



Briefing paper

Building the evidence base for regional water planning

2026



**WATER SYSTEMS
INTEGRATION**

Contents

INTRODUCTION: WATER PLANNING REFORM IN THE UK	3
WHY IS A MORE HOLISTIC, EVIDENCE-BASED SYSTEMS APPROACH NEEDED?	4
WHAT EVIDENCE IS NEEDED FOR REGIONAL WATER PLANNING?	5
HOW CAN INTEGRATED WATER SYSTEM MODELLING PROVIDE BETTER EVIDENCE FOR WATER PLANNING?	7
NEXT STEPS: TESTING AND DEVELOPING THE EVIDENCE BASE FOR REGIONAL WATER PLANNING	10

Key points

- Taking a systems approach to water management enables decision-makers to design policies that reflect how water infrastructure and natural systems operate in practice, delivering savings for consumers and farmers while achieving measurable improvements in environmental outcomes.
- Regional water planning requires an evidence base that supports systems-based decision making. This includes:
 1. agreeing on a consistent set of water system *baseline indicators*, and
 2. using *integrated modelling* approaches capable of representing interactions between natural and engineered systems across both urban and rural areas.
- Recent advances in integrated modelling mean that these approaches can now support policies addressing multiple aspects of water management simultaneously, allowing interventions to be assessed across the whole water system rather than in isolation.
- The examples presented in this briefing demonstrate how streamlined indicators and integrated models can provide new insights for decision making, for example, by identifying lower-cost pathways for pollution reduction across rural and urban sources, assessing the cumulative impact of new housing development, and revealing co-benefits and trade-offs between water supply, flood risk, and environmental objectives.
- The move to regional water planning provides an opportunity to test and refine approaches to evidence creation for water management. Regulators, water companies, local authorities, catchment partnerships, and researchers should work together to develop evidence that is transparent, comparable across regions, and capable of supporting robust decision-making under future uncertainty.

Introduction: water planning reform in the UK

The UK Government published a white paper on water reform (‘A New Vision for Water’) in January 2026.ⁱ It contains plans to reform the approach to water planning, reducing the current complex system down to two core planning frameworks: one for water supply (which will include supply provision, demand management and supply infrastructure) and one for water environment (which will include sewers and sewage treatment, pollution reduction and nature restoration).

In addition, the Government intends to introduce a new regional water planning function, which will address the “missing middle” governance gap. This reflects the fact that, while current governance is split between national-level strategies and local catchments, it is often at the level of the river

basin (that is, the regional level) where coordination is required if questions of water availability, water quality and flood resilience are to be addressed effectively. The Government hopes that regional water planning will “enable a more holistic, coordinated approach to water environment and supply planning which aligns with the long-term priorities”.ⁱⁱ

This briefing explores the case for taking a more holistic approach to water planning and proposes some concrete steps towards making that a reality. More specifically, while holistic approaches can encompass many important dimensions, including stakeholder engagement, water governance, institutional coordination and decision-making processes, this briefing focuses on the **evidence needed to support proposed regional water planning**.

Why is a more holistic, evidence-based systems approach needed?

From an administrative perspective, it might appear easier to consider different aspects of the water system separately. However, all parts of the water cycle are connected physically and operationally, which means that interventions in one area can have consequences elsewhere (see box 1). If these potential co-benefits or trade-offs are not taken into account during planning, it will not be possible to accurately assess which are the most effective interventions.

More fundamentally, a systems approach to management enables decision-makers to tailor policies to the real context of water infrastructure, delivering savings for consumers and farmers while achieving measurable improvements in environmental outcomes.

A further advantage of using a systems approach is that it captures the feedback loops and interactions within the system. This leads to a more realistic picture of how the system behaves and what outcomes are likely. By contrast, more siloed approaches fail to account for impacts that result from interactions between parts of the system that are physically connected but assessed separately. They therefore risk either overestimating or underestimating impacts.

Box 1. Water system co-benefits and trade-offs

When thinking about the water system, policymakers need to deliver across three critical aspects:

- Ensuring safe and secure supplies of water,
- Delivering a protected and enhanced environment, and
- Achieving reduced risk of harm from flooding.

But interventions to address one outcome can affect the others. For example:

Trade-offs (avoiding unintended consequences)

- Reducing household water use helps improve security of supply, but it also reduces the amount of water passing through treatment plants, which can cause an increase in the concentration of pollutants found downstream, harming the environment.ⁱⁱⁱ
- Reducing groundwater abstraction helps to protect the health of rivers, but can also increase the risk of flooding from rivers (because there is less capacity available to absorb heavy rainfall).^{iv}
- Building new reservoirs can help to secure the water supply, but by changing flow patterns, it can also affect water quality downstream.^v

Co-benefits (maximising synergies)

- Wetlands can help to increase groundwater recharge (improving drought resilience), improve water quality (by diluting pollutants) and store excess water to mitigate flooding.^{vi}
- Nature-based sustainable drainage systems can act as natural filters, cleaning polluted runoff from roads and agricultural land before it enters the water system. They can also help to reduce surface water flood risk by diverting rainwater away from the combined sewer system.^{vii}
- Nature-rich landscapes (like woodlands) can slow down rainfall to reduce flood risk from runoff, while simultaneously recharging groundwater supplies, which helps improve drought resilience.^{viii}

What evidence is needed for regional water planning?

The White Paper states that “decisions on regional water planning should be evidence-based, transparent and subject to clear oversight mechanisms.”^{ix}

Historically, key water company plans, including Water Resources Management Plans (WRMP) and Drainage and Wastewater Management Plans (DWMP), have been developed using a range of indicators derived from multiple simulation models designed for specific infrastructure systems and planning objectives.^x However, it is not straightforward to integrate these results in a way that allows assessment of how interventions in one part of the system may affect other parts. As a

result, there is a risk that suboptimal options are implemented because important co-benefits and trade-offs remain hidden.

To fully understand co-benefits and trade-offs, we argue that it will be necessary to agree on a set of *water system baseline indicators* and to use *integrated modelling approaches* capable of simulating these indicators within a unified framework.^{xi}

Baseline indicators

One possible way to align the new water supply and water environment plans is to assess changes in a common set of *baseline indicators* that reflect both external drivers, such as climate change and development, and internal interventions within the water system. At a systems level, these indicators should be derived from integrated model simulations (see below) so that changes in flood, drought and pollution risks can be assessed consistently across planning objectives. Such indicators may include:

1. River flows, capturing changes in water availability, extreme low and high flow conditions, and interactions between groundwater and surface water.
2. Surface runoff, indicating changes in conditions associated with surface water flooding.
3. River water quality, reflecting the combined impacts of abstractions, discharges and diffuse pollution on the water environment.

These indicators are not intended to be exhaustive but illustrate how a shared evidence base can support consistent assessment of interventions across both supply and environment plans.

Integrated models

A substantial amount of work has recently gone into the development of *integrated models* for water systems. Such models allow representation of the demands and impacts of multiple sectors and actors' decisions, and enable quantitative assessment of interventions across water supply, water quality and wider environmental objectives. In this briefing, we refer to integrated water systems models as those capable of simulating interactions between natural and engineered systems across both urban and rural areas.

As these models have become more sophisticated, incorporating a wider range of variables and representing processes more accurately, their applicability and relevance for planning has increased. Integrated models can support the development of policies that address multiple aspects of water management simultaneously and consider interventions across the whole water system.

Interventions may include:

- new infrastructure,
- operational changes to existing systems,
- nature-based solutions,
- demand and behavioural measures,
- land management actions, and
- regulatory or policy changes that influence water use and environmental outcomes.

Integrated models allow systems-level policies to be translated into clearly defined strategies and practical regional scenarios. At a systems level, interventions can be described in terms of their intended function and outcomes, for example, the percentage reduction in runoff, mitigation of flood risk, improvements in water quality, or increases in water availability compared to a baseline scenario, while their specific design and delivery can then be developed through more detailed local modelling.

How can integrated water system modelling provide better evidence for water planning?

This section provides illustrative examples of the types of indicators, interventions and systems-level impacts that can be derived from integrated water systems modelling. The examples are drawn from studies using an integrated water systems modelling framework called WSIMOD (Water Systems Integration Modelling Framework), which was developed by researchers at Imperial College London.¹

The applications shown below demonstrate the type of evidence that can be used to support regional water planning and illustrate the type of evidence required to support effective decision-making. The intention is not to present detailed modelling results, but to demonstrate how integrated analysis of high and low flows and water quality can be consistently evaluated across water supply, water quality, and environmental objectives, and how co-benefits and trade-offs can be identified between water supply and water environment objectives.

1. Understanding interactions between supply and wastewater systems: London (River Thames)

Interventions in the water system can have impacts across both water supply and water quality outcomes. By using integrated modelling, it is possible to investigate which interventions provide the greatest benefits across multiple indicators, and where trade-offs between different water

¹ Water Systems Integration Modelling Framework (WSIMOD) is an open-source integrated water systems modelling framework developed at Imperial College London to simulate interactions between water infrastructure, natural systems and human activities across catchments and urban areas. Further details are available in: Dobson, B., Liu, L., & Mijic, A. (2024). Modelling water quantity and quality for integrated water cycle management with the Water Systems Integrated Modelling framework (WSIMOD) software. *Geoscientific Model Development*, 17(10), 4495-4513.

system objectives might arise.

This study investigated a range of different potential urban water system interventions in both supply (new reservoir, wastewater reuse, demand reductions and leakage reductions) and wastewater (green roofs, rainwater harvesting and stormwater storage). The modelling allowed researchers to investigate outcomes for both water supply and river water quality in London.^{xii}

The modelling showed that:

- Of the supply-side options, demand and leakage reduction provided the strongest co-benefits, demonstrating the potential to deliver improvements across both supply and environmental indicators.
- For wastewater options, rainwater harvesting showed the clearest system-level benefit.
- Wastewater reuse delivers substantial benefits but may introduce environmental trade-offs that require careful evaluation.

2. Demonstrating how urban- and rural- coordination can deliver cost savings for pollution management: River Cherwell catchment (Oxfordshire)

Integrated modelling makes it possible to consider both the urban and rural parts of a catchment simultaneously (rather than looking at each in isolation, as is usually the case in more traditional forms of modelling). This study looked at coordinated urban- and rural-approaches to pollution management that have the potential to deliver significant cost savings.

Seasonality affects pollution deriving from rural and urban sources differently; agricultural activities are the main driver of river quality during wet periods because of the increased levels of runoff carrying pollutants into rivers. In dry periods, however, urban activities dominate because wastewater (effluent) makes up a larger proportion of river flows.

Integrated modelling was able to show that policies that targeted rural fertiliser usage during wet periods and urban wastewater treatment during dry periods could cut pollution by up to 30%, saving almost 40% of intervention costs.^{xiii}

3. Understanding the impact of new housing and delivering water neutrality (London)

New urban developments can increase water demand, urban flood risk and river water pollution levels. An integrated modelling approach can help planners to understand how to manage current and future water pressures at a city scale.

This study examined how plans to build new homes in London might affect water supply and the extent to which various interventions might be able to deliver water neutrality (that is, where the additional water demand created by population growth in new housing developments can be offset through water savings in the same area).

The modelling revealed that if interventions—including the provision of green roofs and other nature-based solutions, water efficient appliances, water reuse systems such as rainwater harvesting, and social awareness campaigns—were applied only to new housing developments, their impact would be limited. A key finding was that only 71% of urban consumer demand, 48% of urban flood risk, and 63% of river water quality impacts can be offset within new urban developments through the implementation of water neutral design options.

The remaining proportion required to fully achieve water neutrality (offsetting impacts by 100%) must therefore come from retrofitting existing infrastructure. The analysis indicates that this would require interventions across a comparable scale of existing housing to that represented by new developments, either by improving the efficiency of older housing stock or by introducing additional nature-based solutions (NBS) across London's urban fabric.^{xiv}

4. Optimising nature-based solution portfolios (Norfolk)

Integrated modelling is particularly valuable when trying to assess the combined impacts of multiple interventions. In this study, integrated modelling was used to assess the benefits of different NBS portfolios with respect to water resources, flood, water quality and implementation costs. It focused on the Wensum and Yare catchments in Norfolk.

The study explored five different types of NBS: runoff attenuation (such as on-site ponds or wetlands), regenerative farming (which allows soil to store more water), creating new floodplains for rivers, urban green space (such as rain gardens and green roofs), and wastewater treatment wetlands.

The modelling was used to identify the most effective portfolio of interventions for a given level of investment, highlighting the lowest-cost combinations capable of delivering the greatest overall system benefit. The results show that different investment levels lead to different optimal portfolios, reflecting trade-offs between improving water availability and improving water quality.

For example, a lower-cost NBS portfolio increased water availability by around 50% but achieved only a 10% reduction in pollutants, whereas a substantially higher level of investment shifted the optimal portfolio towards water quality improvements, reducing pollutants by around 50% while increasing water availability by approximately 20%. This demonstrates that optimisation does not maximise a single outcome but instead identifies the most efficient balance between competing objectives under realistic investment constraints.

5. Quantifying co-benefits of a single intervention (Enfield)

Some water system interventions can provide multiple benefits. Integrated modelling can help to assess benefits across more than one set of indicators.

In this study, integrated modelling was used to understand the potential benefits of constructed wetlands on the urban water system in the London Borough of Enfield. Wetlands can help to *lower*

the level of peak flow in rivers during rainy periods (thereby helping to reduce flood risk) as well as *increasing* flows during dryer periods (helping mitigate drought risk).

The modelling showed that converting 1% of the catchment area to constructed wetlands can decrease high flows by 18–23% and increase low flows by 35–50%, reducing the flashiness of the urban water cycle.^{xv}

Next steps: testing and developing the evidence base for regional water planning

The examples presented in this briefing illustrate how integrated modelling can support the creation of a consistent and transparent evidence base for regional water planning, enabling comparison of interventions across objectives and supporting transparent decision making. They are not intended to prescribe specific methods or interventions, but to demonstrate the type of evidence required to assess co-benefits and trade-offs across water supply and water environment objectives.

As regional water planning develops, there is an opportunity for regulators, water companies, local authorities, catchment partnerships and researchers to work together to test and refine approaches to evidence creation. This includes:

- agreeing on appropriate baseline indicators,
- exploring how integrated modelling can be applied at the regional scale, and
- developing practical ways to translate systems-level analysis into implementable options within the water supply and water environment plans.

We therefore encourage stakeholders involved in regional planning to engage in testing and applying these approaches in real planning contexts. Early collaborative testing will help ensure that regional water planning is supported by evidence that is transparent, comparable across regions, and capable of supporting robust decision-making under future uncertainty.

Developing this shared evidence base will be an important step towards delivering the ambition set out in the White Paper: a more coordinated, efficient and outcome-focused water system that delivers secure supplies, a healthy environment and reduced flood risk.

Authors and contacts

This briefing was written by:

- [Prof Ana Mijic](#) , Professor of Water Systems Integration, Faculty of Engineering, Imperial College London
- Dr Eduardo Rico Carranza , Research Associate in Digital Twins and Water Systems, Faculty of Engineering, Imperial College London
- Jenny Bird, Campaign Manager, Grantham Institute, Imperial College London

Media enquiries: Grantham.media@imperial.ac.uk

Policy enquiries: j.bird@imperial.ac.uk

Acknowledgements

We would like to thank colleagues in the Water Systems Integration Research Group in Imperial's Department of Civil and Environment Engineering who contributed to the original papers cited in this briefing and who provided feedback on the interpretation of the results.

We would also like to thank Caterina Brandmayr in the Grantham Institute for comments on an earlier version of this briefing.

Please cite:

Mijic, A., Carranza, E., and Bird, J. (2026). Building the evidence base for regional water planning. Grantham Institute and Water Systems Integration Report.

DOI: <https://doi.org/10.25560/128141>

This work is licensed under a [Creative Commons Attribution-Non Commercial-No Derivatives 4.0 International License](#).



References and further reading

ⁱ HM Government (2026) [A New Vision for Water](#), CP 1490, January 2026

ⁱⁱ *ibid*

ⁱⁱⁱ Whaley, M. E., Benton, L., Bromwich, B., Mijic, A., Rousseau, E., Whaley, M. P., & Dobson, B. (2024). Implementing a systemic approach to water management: piloting a novel multi-level collaborative integrated water management framework in east London. *AQUA—Water Infrastructure, Ecosystems and Society*, 73(6), 1113-1134.

^{iv} *ibid*

^v Mijic, A., Bromwich, B., Crilly, D., Dobson, B., Forrow, D., Giambona, J., Kirk, S., Liu, L. and MacDonald, R. 2022. Systems Approach to Regional Water Planning, Centre for Systems Engineering and Innovation, Working Paper Series, No. 1

-
- ^{vi} Mott MacDonald (2022) [OxCam Integrated Water Management Framework, Phase 1 Report](#), July 2022
- ^{vii} Enabling Water Smart Communities (2026) [What is Integrated Water Management?](#) Accessed 3 February 2026
- ^{viii} Environment Agency (2021) [Systems water management for catchment scale processes: Development and demonstration of a systems analysis framework](#). Chief Scientist's Group report, May 2021
- ^{ix} HM Government (2026) [A New Vision for Water](#), CP 1490, January 2026
- ^x Mott MacDonald (2022) [OxCam Integrated Water Management Framework, Phase 1 Report](#), July 2022. p. 164
- ^{xi} Mijic, A., Bromwich, B., Crilly, D., Dobson, B., Forrow, D., Giambona, J., Kirk, S., Liu, L. and MacDonald, R. 2022. Systems Approach to Regional Water Planning, Centre for Systems Engineering and Innovation, Working Paper Series, No. 1
- ^{xii} Dobson, B., & Mijic, A. (2020). Protecting rivers by integrating supply-wastewater infrastructure planning and coordinating operational decisions. *Environmental Research Letters*, 15(11), 114025.
- ^{xiii} Liu, L., Dobson, B., & Mijic, A. (2022). Hierarchical systems integration for coordinated urban-rural water quality management at a catchment scale. *Science of The Total Environment*, 806, 150642.
- ^{xiv} Puchol-Salort, P., Boskovic, S., Dobson, B., van Reeuwijk, M., & Mijic, A. (2022). Water neutrality framework for systemic design of new urban developments. *Water Research*, 219, 118583.
- ^{xv} Peng, F., Liu, L., Gao, Y., Krivtsov, V., Srivastava, S., Dobson, B., & Mijic, A. (2025). Simulation of the impacts of constructed wetlands on river flow using WSIMOD. *Journal of Hydrology*, 657, 133065.