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Evgenii S. Matrosov

The University of Manchester, evgenii.matrosov@manchester.ac.uk

Julien J. Harou

The University of Manchester, julien.harou@manchester.ac.uk

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Identifying Efficient and Robust Water Supply Investments for East England

Evgenii S. Matrosov^a, Julien J. Harou^a

^a*School of Mechanical, Aerospace and Civil Engineering, The University of Manchester, Manchester, M13 9PL, UK, evgenii.matrosov@manchester.ac.uk, julien.harou@manchester.ac.uk*

Abstract: In response to uncertainties about climate, population, economic and institutional changes, water resource system planners increasingly seek to select both robust and efficient system designs, i.e., those that work best across a broad set of plausible futures. Concretely water utilities must identify which portfolios of investments in new infrastructure, demand management schemes and increased regional connectivity together lead to cost-effective robust systems. System design under uncertainty methods such as Many-Objective Robust Decision Making (MORDM) help decision makers find robust strategies while optimising over many stakeholder performance objectives. Most studies using many-objective search have focused on relatively small systems with interconnected components. However, many utilities or regional water authorities require an approach to select and plan investments throughout extended service areas. This requires optimising over large regional systems which may have isolated subsystems, hydrologically different areas, and populations with interests not necessarily aligned to those of the whole service area. Large regional systems typically include many stakeholders groups with locally specific priorities and some regional transfers (of water or benefits) may not be politically feasible. Because search algorithms used in MORDM lose performance as more objectives are considered and Pareto surfaces become more difficult to interpret when dimensions increase, performance objectives (e.g. cost, reliability, etc.) are often aggregated system-wide. This may result in good overall system performance but poor performance for some individual stakeholder groups (by sector or region). We present a study of four East England water utilities which considers various 'deep' uncertainties within the search to identify both efficient and robust regional water system designs. We describe how using regional objectives with constraints on local performance, and interactive visualisation software, which displays both optimized aggregate and disaggregated (local and/or sector specific) metrics, helped stakeholders select portfolios for further more detailed stress testing.

Keywords: Multi-Objective Robust Decision Making, Deep Uncertainty, Fresh Water Supply