26th International Congress on Modelling and Simulation, Adelaide, SA, Australia, 30 Nov–4 Dec 2025
mssanz.org.au/modsim2025

ParetoPick-R; an interactive tool for turning multi-objective optimisation results into actionable solutions

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Abstract: Interpreting highly-dimensional data often constitutes a cognitive overload for both scientists and stakeholders. A limited understanding of complex result datasets can bias decision making. Intuitive tools that render these results understandable and accessible are therefore essential, particularly when decision making relies on a common understanding of the data.

This presentation describes the main capabilities of ParetoPick-R, an R-shiny application developed for the last procedural steps of the EU H2020 project OPTAIN (OPtimal strategies to retAIN and re-use water and nutrients in small agricultural catchments across different soil-climatic regions in Europe, https://www.optain.eu/).

The OPTAIN project aims to optimise the spatial allocation and combination of Natural/Small Water Retention Measures (NSWRM) within 14 catchments across Europe. Alongside intensive stakeholder consultation, the project's workflow employs a suite of models and an optimisation algorithm. The result is a set of Pareto-optimal NSWRM implementation plans for each individual case study catchment. Four objectives were considered for Pareto optimality, meaning each NSWRM scenario represents a specific land use plan (decision space), as well as a point in a four-dimensional objective space. ParetoPick-R has been developed to make these large sets of optimal results actionable for researchers and stakeholders and to support them in finding the most promising options for NSWRM implementation.

For this purpose, the tool implements three main strategies;

1. Interactive and engaging visualisation techniques for assessing the relationships among objectives and for linking objective and decision space. The user can explore the data in a playful way and change aesthetic settings, limit the objectives and measures as well as create maps of NSWRM implementation. The complex multi-dimensional data is rendered tangible and understandable.
2. Intuitive data reduction through a clustering algorithm that can be tailored to individual case studies. This process identifies representative, meaningful and manageable data subsets.
3. An Analytical Hierarchy Process (AHP) that allows to systematically allocate preferences and priorities among objectives as well as across the decision space. A single solution best aligning with their respective preferences is determined for each stakeholder. The AHP can be combined with the clustering.

The capabilities of ParetoPick-R are showcased using examples from the stakeholder interviews that employed the tool to identify suitable implementation plans from the perspective of different sectors. Moreover, the challenges arising during the tool's development are highlighted. These insights are relevant for other decision-making projects dealing with complex multi-dimensional data.

Keywords: *decision-support, multi-objective optimisation, visualisation, Analytical Hierarchy Process, R shiny*

