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A case study of payments for ecosystem services and the need for integrated catchment management: experiences from the Westcountry Rivers Trust

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Case Study

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Abstract

This case study uses the concept of ecosystem services and specifically payments for ecosystem services, alongside five experiences from the Westcountry Rivers Trust (WRT), which celebrates its 30th anniversary in 2024, to demonstrate the need for integrated catchment management (ICM). It highlights the multifaceted benefits that ecosystems provide to human well-being, the challenges faced in managing these often-siloed services and the role of ICM in preserving and enhancing multiple ecosystem services, focusing on the water-related drivers of flooding, drought, water quality and aquatic biodiversity. Through WRT projects this case study highlights practical applications and successes in managing ecosystem services at the catchment level and what considerations are needed for future integration and delivery of multi-benefit solutions. This paper is derived in part from the interviews and workshops undertaken as part of the Atlantic Area Interreg funded Triple C project (EAPA_772/2018), as well as contributions from the Horizon funded, InnWater project (Horizon EUROPE No. 101036683 and UKRI No. 10066637) and the OFWAT-funded, mainstreaming Nature-based Solutions.

Impact statement

The Westcountry Rivers Trust can now integrate the myriad of different siloed funding streams they use to deliver nature-based solutions at a landscape scale thus facilitating an integrated catchment management approach by using past (Triple C) and present (InnWater & Mainstreaming NbS) projects to assess and breakdown the barriers to upscaling.

Introduction

Ecosystem services, the benefits humans derive from ecosystems, have gained significant attention in environmental management and policymaking over recent decades. Ecosystem services play a crucial role in supporting human well-being and economic development (Millennium Ecosystem Assessment, 2005). These services can be categorised into four main types:

- Provisioning services including the production of food, water, timber and other resources.
- Regulating services encompass the regulation of climate, floods, diseases and water quality.
- Cultural services involve recreational, aesthetic and spiritual benefits derived from ecosystems.
- Supporting services include nutrient cycling, soil formation and primary production, which are necessary for the production of other ecosystem services.

Despite their importance, ecosystem services are often undervalued and overlooked in decision-making processes, leading to their degradation and loss. One of the main challenges in valuing ecosystem services is the difficulty in quantifying and monetising their benefits, especially those that are non-market and intangible in nature. In addition, there is often a lack of awareness and understanding of the connections between ecosystems and human well-being, resulting in their unsustainable use and management. Addressing these challenges requires improved methods for valuing ecosystem services, increased awareness and education, and integrated approaches to natural resource management.

Over the past decades, degradation in some of the most clearly observed ecosystem services that have high use values, such as poor water quality, flood resilience and carbon sequestration has been the focus of emerging local, regional, national and international payments for ecosystem service (PES) schemes.

Payments for ecosystem services

PESs are a conservation and sustainable development strategy aimed at incentivising landowners or resource users to protect or enhance specific ecosystem services. PES schemes involve compensating individuals or communities for the ecosystem services they provide or for adopting land management practices that benefit the environment.

These payments can take various forms, including direct payments, subsidies, tax incentives or tradable credits. PES programmes often target services such as carbon sequestration, water purification, biodiversity conservation and river catchment protection. By assigning economic value to ecosystem services, PES aims to internalise the external costs of environmental degradation and provide financial incentives for conservation actions.

Participation is *voluntary* for both *buyers* and *sellers* (at least one of each), and trade is *conditional* on *well-defined* ecosystem services being delivered (Wunder, 2005).

1. *Voluntary participation:* Participation in PES initiatives is voluntary for both buyers and sellers. Individuals and organisations choose to engage in these arrangements based on their own interests, values and objectives, fostering a collaborative approach to environmental stewardship.
2. *Buyer:* The buyer voluntarily participates in the PES scheme, recognising the value of the ecosystem service and choosing to invest in its preservation or enhancement. This could be a governmental agency, a private company or a non-profit organisation with an interest in maintaining or improving environmental quality.
3. *Seller:* Similarly, the seller enters into the PES agreement voluntarily, agreeing to undertake specific actions on their land or property to generate the desired ecosystem service. This could involve adopting land management practices, preserving natural habitats or restoring degraded ecosystems.
4. *Conditional trade:* The trade between the buyer and seller is contingent upon the provision of the targeted ecosystem service. Both parties agree to specific terms and conditions regarding the actions to be taken and the outcomes to be achieved. Payment is made only if the agreed-upon environmental benefits are delivered.
5. *Well-defined ecosystem services:* The ecosystem services involved in the PES scheme are carefully identified and defined to ensure clarity and effectiveness. These services could include water purification, carbon sequestration, habitat preservation, pollination or erosion control, among others. Clear definitions help establish measurable objectives and facilitate monitoring and evaluation of the programme's success.

By being voluntary and based on well-defined ecosystem services, PES initiatives encourage cooperation between buyers and sellers, promoting sustainable resource management and conservation while providing economic incentives for environmental stewardship.

Since Wunder's definition in 2005, PES schemes have evolved significantly, reflecting increased recognition of ecosystem service values and the need for sustainable management. Recent studies emphasise the integration of PES into broader conservation strategies, enhancing biodiversity and climate resilience (van Noordwijk & Leimona, 2017). Emerging approaches advocate for co-design with local communities, ensuring equitable benefit distribution and long-term sustainability (Branco-Soares et al., 2022). In addition, digital technologies and blockchain are being explored to improve transparency and efficiency in PES transactions (Salzman et al., 2018).

To date PES initiatives have been implemented worldwide, addressing diverse environmental challenges and socio-economic contexts. They have shown promise in promoting sustainable land management practices, preserving biodiversity and enhancing ecosystem resilience. However, PES programmes also face challenges related to governance, equity, additionality and monitoring effectiveness, and they are still often used to manage single problems rather than driven by multiple problems. These advancements and challenges underscore a shift towards more inclusive and technologically enhanced PES models which the Westcountry Rivers Trust (WRT) has been trying to achieve over its 30 years of operation.

Five experiences from the WRT

The WRT is an environment charity set up in 1994 to protect the rivers and watercourse of the Cornwall, Devon, Dorset and Somerset and to educate the public in water management. Below are qualitative examples of a mixture of direct PES schemes and semi-PES schemes where the buyer of ecosystem services (water company, local authority, developers or anglers) funds or supports the scheme to deliver specific ecosystem services. The following five project experiences are not provided to create a detailed quantitative assessment ecosystem service, but rather show the diversity of PES drivers to deliver nature-based solutions (NbS) and the need for integrated catchment management (ICM). There are several existing meta-analyses that synthesise data from various sources to assess quantitative impact of NbS. For example, Seddon et al. (2020) examined the global effectiveness of NbS in urban, agricultural and coastal environments, demonstrating significant benefits for biodiversity and climate adaptation, whereas Nesshöver et al. (2017) highlighted the cost-effectiveness of NbS compared to traditional engineering solutions, emphasising their long-term economic and environmental advantages.

All the WRT schemes detailed below were designed to operate over a lowland farmed landscape slowly adapting a poor farming structure into a good farming structure. Figure 1 is the WRT 'Good Farm, Bad Farm image', which highlights some of the NbS that can be deployed such as soil management, wetland and pond creation and installing buffer strips and fencing. These are designed in the most part to work with farm business models and as such are funded in part by the farmer, but some that directly push against the provision of food need 100% incentivisation.

Restoration of soils for drinking water protection: River Otter Case Study (Upstream Thinking)

The River Otter catchment in Devon, England, has been subject to increased nitrates due to agricultural intensification, which has degraded raw water supplies and increases treatment costs for the water company. In 2010, a PES scheme was launched called Upstream Thinking to address this pressure and WRT worked with farmers across the catchment restoring soil health and managing nutrients as well as wider NbS such as managing nutrients and soils as well as planting trees along riverbanks, protecting and stabilising river channels, reducing erosion and filter pollutants from runoff. Monitoring and evaluation of soil nitrate losses have shown that this approach is not only beneficial for the water company and the environment but also the farmer as they need to apply less nutrients. This PES scheme has a single buyer (the Water Company) but multiple sellers (farmers), and the conditional service of improved water quality conditionality is demonstrated through monitoring by the WRT but also by the University of Exeter (Grand-Clement et al., 2021).

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Figure 1. Good farm (right) bad farm (left) diagram showing engineered farm infrastructure alongside Nature based Solutions that can be used to enhance ecosystem service provision.

Natural flood management: River Dart (Devon Resilience Innovation Project)

The River Dart catchment sits in South Devon draining a significant proportion of Dartmoor and has experienced flooding and erosion due to land use changes and climate variability. The WRT has implemented a natural flood management programme to protect the village of Ashburton to restore natural processes and reduce flood risk by rebuilding soil health but also through habitat creation and NbS that slow and divert water in the environment. This includes creating leaky dams, re-meandering rivers and restoring river buffers to slow the flow of water and retain floodwater upstream. The work is funded through the Local Authority (Devon County Council) and the Environment Agency, and monitoring and evaluation undertaken by WRT have demonstrated the local effectiveness of these measures in reducing flood risk and enhancing biodiversity. This scheme has two buyers and multiple sellers (farmers) that voluntarily provision flood management measures.

Reducing phosphate through strategic land fallowing: River Camel (Transform Ar)

The River Camel catchment in Cornwall, England, has been impacted by agricultural and sewage-derived phosphates, and due to a European judgement effecting designated areas (e.g. Special Areas of Conservation), all housing development has been halted. The WRT has worked with developers, the County Council and farmers to implement strategic land fallowing of river corridor buffers to reduce the amount of phosphate used within the catchment and allow development to occur. Measures are assessed using a standard calculator and Natural England guidance which shown significant reductions in phosphate levels, leading to improved ecological health and development opportunities. This can be seen as a classic PES scheme where there are multiple buyers (developers) and multiple sellers (landowners) who can trade agricultural land for alternative land use. There are close trading regulations to ensure conditionality including creation of long-term covenants protecting new land use. This is similar to the UK Biodiversity Net Gain scheme where trading is assessed via a Biodiversity Metric.

Increasing water storage for drought: River Tamar (Water Net Gain)

The River Tamar catchment straddles Cornwall and Devon and is a key abstraction zone for the Water Company but is also a key supply zone for the milk buying sector. However, climate change is impacting water availability which is causing drought and water shortages. There is also a significant impact on the river, as lower flows drive higher temperatures and higher pollutant concentrations. This in turn leads to algal blooms and the presence of cyanobacteria on our systems. These have a significant impact on river health and aquatic species survival. WRT are working with

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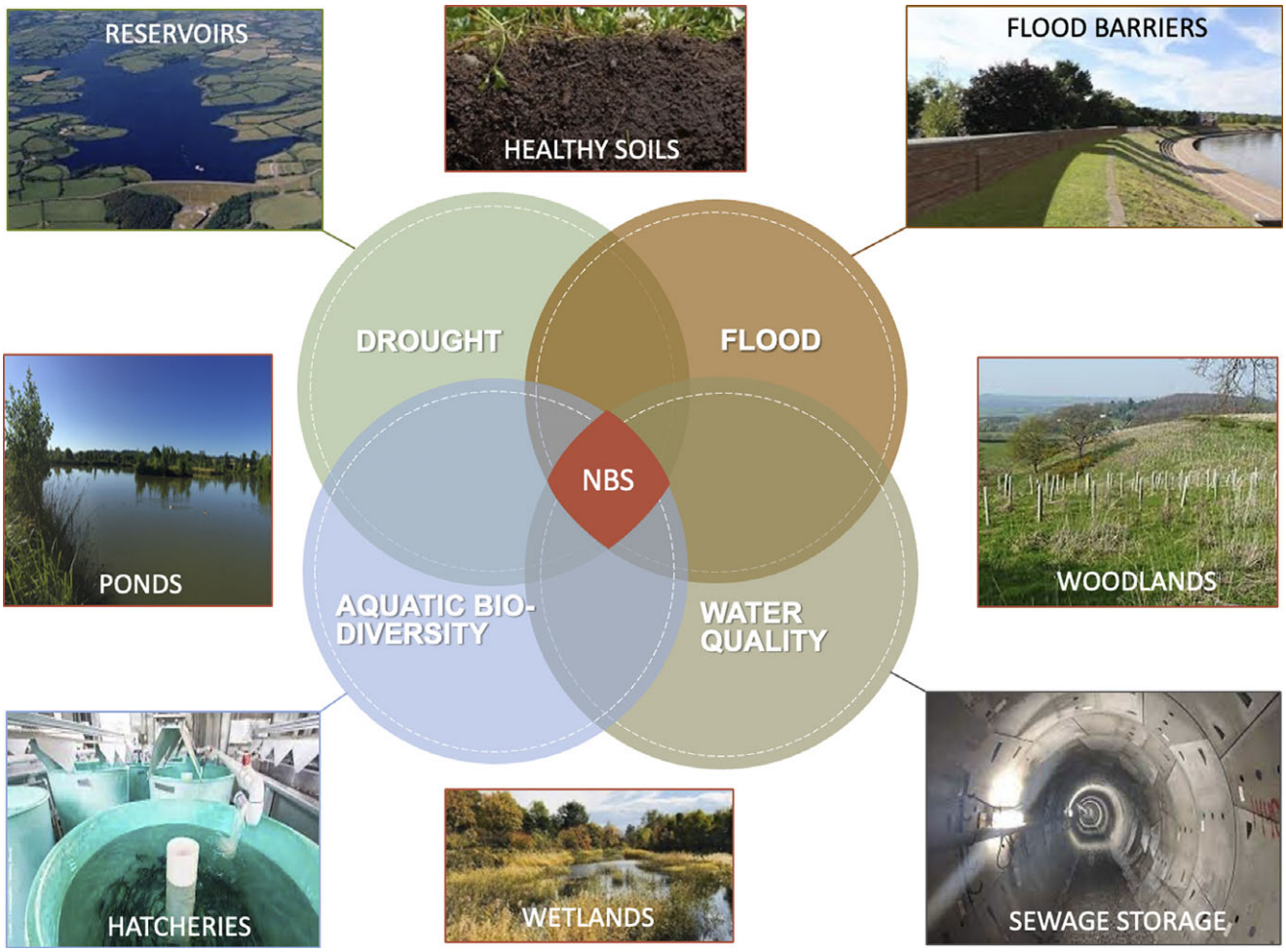

Figure 2. Siloed parts of the water sector and examples of engineered single focus solutions compared to multi-benefit Nature based Solutions that generate benefit across all silos as well as wider ecosystem service enhancements.

both water companies and milk buyers through an OFWAT (water company regulator) project to develop ponds and lake stores within the catchment to hold excess winter rainfall. While the scheme is in the research and development phase, it is designed to run alongside other flood risk schemes that slow and divert water. This PES scheme could have multiple buyers interested in replenishing fresh water supplies and multiple sellers (farmers) who can voluntarily use stored water to offset mains use or sell back into the river a key period of drought when river species are at maximum risk.

Enhancing river fisheries: River Fowey (Water for Growth)

The River Fowey catchment in Devon, England, is an important salmon and trough fishery but is in decline due to a lack of access to high-quality spawning and juvenile habitat. The WRT has implemented a range of fisheries and biodiversity enhancement activities to improve fish access to high-quality habitats in the upper catchment. This includes in-river habitat creation, buffer strips and weir removal or fish passage. While the larger weir removal and river restoration projects are predominantly grant funded, WRT have set up an Angling Passport scheme where anglers pay to fish the river and the funding is used to improve local habitats. Monitoring and evaluation through electric fishing surveys of juvenile fry numbers have demonstrated positive outcomes, including increases in fish numbers, angling and wider economic benefits. Whilst not a PES scheme in its entirety, the Angling Passport is a PES scheme where multiple buyers (anglers) voluntarily pay multiple sellers (beat owners) to fish their river with trading via WRT.

All five projects draw on multiple actors from across the public, private and charitable sector including but not limited to Local Authority Risk Management Agencies, Environment Agency, Natural England, Forestry Commission, Water Companies, Milk Buyers, farmers, Wildlife Trusts, Farming and Wildlife Group and Fisheries Associations. The Trust works with all of these partners through a mixture of routes from one to one conversations to local level catchment partnerships and from the Regional Flood and Coastal Committees to the West Country Water Resource Group.

While these schemes are driven by different actors and issues (water quality, flooding, development, drought, angling), in developing them, the WRT follows an ecosystem approach, which is a holistic framework for managing natural resources sustainably, emphasising the conservation and restoration of ecosystem integrity, biodiversity and function. It advocates for adaptive management, stakeholder participation and the integration of diverse knowledge sources to address environmental challenges while promoting socio-economic development. Guided by principles such as sustainable use and the precautionary approach, WRT seeks to balance human needs with the preservation of ecological systems. The ecosystem approach was endorsed by international agreements like the Convention on Biological Diversity (CBD) and is applied in

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various contexts to promote ecosystem resilience and ensure the well-being of both present and future generations (CBD, 2000). However, while the above case studies were framed against the ecosystem approach, they have fundamentally been driven by single siloed problems rather than through ICM.

Integrated catchment management

ICM is an approach to natural resource management that considers the entire catchment as a unit for planning and decision-making (Garrido et al., 2018). It recognises the interconnectedness of land, water and ecosystems within a catchment and aims to balance competing demands and interests for sustainable development. The principles of ICM include holistic planning, stakeholder engagement, adaptive management and sustainable use of natural resources.

ICM is important for preserving and enhancing ecosystem services, as it allows for holistic management of land, water and ecosystems within a catchment. It is very much aligned to the ecosystem approach but specifically and intentionally focuses on the water-based services which are highly defined by hydrological boundaries, whereas other ecosystem services have wider often un-delineated boundaries (such as carbon sequestration which can be brought internationally). By considering the multiple interactions and trade-offs between different uses and users of natural resources, ICM can help to reconcile competing interests and achieve sustainable development goals. Furthermore, it promotes collaboration and partnership among stakeholders, including government agencies, local communities and the private sector, to address complex environmental challenges.

Despite its potential benefits, ICM faces several challenges in implementation, and in the UK, there is still a siloed approach where the drivers for drought, flooding, water quality and aquatic biodiversity are still separate and often drive technical single-focus engineered solutions rather than more holistic multi-foci NbS (see Figure 2). These barriers to adopting ICM include these institutional silos but also fragmentation and jurisdictional boundaries, which can hinder coordination and collaboration among different stakeholders. There may also be conflicts of interest and competing demands for natural resources, particularly in areas with high population density and intensive land use. In addition, there may be limited resources and capacity for implementing ICM approaches, especially in developing countries. Following workshops and interviews with water managers across Europe undertaken through the Triple-C project (Atlantic Area Interreg) key steps to adopting ICM were:

1. *Better spatial and temporal mapping and planning of ecosystem services/drivers*: Despite several local, regional, national and European initiatives, there is still a lack of adequate spatial and temporal mapping and planning of overlapping catchment-based ecosystem services and drivers across both public, private and civil sectors. This means that creating an ICM approach is more challenging as groups and organisations are working at different scales, with different objectives and ambitious and to different drivers leading to less integrated delivery programmes. Alongside this, is a lack of nested mapping so that planning can happen at a variety of water relevant sizes (e.g. water body, catchment, region) as well as data being viewable on other areas (e.g. local authority planning scale).
2. *Clearer use of language in communicating multiple benefits*: The language used in communicating ICM and the delivery of NbS and wider changes to the landscape to improve ecosystem service function needs careful consideration. A diversity of language is needed depending on the stakeholders involved from complex language within academic literature of systems approached to simplistic lay person language for working with local communities and the public. Narratives such as ecosystem services can be helpful but are not common terms so need a lot of explaining or better still being replaced with simpler terms. Particular attention is necessary when using words open to interpretation such as sustainability and resilience.
3. *Improved integration of planning units to encompass water management*: The lack of spatial and temporally scale that adequately unites and articulates water quality and quantity drivers with other local authority planning units is a significant challenge. It is unlikely that planning authority units will be re-articulated with water management units in the short to medium term so better visual tools are required. In the long-term consideration should be made to improving the integration of planning units in water management to ensure water quality and quantity outcomes are manageable through the planning process.
4. *Improved integration of water groups (flood, drought, pollution and aquatic biodiversity)*: Currently, there are multiple water groups encompassing flood, drought, pollution and aquatic biodiversity that have been created through various European drivers (Habitats Directive, Water Framework Directive, Floods Directive, etc.). These have been helpful in articulating the pressures these individual water-related issues are under, but they are now reinforcing silos within society that causes both funding and delivery to be siloed. There is some articulation between water management groups, but these tend to be informal with individuals generating cross over and interlinkage rather than formal legal overlap.
5. *Improved funding/procurement frameworks to allow delivery of NbS*: As mentioned above, the above water-related silos are making it harder to integrate delivery but, in addition, the processes and requirements for justifying 'end of pipe' engineered solutions with a high degree of outcome certainty (i.e. flood defence banks, water treatment works, etc.) are not compatible with justifying and procuring NbS through a partnership approach. Multiple NbS deployed at a catchment scale are inherently less certain in terms of their desired outcomes than their single engineered solution, but the same framework is being used to assess them. This is leading to NbSs being removed from options appraisals and the procurement need to establish value for money through a competitive process limits multi-partner collaborative working.
6. *Better partnership working with balanced risk management through legal agreements*: When partnership working to deliver multi-benefit ecosystem services via NbS can be procured, there is a risk funders create contracts where the risks rest on the deliver partners rather than all partners. As discussed, NBS are inherently uncertain in their outputs delivered (e.g. hectares of wetland buffer) but even more so the outcomes derived (e.g. cleaner water or less flooding). Special attention needs to be paid to setting up contracts to distribute these risks fairly or design a market scheme where investors accept this risk but against a higher reward, such as green investment or green finance bonds.
7. *Increase apprentice, training/learning opportunities for cross partner working in ICM and NbS*: When the above challenges have been managed and ICM is procured and delivered

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through multi-partner delivery programmes of NBS against an integrated spatial and temporal plan, the next major challenge will be work force capacity. The expected size and scale of delivery needed to address the water quality and quantity pressures across flooding, drought, pollution and aquatic biodiversity loss, given climate change is considered immense. As such future schemes will need to invest in building capacity and capability across all delivery partners and sectors. Specific attention should be paid to apprenticeships, training and learning programmes to deliver ICM.

8. *Acknowledgement that water management needs systems thinking through both inter-disciplinary and trans-disciplinary partnership working*: Alongside the above academic research must align and articulate with ICM through inter-disciplinary and trans-disciplinary partnership working. Improved systems thinking at a catchment scale must increase in order to improve and monitor our understanding and ability to predict outcomes based on the outputs we deliver. In addition, a greater level of catchment condition assessment should be facilitated through both academic, regulator and civil society data collection. This includes Citizen Science programmes to increase the data we have on the aquatic environment.
9. *Successes and challenges in managing ecosystem services*: The case studies from the WRT demonstrate the effectiveness of ecosystem-based approaches in preserving and enhancing ecosystem services. By integrating scientific knowledge, local expertise and stakeholder engagement, these projects have achieved positive outcomes in terms of flood risk reduction, water quality improvement, biodiversity conservation and recreational opportunities. The success of these projects highlights the importance of collaborative partnerships, adaptive management and community involvement in managing ecosystem services at the catchment level.

Despite their successes, the case studies also highlight several challenges in implementing ecosystem service-based management approaches. These include limited resources and funding, institutional barriers and conflicting interests among stakeholders. In addition, there may be uncertainties and complexities associated with ecosystem dynamics and the delivery of ecosystem services, which can make it difficult to predict outcomes and evaluate effectiveness. Addressing these challenges requires improved governance structures, innovative financing mechanisms and adaptive management approaches that can respond to changing environmental conditions.

From the case studies, several lessons learned and best practices can be identified for managing ecosystem services in the context of ICM. These include the importance of stakeholder engagement and collaboration, the need for adaptive management and monitoring, and the value of investing in natural infrastructure and ecosystem restoration. By learning from past experiences and sharing best practices, decision-makers and practitioners can enhance their capacity to manage ecosystem services effectively and sustainably.

Future directions and recommendations

To address the challenges and opportunities associated with managing ecosystem services, it is essential to enhance stakeholder engagement and collaboration. This includes involving a diverse range of stakeholders, including government agencies, local communities, businesses, and non-profit organisations, in decision-making processes and implementation efforts. By fostering partnerships and building consensus among stakeholders, ICM can achieve greater buy-in and support for ecosystem-based approaches.

To achieve meaningful and lasting impacts on ecosystem services, it is crucial to scale up ICM approaches beyond individual projects and pilot sites. This requires mainstreaming ecosystem service and funding into policy frameworks, planning processes and investment strategies at regional, national and international levels. By integrating ecosystem services into broader development agendas, decision-makers can ensure that environmental sustainability is prioritised alongside economic growth and social development.

To support evidence-based decision-making and adaptive management, it is essential to invest in research and monitoring of ecosystem services and their interactions within catchments. This includes developing standardised methodologies for assessing ecosystem services, collecting baseline data on ecosystem health and resilience and monitoring trends and changes over time. By improving our understanding of ecosystem dynamics and the benefits they provide, decision-makers can make informed choices about managing natural resources and mitigating environmental risks.

To create an enabling environment for managing ecosystem services, policymakers need to adopt supportive policy frameworks and regulatory mechanisms. This includes integrating ecosystem service considerations into environmental legislation, land use planning regulations and water resource management policies. In addition, policymakers can provide incentives and support for ecosystem-based approaches through financial mechanisms, capacity-building initiatives and knowledge-sharing platforms. By creating the right policy incentives and institutional frameworks, policymakers can encourage sustainable practices and investments that enhance ecosystem services and human well-being.

Case study conclusion

In conclusion, ecosystem services can play a critical role in supporting human well-being, economic development and environmental sustainability, and the work of WRT highlights the myriad of different buyers for PES type schemes but that these are often single focus drivers and work is needed to unite multiple drivers. ICM offers a promising framework to link these drivers for preserving and enhancing ecosystem services, by considering the interconnectedness of land, water and ecosystems and balancing competing demands and interests for natural resources. Project examples from WRT illustrate the practical applications and successes in managing ecosystem services at the catchment level, highlighting the importance of collaborative partnerships, adaptive management and community involvement. Moving forward, it is essential to break down funding silos, enhance stakeholder engagement, scale up ICM approaches, build capacity and increase transdisciplinary working to sustainably manage ecosystem services and ensure the long-term resilience of our river catchments.

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Author contribution. The author has been at the Westcountry Rivers Trust for 20 years, two-thirds of the Trust's history and has an active role in the conceptualisation, development and running of all summarised Trust project experiences. The author has also been involved in the development of several

regional PES schemes working with a variety of partners and EU projects working on water governance and Integrated Catchment Management. All work/contributions represent the views of the author and the Westcountry Rivers Trust.

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Competing interest. The author is Chief Executive Officer of the Westcountry Rivers Trust and is a member of all Catchment Partnerships across Cornwall, Devon, Somerset and Dorset, involved with the Local Nature Partnerships, the environmental representative on the South West Regional Flood and Coastal Committee and a member of the West Country Water Resource Group.

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