger
Juniorprofessor
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Certificado: University of Maryland, EE. UU.



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Maryland, September 03, 2024

I hereby certify that Álvaro Javier Moyano Salcedo has completed a research stay in our department from September 15 to December 15, 2023. This stay was part of the project titled "GlobSalt," which aims to model global river salinization. Additionally, Álvaro worked with me on compiling and analyzing data regarding the effects of salinity in wastewater treatment plants and their contributions of salt ions to streams and rivers.

Álvaro participated in a series of meetings focused on river dynamics in the USA, particularly pollution issues such as freshwater salinization. He also took part in a water taste test at a water treatment plant experiencing salinization, a project associated with the Occoquan Watershed Monitoring Lab at Virginia Tech. As a result of the research stay and the work completed, his contributions are highlighted in the articles presented in his doctoral thesis: Chapter I, titled "GLOBal river SALiniTy and associated ions (GlobSalt)," and Chapter IV, titled "Assessing the effects of salinity on microbial communities and pollutant removal in urban wastewater treatment plants."

We wish Álvaro Javier Moyano Salcedo all the best in his future academic and professional endeavors.

Signed:

A handwritten signature in cursive script that reads "Sujay Kaushal".

Sujay Kaushal
Professor
University of Maryland
Email: skaushal@umd.edu

Informe evaluador: University of Coimbra, Portugal



Departamento de Ciências da Vida
FCTUC FACULDADE DE CIÊNCIAS E TECNOLOGIA
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REPORT ON THE DOCTORAL THESIS of Alvaro Javier Moyano Salcedo

The Doctoral Thesis of Alvaro Javier Moyano Salcedo, supervised by Dr. Miguel Cañedo-Argüelles Iglesias (IDAEA-CSIC) and Prof. Dr. Humbert Salvadó Cabré (Universitat de Barcelona), entitled “Causes, effects, and management of river salinization in Spain with special attention to wastewater treatment” deals with a main global and timely problem: freshwater salinization. It gives important contribution to the clarification of global patterns of rivers’ salinization, its geographic and temporal variability, on its primary and secondary causes and consequences, and provides valuable insights on possible interactions with another pervasive environmental stressor - nutrients. The thesis also considers the salinity effects on urban wastewater treatment plants (WWTPs), its impacts on microbial communities and pollutant removal efficiency. Finally, the document translates the author’s concern about this geographically expanding and intensifying problem while providing important suggestions, within distinct contexts and to several social groups, for ecosystems’ management and mitigation strategies. The performed study integrates *in silico*, field and laboratorial work that contribute to achieve the main established goals.

This thesis presents a sound and high-quality scientific work. Its quality is evident in terms of publications: one submitted (Scientific Reports) and three already published (Hydrobiologia, Science of The Total Environment, Journal of Water Process Engineering) papers in Q1 journals of high impact factor; Alvaro Salcedo is the first author in all cases.

The text is clear, but the organization and multiple subsections would have profited from a revision, particularly to avoid repetitions and redundancies across the sections. In particular, the last (important) sections (“Overall Discussion” and “General Recommendations”) could have been more concise. Also, it would seem (to me, obviously) more logical to include “General Recommendations”, where future scenarios are included, as a last section (before “References”).

Keeping in mind the high scientific quality of the thesis, I believe that the document would have deserved a uniform format. In my opinion, the performed scientific work, further translated into papers, should have been included according to the chosen editorial “thesis format”. The integration of the published papers, in their original distinct formats and with their multiple authors, should have been avoided. These papers should have been included as annexes.



Considering the thesis organization – “General Introduction”, “Objectives”, “Results”, “Overall Discussion”, “General Recommendations”, “Conclusions”, “References”, “Appendices” –, from now on, I shall refer these divisions as *sections* (and *subsections*) and the papers included in the section “Results” will be referred as *chapters*.

Considering the **Title**, I do not understand the need to include “with special attention to wastewater treatment” as this is one of the four, equally important (to me) chapters, but it is globally adequate.

Section 1. “General Introduction” is complete, updated and provides a good scientific ground for the work performed. It seems that Subsections 1.2. and 1.3/1.4/1.5/1.6 could have been coherently merged and reduced showing the outline of the thesis and ending in well-stated objectives (or giving origin in the next section – **Section 2**).

Section 3. “Results”

Chapter I (“GLOBal river SALiniTy and associated ions (GlobSalt)”) presents the construction and analyses of a solid and integrated global dataset (GlobSalt), mostly based on multiple online sources providing data on salinization of rivers. Despite some geographical and temporal bias found in available information on freshwater salinization, the gathered information, covering c.a. 20% of the rivers worldwide, allowed the identification of the global mean ($509 \pm 205 \mu\text{S cm}^{-1}$) and dominant range of rivers’ EC ($50\text{--}500 \mu\text{S cm}^{-1}$) while pointing specific geographic areas where salinity may present higher mean values. This comprehensive temporal and spatial perspective also include information on traditionally poorly considered areas such as Asia and Africa, and several water quality parameters (13) closely linked with freshwater salinization (i.e., besides EC). The final GlobSalt “optimized” dataset constitutes an important step forward the identification of more susceptible areas where protection of aquatic life must be of major concern and ecosystem management strategies should be implemented. In this chapter, the inclusion of tables and figures close to their reference in the text would have facilitated the comprehension of the methodology and results to the reader.

Chapter II (“Human activities disrupt the temporal dynamics of salinity in Spanish rivers”) corresponds to an already published paper in Hydrobiology (2023). It deals with the importance of human activities on the temporal dynamics of salinization (assessed as EC) of 91 Spanish rivers from 2007 to 2011. Based on “long-term data and high temporal resolution”, results showed agriculture as the main driver of disruption of the natural temporal variability in freshwater salinization, besides de-icing activities, mining and wastewater discharges. Results also state for the importance of interactions between multiple human pressures and EC natural temporal variability that limits the establishment of “temporal signatures” for distinct human activities. This approach constitutes an important ground for further studies on the ecological



impacts and establishment of protective measures in streams affected by EC variability promoted by distinct and/or concomitant human activities.

Chapter III ("What happens when salinization meets eutrophication? A test using stream microcosm"). This chapter corresponds to an interesting short-time microcosm experiment where the effects of a concomitant addition of salt and nutrients (several levels) on biofilm structural and functional parameters, as well as macroinvertebrates' richness and diversity, were assessed. The chapter is well constructed, the experimental design is elegant, results and discussion interesting, and figures are appealing and enlightening. Importantly, this chapter gives raise to other relevant lines of inquiry such as (particularly interesting to me) the importance of the trophic interactions on the response of aquatic diversity to salinization coupled with other stressors.

Chapter IV ("Assessing the effects of salinity on microbial communities and pollutant removal in urban wastewater treatment plants") deals with a the little explored theme of the importance of salinity on wastewater treatment process. In particular, the study focus on the salinity dynamics of (7) wastewater treatment plants (WWTPs) and its effects on the protozoa communities and pollutant removal. This is an original study that shows a reduced capacity of the WWTPs to remove EC and important deleterious effects of high EC levels and peaks on microbial communities (diversity, richness) impairing organic matter removal and the wastewater treatment process. Considering the crucial importance of the WWTPs to freshwater quality and human health, this chapter, and its conclusions, are of particular relevance.

In all chapters, data/results are well presented, the figures are careful elaborated and discussions are complete leading to relevant conclusions.

Section 4. The thesis includes an "**Overall Discussion**". This seems to constitute a further high quality discussion of each scientific "Chapter" (Section Results 3.2 – 3.5). Considering the quality of the previous chapter's discussions, I would expect a single integrative approach of the studies (eventually, but not necessarily, not subdivided by chapter) instead of a fractured, occasionally repetitive, text. In fact, as a suggestion, part of the (very good and interesting) ideas here presented could have been added to the discussion sections of each chapter, if the paper itself was not used. That would have avoided redundancies with previous and posterior sections.

Section 5. "General Recommendations". This is a useful chapter that translates acquired knowledge during the PhD and the important applicability of the performed studies, particularly in Spain. Nonetheless it would have profited from a more focused and synthetic approach. Some subsections could have been avoided (e.g. "open questions") or integrated in other (sub)sections. In parallel with several interesting and useful proposals/recommendations, some measures are also general/vague and could have been condensed.



Section 6. Conclusions are synthetic and clear! In my opinion, this section could appear before “General Recommendations”. This is, obviously, subjective.

7. References. High number of relevant and updated list of references. I assumed that these references correspond to the entire document, except sections where the papers are included (**Section 3. “Results”**: Chapters I-IV). If so, and if I’m not mistaken, some references seem to be missing (*e.g.*, Braukmann & Böhme et al. 2001?; Schröder et al., 2015; Osburn et al., 2022).

Globally, the Doctoral Thesis of **Alvaro Javier Moyano Salcedo** has very high quality standards and corresponds to a hard and serious scientific work. In accordance with the above comments, I recommend this thesis to be considered for defence to qualification for a Doctorate Degree by the Universitat de Barcelona.

Assinado por: **CRISTINA MARIA MOREIRA
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Professora Associada

Faculdade de Ciências e Tecnologia da Universidade de Coimbra

Informe evaluador: University of Rennes, France



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Rennes, January, 2nd 2025

**Report on the thesis presented by Alvaro Javier Moyano Salcedo
with a view to obtaining a Doctorate degree by the Universitat de
Barcelona**

Title of the Thesis:

Causes, effects, and management of river salinization in Spain
with special attention to wastewater treatment

1. General comments of the thesis

The document written by Mr Moyano Salcedo summarizes his work, carried out mainly in Spain but also in part on a global scale as part of documentary analyses.

The manuscript is written entirely in English, it is clearly written and easy to read. It starts with a long introduction with the state-of-the-art of literature followed by the main objectives of the thesis. The results are organized into four chapters, ranging from the global to the very local scale, with the impact of freshwater salinization on wastewater treatment plants, each chapter responding to one of the main objectives of the thesis. Each chapter is constituted by an article published or submitted to international peer-reviewed journal (*Scientific Report, Hydrobiologia, Science of The Total Environment, Journal of Water Process Engineering*). After the results, the manuscript includes a fourth section on 'overall discussion' and a fifth section on 'recommendations'. Finally, the manuscript ends with a conclusion.

2. Specific comments

- Introduction:

This section contains a very good 35-page literature review on the natural and man-made causes of salinization. Even if the section is complete as far as causes are concerned, the literature cited in the first part of the introduction is largely unbalanced with mainly very recent studies (between 2018-2024) and lacks major historical literature such as the articles by Williams, Bunn and other colleagues in Australia in the 90s or 20s for climate-related salinization and numerous articles in France and Germany concerning the extraction of natural resources. Even if some of these studies are already cited in reviews found everywhere (Cañedo-argüelles et al., 2013, 2016; Kaushal et al., 2023), some of them (e.g. the most important ones) could be cited to avoid giving the impression that nothing was done/known before 2010.

It is also strange for me to place the introduction of each chapter in the general introduction. For example, introductory section 1.3 for chapter 1, 1.4 for chapter 2 etc.... I am not familiar with the structure of PhD thesis in Spain but it would be clearer to put these sections directly as the introduction of each chapter. This will avoid chapters being made up of a single published manuscript.

Regarding the main objectives of the study, I suggest rewriting the main objective 'The main objective of this thesis is to assess the main causes and consequences of river salinization, with a particular focus on urban wastewater treatment'. Indeed, the juxtaposition of a very general objective 'the main causes and consequences of river salinization' with a very specific objective 'with particular emphasis on urban wastewater treatment' is very strange. I suggest deleting the part on wastewater, which is covered in a single chapter, and adding temporal dynamics, which is a broader objective, instead.

- Chapter I: GLOBal river SALiniTy and associated ions (GlobSalt):

This 25-page chapter corresponds to a manuscript submitted to Scientific Report in April 2024. It is based on a very impressive database containing several million of data collected in 85 countries on every continent. To improve the coherence of the chapter, I suggest adding to this chapter section 1.3 of the introduction associated with this chapter and section 4.1 of the overall discussion.

- Chapter II: Human activities disrupt the temporal dynamics of salinity in Spanish rivers:

Chapter 2 focuses on the temporal dynamics of salinization due to human activities in Spain. In the introduction, several examples of temporal dynamics in relation to human activities are provided.

Despite considerable and good works in synthesising the information, some parts of the introduction may give rise to misunderstandings. For example, in areas affected by mining activities, the introduction focuses on the impact of soil leaching, which can lead to an increase in salinity. However, I would recommend being more balanced with this assumption. This is because leaching is mostly reduced by the fact that mines are underground in many places (in the US or Europe for example), so the leaching process does not directly lead to an increase in salinity, but may only lead to an increase in saline groundwater inputs and potentially river salinity. However, when discharge is increased, salt is also diluted and salinity can potentially be reduced. The direct link between leaching and salinization is hence not obvious. Furthermore, in Europe, saltwater inputs from mining can be controlled and saltwater discharges can be controlled according to the salinity of the water in the river (see Piscart et al. 2005, 2006 as an example). As a result, there are no temporal dynamics, since saltwater inputs increase as river discharge increases in order to keep river salinity as close as possible to the limit imposed by legislation.

The manuscript published in *Hydrobiologia* in 2022 is very interesting and gives a new insight into the temporal dynamics of salinization linked to human activity in Spain.

Finally as for chapter 1, I suggest to move in this chapter the first part of the section 4.2 of the overall discussion (the part before "Assessing temporal variations in FS influenced by WWTPs using GlobSalt and HydroWaste data").

Chapter III: What happens when salinization meets eutrophication? A test using stream microcosms:

As with the previous two chapters, Chapter 3 consists of a publication (*Science of the Total Environment*, 2024) on the interaction between salinization and eutrophication. The study was carried out using a microcosm experiment. This interesting preliminary study highlighted

complex interactions between eutrophication and salinization with a potential antagonism between the two stressors and calls for further studies to better understand the underlying mechanisms.

Again, I suggest moving section 4.3 from the discussion in this chapter and separating the section 'Salinity influence on river phytoplankton using WQP and GlobSalt Data' into a specific study in chapter 3.

- Chapter IV: Assessing the effects of salinity on microbial communities and pollutant removal in urban wastewater treatment plants:

This last chapter is a manuscript published in the *Journal of Water Process Engineering* in 2024. This original study focuses on the effects of salinity on microbial communities in wastewater treatment plants and the resulting impact on pollutant removal efficiency. The results confirmed a significant impact of salinity on microbial communities and their efficiency. As with the previous chapters, I suggest moving the first part of section 4.4 (the part preceding 'Assessment wastewater discharges effect on freshwater salinization: A global approach with HydroWaste and GlobSalt') from the discussion in chapter 4.

- Overall discussion:

This section is balanced and well written, as is the rest of the document. However, it is mainly a juxtaposition of the discussion of each chapter. I propose to move the parts of the discussion relating to each chapter to their specific chapter and to retain in the overall discussion only those parts that deal with the interaction between several chapters. For example, several parts of the discussion combine the GlobSalt database (chapter 1) with other studies (chapters 2 and 4). For me, these interactions between chapters constitute the overall discussion.

- General recommendations:

This section is a little disappointing because it is too general and could be written without any study. This feeling is probably due to the fact that the results of the thesis are not clearly used to support the recommendations. The recommendation for Spain are much better and clearer. This is an original and a very nice contribution of the thesis. Perhaps this section could be merged with the overall discussion "overall discussion and recommendations".

- Conclusion of my report:

The manuscript highlights the very substantial work carried out by Mr. Moyano Salcedo, both in terms of acquiring a large amount of data and analyzing and interpreting them. The work carried out has led to significant advances in our knowledge of the impact of salinization on freshwater ecosystems in Spain and at a global scale. The work carried out is also well recognized, with 4 publications in top-level journals. This PhD thesis is also part of conceptual approaches that go beyond the simple framework of the study with innovative methodological approaches to observation and *in situ* experimentation of these particular environments. The manuscript is very well written and of very high quality, although the structure could be significantly improved by moving parts of the introduction and discussion to different chapters. I would therefore like to congratulate Mr Moyano Salcedo on his work and give my unreserved support to his application for a doctorate degree by the Universitat de Barcelona. Moreover, I recommend this PhD thesis for the "Doctor Europaeus" Mention"

Christophe Piscart,



Informe final de la comisi3n de seguiment doctoral



UNIVERSITAT DE
BARCELONA

Departament de Biologia Evolutiva, Ecologia i Ci3ncies Ambientals

Programa de Doctorat en Ecologia, Ci3ncies
Ambientals i Fisiologia Vegetal

INFORME DE VALORACI3 DE LA TESI INFORME DE VALORACI3N DE LA TESIS REPORT ASSESSMENT OF THE THESIS

Comisi3 de Seguiment / Comisi3n de seguimiento / Follow-up comission

Portaveu	N3ria Bonada	Instituci3	Universitat de Barcelona
	Lorenzo Proia	Instituci3	BETA Technological Centre – University of Vic – Central University of Catalonia
Vocal 1			
Vocal 2	Sujay Kaushal	Instituci3	University of Maryland

Nom del doctorand Nombre del doctorando / Name of the PhD student	Alvaro Javier Moyano Salcedo
T3tol de la tesi T3tulo de la tesis / Title of the thesis	Causes, effects, and management of river salinization in Spain with special attention to wastewater treatment

Especifiqueu les raons que avalen la qualitat de la tesi

Especificar los motivos que avalan la calidad de la tesis / Specify the reasons endorsing the quality of the thesis

1) Rellev3ncia dels objectius científics respecte a la recerca actual en l'àrea de l'estudi Relevancia de los objetivos científicos respecto a la investigación actual en el área del estudio Scientific relevance of the objectives outlined with regard to the current research being conducted in the area
The objectives outlined are of high scientific relevance as evidenced by the extensive and very complete general introduction of the manuscript. Salinization of freshwaters is a very important issue with potential severe and long-term consequences for human well-being and health. To investigate on causes and effects also looking at management strategies is definitively a great contribution to advances in science with a potential great impacts on policies. Álvaro's PhD thesis provides a very comprehensive view on the topic. Each one of these topics could have been a thesis in itself, and this follow-up comission considers that Álvaro was able to conduct in depth research leading to insights and advancements in each reasearch area (and more).
2) Rellev3ncia i adequaci3 de la metodologia Relevancia y adecuaci3n de la metodologia Relevance and appropriateness of the research methods
The methodologies applied combine experimental work under controlled conditions, field research, data collection and modelling, including novel approaches. This wide range of methodologies give an added value to the research

carried out and are relevant and adequate to answer the scientific questions planned. Álvaro has used these methodologies in a proper way to address the different objectives of the PhD.		
3) Valoració dels resultats: importància en l'àrea de recerca, originalitat i interès Valoración de los resultados: importancia en el área de investigación, originalidad e interés Assessment of results: importance in the research area, originality and interest		
The results obtained are original, novel and imply a significant step forward in the knowledge about the salinization effects on freshwater ecosystems and regional and global scale. In particular, the results of the experimental work carried out are particularly relevant because evidenced the interactive effects of two (often) co-occurring stressors such as nutrient excess and salinization on simplified fluvial food webs. The research about the salinization effects on the microbial communities of WWTP and its relative performance is also very original and of high scientific and applied interest. This follow-up commission considers that the research impact of the results derived from this PhD thesis will significantly advance the research on the effects of salinization and could eventually have also a significant societal impact given the applied character of the topic. In addition, the way Álvaro addressed this topic (combining different methodologies and approaches) could also inspire other researchers working on other kind of human impacts.		
4) Qualitat i rellevància de les discussions i conclusions Calidad y relevancia de las discusiones y conclusiones Quality and relevance of the discussion and conclusions		
The quality of the discussion and conclusions is excellent and are extremely well-written. Alvaro has related the analysis of his results with other findings in the global literature. One of the major strengths of this thesis (there are many) is that it combines observational work with broader synthetic work. This thesis will help us conceptualize the drivers and effects of salinization, particularly in the built environment and engineered water systems. This follow-up commission particularly appreciate the general recommendations as well as the specific ones per each sector mentioned. The idea of science providing evidence to support the decision-making process at all levels (public administration, industry, policy makers etc.) increase significantly the relevance of the applied research carried out and the conclusion reached.		
5) Observacions Observaciones Final remarks		
This is a remarkable and epic thesis. Álvaro has gone the extra mile in completing such a masterful set of chapters and extensive body of work. It is remarkable that he has been able to complete it in a relatively short time. His achievements, with 3 of the four chapters already published in Q1 journals, is another proof of the excellence of the research carried out and the relevance of the results obtained. It is clear that Álvaro is very driven and he also had some wonderful support from his two advisors. In the end, Álvaro should feel very proud for creating this body of work, and it has many implications regarding our understanding of salinization, ecological, and engineering issues.		
	Sí / Yes	No
Segons aquest informe, la tesi és apta per a la seva defensa? Según este informe, ¿considera que la tesis es apta para para su defensa? According to the report, may you recommend the public defense of this thesis?	Yes	

Barcelona, 20th September 2024

Signatura / Firma / Signature



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Aquest informe s'ha de lliurar en pdf al President de la Comissió Acadèmica del Programa de Doctorat

Este informe debe ser enviado en pdf al Presidente de la Comisión Académica del Programa de Doctorado
Please send this report in pdf to the President of the Academic Commission of the Doctoral Program