



University
of Exeter

Open Research Awards 2025

ESE disciplines prize

Babak Zolghadr-Asli (Centre for Water Systems)

Title of case study

STML-AquaCrop – An open-source framework for desalinated water optimisation in arid agriculture

Introduction to the case study

As freshwater scarcity continues to threaten food security worldwide, particularly in arid regions, a pressing question arises: Can seawater desalination be a viable and sustainable solution for irrigated agriculture? This project explores that question by assessing the agronomic, environmental, and economic potential of desalinated water use in agriculture — with a focus on the Atacama region of Chile. By leveraging crop modelling, optimisation, and open data practices, the research demonstrates how strategic irrigation scheduling and planting date selection can boost agricultural productivity while navigating resource constraints.

Detail the practices you have used to support openness/reproducibility

This project embraced a wide range of open and reproducible research practices. A key technical contribution involved the development of a novel, self-tuning multi-layer optimisation algorithm (STML), designed to autonomously carry out optimisation tasks without requiring manual parameter tuning. Both the peer-reviewed paper (link below) and the full source code (link below) are freely accessible.

To apply STML to real-world challenges in agriculture, I significantly extended the open-source AquaCrop-OSPy crop model, integrating more than 1000 lines of new Python code. These modifications introduced custom modules for climate-informed irrigation scheduling, Monte Carlo simulations to address soil uncertainty, and seamless integration with the STML optimiser. This extended model is also shared openly on GitHub (AquaCrop-OSPy Extension).

Beyond technical contributions, I am passionate about sharing open science principles through teaching and outreach. I have introduced AI and Python-based research tools to early-career researchers through talks and courses, including EngimAL, an open event hosted by the University of Exeter (YouTube recording with link below). During a visit to the University of Queensland in Australia — as part of my joint PhD programme with the University of Exeter — I also volunteered with the Wonder of Science initiative. As a Young Science Ambassador, I mentored high school students in remote areas and promoted inclusive, evidence-based STEM education.

Most recently, I contributed to public engagement through a feature on The Naked Scientists podcast, where I discussed the implications of AI in water infrastructure. This was linked to a Cambridge University Press open-access paper that was later nominated for “Paper of the Year.”

Outline any barriers or challenges you encountered, and how they were handled

While my experience with open research has been overwhelmingly positive, I've also encountered meaningful challenges. One of the most significant arose during the development of the AquaCrop-OSPy extension. Despite months of coding and model integration, the project stalled due to a lack of high-quality local data needed to calibrate the model. This was a harsh reminder that what we lack in water engineering is not just modelling sophistication, but robust and accessible datasets. This very challenge became the theme of the aforementioned paper and podcast — a call for shifting focus from model-centric to data-centric approaches.

What benefits have you identified from your case?

As an international student, I've found that embracing open research practices — supported by my incredible supervisory team — has significantly extended the reach of my work beyond institutional boundaries. Sharing code, models, and findings openly led to meaningful coverage in media outlets and broader public engagement, which in turn made it easier to secure interest and support for practical implementation of these ideas. I've received valuable feedback, collaboration offers, and most importantly, seen citations and use of my work across different contexts. Knowing that someone, somewhere, found these tools or approaches useful enough to apply in their own research is deeply fulfilling — and a powerful reminder of the collective impact that open science can enable.

How do you plan to continue this case moving forward?

Over the past year, I've been genuinely inspired by the tangible impact that open-source research can have — so much so that I've dedicated a large part of my free time to learning new software libraries and tools that allow me to build more accessible, user-friendly interfaces for the models and scripts I develop. My goal is to transition from simply sharing code to delivering fully independent, freely available software with intuitive GUIs, so that a broader audience — including those without programming experience — can benefit from these tools. Balancing this with the final stages of my PhD has certainly been challenging, but I see it as a valuable opportunity to expand my skill set and, more importantly, to make a meaningful contribution to others in the field.

Conclusions

This project has reinforced my belief in the power of open research to create real, lasting impact — not only by advancing science but also by making it more inclusive, collaborative, and transparent. From building new tools and models to sharing them freely, every step of this journey has taught me that openness isn't just a methodology — it's a mindset. Being recognised through this award would mean a great deal to me. As someone who truly values these principles, it would be an honour to contribute to the open research community at Exeter in a more visible way — and to keep building tools and resources that others can benefit from.

Links to any materials/resources relevant to the case

[1] AquaCrop-OSPy Extension – Smart Irrigation Modelling Tools

GitHub repository:

https://github.com/BabakZolghadrAsli/Aquacrop_OSPy_extension

[2] STML – Self-Tuning Multi-Layer Optimisation Algorithm

Open-access paper:

<https://www.sciencedirect.com/science/article/pii/S1568494624008196>

GitHub repository:

<https://github.com/BabakZolghadrAsli/STML>

[3] EngimAL – Open Python/AI Event by the University of Exeter

YouTube recording:

<https://www.youtube.com/watch?v=59CcTeNDlbo>

[4] Wonder of Science – STEM Outreach Initiative (UQ, Australia)

Program website:

<https://wonderofscience.com.au>

[5] The Naked Scientists – Podcast Interview on AI & Water Engineering

Episode link:

<https://www.thenakedscientists.com/articles/interviews/ai-aiding-water-infrastructure>
