Out of the Blue

New thinking on water, social and natural capital

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CONTENTS

Lord Chris Smith
Chairman of the Environment Agency

FOREWORD

Water - a precious and finite resource.

For far too long, here in Britain, we have regarded water as an infinitely available, inexhaustible, free resource. It isn't, of course. In reality it is one of the most precious – and finite – resources that we have. And we depend on it to sustain life, wellbeing, food and farming, much of industry, and the ecology of our rivers and lakes. It is a store of essential natural resource that sustains us, and that in turn we need to steward well, for our own sake and for the sake of future generations.

We were rather forcefully reminded of this in 2012. In many parts of England, in the first three months of 2012, we were facing the prospect of a serious drought, following two exceptionally dry winters. Groundwater levels were perilously low. Chalk streams that wouldn't normally dry up until the high summer were already dry by February. Reservoirs had in some cases reached historically low levels. And then in the late spring, the heavens opened, and it hardly stopped raining for months. We faced eleven major flooding events, all across the country, through the summer and autumn. In the North East of England the River South Tyne at Haydon Bridge was at its lowest recorded March level – 28% of the long-term average – and then suddenly by June it was running at 406% of its summer average.

The pattern was repeated in most parts of the country. It was a salient reminder to us all of how much we depend on rivers and the water they carry. And the science of a changing climate tells us that we are likely to face increasingly extreme patterns of weather. There will be more droughts, and more floods, over the decades to come. Flows will be both lower and higher than have been familiar in the past. We are going to have to get used to more unpredictability, more variation, more extremes.

That makes the issue of what value we place on the natural capital of water, and how we look after it, right at the heart of our environmental policy-making. But crucially it puts it right at the heart of our economic and social policy-making too. This is a lesson that parts of the world of business have already embraced. Many companies are making strenuous efforts to reduce water use – because it makes not just environmental but also economic sense for them to do so. Sainsbury's have achieved a 50% reduction in water use; Coca-Cola Enterprises' factories in Britain and France are now their most water-efficient production plants in the world; and Sunlight, the UK's largest textile rental and laundry organisation, has reduced water usage by 12% in a two-year period.

We need to get better, in the rest of society, at learning these lessons too. That's where this publication from Arup is so important. It points us in the right direction. It makes us realise the real, holistic value of water. It encourages us to think about usage levels, about abstraction rates, about storage, about water quality, about the way we pay for water, about the part water stewardship can and must play in overall sustainable development. Above all, it reminds us that water is part of that fundamental "bank" of natural capital on which we all draw, but which we must all sustain.

It does something else equally important, too. It encourages us to think long-term rather than short-term. Husbanding our water resources, valuing them properly, and thinking about their future, aren't things that matter only for the next year or two, or over an election span, or even over a corporate planning cycle. They are things that matter over decades and generations to come. We must plan not just for next year, but for a much longer future. And there is an ever greater responsibility that comes with that.

This publication will help us to fulfil that responsibility.

"We are going to have to get used to more unpredictability, more variation, more extremes."

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Mark Fletcher
Global Water Leader
Arup

SYNOPSIS

and conclusions - on natural and social capital

Over the course of this century water will become ever more critical to people and business. A growing world population and increasing living standards will drive inexorably rising demand for water. Yet at the same time a changing climate means the planet is more prone to water distress – droughts and shortages, floods and excess, and sometimes both, will become regular occurrences not freak events. Water will be a stretched, sensitive and contested resource. How we manage it to respond to these pressures will be one of the defining challenges for this and future generations.

This 'knowledge catalyst' is about how we rise to these challenges. It brings together new thinking across sectors and disciplines and from around the world. Sustainable solutions that integrate social, economic and environmental perspectives require new collaborations – fusing insights and ideas from engineering, planning, economics, management and environmental and social sciences. In terms of language we are seeking to explore and understand the terms 'social and natural capital'.


UNIVEG
México

The contributions span business, academia, NGOs and public agencies, as well as those from experts at Arup. They range from practical measures in local communities to global perspectives. And each puts forward ideas and approaches that may be innovative now, but which have the potential to become a new and better version of mainstream.

Introductory articles by Anders Berntell and by Les Newby set out the context in more detail, including future trends and issues. On a 'business as usual' trajectory, our global water demands in the year 2030 will surpass the available resource by 40%. That makes clear the importance of long term, innovative and integrated thinking. We need to value water more highly and take into account all of its benefits and impacts. The 'three capitals' approach captures the value of water to people, business and the environment, and there are ever more examples of how such an approach has been applied – ranging from national parks to estuarine ecosystems.

Michael O'Neill and Tony Ware highlight how innovative approaches have been used in Melbourne in the wake of Australia's decade long 'millennium drought'.

They describe a quiet revolution that has ushered in holistic and decentralised solutions. Melbourne's Water Future road map sees a move away from expensive desalination plants to water re-use and conservation. The city has built its water resilience and this will support its continuing role as a sporting and commercial centre. In Wales, Catherine Wenger and Ian Titherington describe a similar array of innovative solutions, forged through partnership and in response to local and institutional needs rather than drought. They ask the question how would we manage water if we valued it differently, using the metaphor of a bank of water for Wales.

The three capitals theme is picked up by Gordon Richardson and Debra Lam who discuss the application of 'triple capital' planning – ranging in scale from Down Ampney in rural Gloucestershire to New York State. They make clear the value of natural ecosystems in adding to resilience, helping to defend against any repeat of natural disasters such as Superstorm Sandy at one level, and adding value to homes, providing livelihoods and leisure experiences at another.

"The contributions span business, academia, NGOs and public agencies, as well as those from experts at Arup."

Across the ocean from New York, Walter Menzies describes how the top down meets bottom up approach of the Atlantic Gateway Partnership is using water to drive the sustainable regeneration of North West England. Focused on the cities of Liverpool and Manchester and the waterways which link them, it is raising ambitions and delivering real change. Liverpool's waterfront has been transformed from a place only visited by 'disaster tourists' to the city's most significant place asset.

At the community level, Alison Ball and Phill Aspden describe ground-breaking work to engage with tenants and value the social benefits of retrofitting homes to high energy standards. Using an innovative methodology they show how social benefits such as reduced fuel bills and carbon savings outweighed the cost of initial investments. They argue that similar approaches could be applied to the valuing sustainable water use, and for whole home or whole community retrofit encompassing energy, water and landscapes. Sarah Louise Fitton and Peter Guthrie also make the case for better taking into account social impacts and benefits, in their case in relation to the design of flood alleviation infrastructure. Again, community engagement and far sighted design should be the norm. John H Matthews looks at big water infrastructure, in particular dams, at the international scale. Echoing the discussion of long term water and climate trends, he contends that design of water infrastructure like hydropower dams can be based on assumptions that no longer hold true. Eco-engineering for new climates is required.

Stuart Orr focuses on the increasing corporate risks associated with water – physical, regulatory and reputational – and on stewardship responses to them. He zooms in on Sasol, an energy and chemicals company in South Africa, to show how enhancing water infrastructure and efficiency in the community can be more cost-effective than dealing with water security issues inside the factory alone.

A trio of articles examine ecosystems services in water environments and how they can best be valued and factored into decision making. Julia Martin-Ortega, Robert C. Ferrier and Jon Rathgen set out how ecosystems services are incorporated into Scotland's 'Hydro Nation Challenge' to become a world leader in the governance and economic value of its water resources.

Rory Canavan and Sue Manson, and Catherine Baldock and Piran White contribute related articles about valuing ecosystems services in the Humber Estuary. The former sets out the case for, and potential approaches to, putting a monetary value on the ecosystems services in the Humber – such as cycling of nutrients, purifying water and flood prevention. The Environment Agency is now pioneering this approach. The second article on the Humber looks at the 'value transfer' approach. This eases the practical application of ecosystems services valuation by allowing values gained from studies to be applied to multiple locations. The debate about the merits or risks of valuing natural capital is core to the discussion.

The articles combine new thinking and real examples. They articulate new ideas about water and how we can manage it for the widest possible good, and demonstrate how that is possible. Whilst each one emphasises different and sometimes contrasting angles, common points are evident. I draw five main conclusions that span the articles and mark out an agenda for sustainable, integrated and resilient water management in the future.

Integrated Water Management – Five Principles for the Future

1) Water is becoming an ever more critical resource. We need to adopt rounded, forward looking water management that fully takes into account economic, social and environmental value.

2) There is great opportunity to widen the application of innovative, next generation solutions that enhance water security, efficiency and quality. These are available and proven – we need to make what is innovative practice now the norm tomorrow.

3) We need to do water infrastructure differently, with far greater levels of community engagement and benefit, catchment based approaches that work with nature, and flexibility built in to adapt to an uncertain future. Homes, businesses and water supply and wastewater infrastructure can combine water and energy efficiency, and provide social and low carbon benefits without significant additional cost.

4) Business must be at the heart of a new approach. Water companies and major water using (or potentially polluting) businesses can demonstrate corporate responsibility, reduce their risk exposure and deliver bottom line benefits through sustainable water management to achieve more sustainable outcomes.

5) Natural and social capital needs to be properly valued. That may involve financial valuation of ecosystem services where these would otherwise be ignored in decision-making, or utilising and better enabling the democratic and planning process to reflect their worth where their benefits are recognised. The social value of infrastructure should be taken into account.

These five principles are not about embarking in wholly new directions; they simply reassert and pull together thinking and opportunities that are already in play. For every example illustrated here, there are countless others in place or being developed around the world. Meanwhile conferences and studies looking at how to value natural capital and adapt to a changing climate take place with increasing regularity. There are debates to be had and approaches to evolve, just as there are simple solutions that can be readily applied now.

This 'knowledge catalyst' is about giving exposure to new thinking and practice, not ending debates or prescribing set solutions. I hope it raises the profile of, and widens the audience engaged in, integrated water management, and that it helps to unite sectors, professions and institutions in responding to one of the greatest challenges of the century ahead – using our most critical resource wisely and to the benefit of all.

Anders Berntell
Executive Director,
2030 Water Resources Group

WATER
AND THE FUTURE

For the last two years, the World Economic Forum's Global Risks report has identified water as one of the top five global risks[1]. In 2013, based on a survey of over 1,000 experts from industry, government and academia, the report rated water supply as the 4th biggest risk in terms of likelihood and the 2nd biggest in terms of impact. That put it ahead of issues to do with weapons of mass destruction, climate change adaptation and chronic social imbalances.

It would not surprise me if water continues to be a top five risk in future Global Risks reports. In light of the number of extreme events involving water in recent years and their devastating global impacts, this would hardly be a revelation. Floods in Pakistan paralysed large parts of the country for many weeks, killing thousands of people and decimating the rural economy. And in the Philippines, Typhoon Haiyan further demonstrated the damage that can be done by too much water.

On top of the destructive human loss, Thailand's slow onset flood illustrates how the economic impact from one local event can be felt across the world. Hard drive production for the world's computers was slashed; global car production slowed as supplies of components were cut; Japan's GDP and global industrial production dipped significantly over the following quarter.

If too much water has killed thousands and led to billions of dollars of economic losses, too little water has also had systemic impacts. Drought in Russia led to restrictions on agricultural exports causing the price of staple grains to rise across North Africa and the Middle East. The resulting food price rises aggravated the tensions that led to the Arab spring; similarly, social instability caused by prolonged drought in Syria helped to start that country's present strife.

Today in many countries 70-90% of fresh water withdrawal is just for growing food. By 2030, 65% more water will be required to meet rising energy, industrial, and urban needs. Even allowing for efficiency measures, a global analysis found that within seventeen years, under a business as usual scenario, we are on track to require 40% more water than the earth can supply. That gap presents urgent economic, environmental, social and political challenges for governments to address.

Water scarcity is no longer merely a series of local or even national crises. International trade in food and energy resources means our water security problem is global. By 2030, global demand for food is projected to grow 40%, yet the lack of sufficient water for agriculture raises the risk of a 30% shortfall in cereal production. Recent fluctuations in food commodity prices and the social, economic and political disruptions they create offer ominous signs of our potential future. Consequently, the water resource challenge is a key risk to global economic stability.

Because of water's interconnected nature, the planning, management, and use of water resources to meet the demands of any one country has a ripple effect across the world. As we grow wealthier, the more freshwater we need to supply cities, power plants and factories and to produce higher protein food such as dairy, meat and fish products. In the 20th century, while population grew by a factor of four, freshwater withdrawals grew by a factor of nine.

But the story goes beyond the scarcity and abundance of water. Water quality is another critical issue. Water pollution incidents have paralysed business operations, causing disruption to global value chains and damaging corporate reputations. Pollution affects economies, not just the health of people and ecosystems.

There is growing concern about future climate change exacerbating water-related risk. However, many countries already cannot manage today's climate variability. Water risks reflect pressures caused by fast growing populations and economies and rapid urbanisation. Meanwhile, drought and floods fundamentally damage the economies of poorer countries, locking them into cycles of poverty.

If water's immediate impacts are often local, water security is now recognised as a systemic risk worldwide. How can the global community respond? The overarching prescription is for an integrated package of investments in information, institutions and infrastructure.

Managing water successfully requires a wide network of water users, public and private institutions to cooperate. However such collaboration rarely occurs unprompted. The political context and momentum for water reform need to be created if a comprehensive set of policies, programs and projects is to be put in place. And that requires institutions which are able to raise awareness, convene partnerships and identify solutions.

This is the role the 2030 Water Resources Group (2030 WRG) seeks to fill. Created by international organisations such as the World Economic Forum, national agencies and major business corporations[2], 2030 WRG works at the invitation of governments to forge diverse water partnerships and ensure sustainable management of water resources – supporting economic growth in their country.

Wide ranging solutions are available and adopting these will be central to meeting the water challenges of the future. For instance, the Managing Water Use in Scarce Environments publication[3] prepared for 2030 WRG by Arup brings together over forty projects that have tackled water scarcity. It spans municipal, industrial and agricultural initiatives and includes detail on costs and impacts. This sort of analysis is important in both stimulating debate and allowing decision makers to appraise options and implement effective solutions.

A multitude of technical solutions are available and in some cases operational. These include water efficiency, recycling and reuse measures, irrigation optimisation, domestic and business retrofit, leakage reduction and demand management approaches.

"Even allowing for efficiency measures, a global analysis found that within seventeen years, under a business as usual scenario, we are on track to require 40% more water than the earth can supply."

However, in reality, the barriers to change are rarely about technical feasibility; they are more often economic, political and institutional in nature. Reflecting that, measures to stimulate and enable wise water management include:

- better awareness of water issues and their social, economic and environmental impacts;
- improved collaboration between the public and private sectors;
- standardised data collection, monitoring and reporting;
- mechanisms and incentives which help reduce consumptive use of water; and
- means of ensuring action at river basin level (and sometimes beyond).

This last point is crucial as individual water uses and initiatives within a catchment area may impact upon one another. For example, an advanced irrigation scheme that in its own terms uses water efficiently to increase consumptive use and crop yields may also reduce the volume of water that infiltrates the ground and recharges aquifers.

Hence prioritisation must focus on reducing consumptive use of water, and decision making needs to be integrated and collaborative – between the public and private sectors, and between local communities and city, regional and national authorities. The focus for local action must be on interventions that deliver the greatest basin level benefit at the lowest unit cost. And at international level there needs to be co-operation to address the causes of water stress – such as climate change – and to foster cooperation and prevent conflict in the face of water scarcity.

It is the combination of widespread practical action and far sighted processes, approaches and partnerships that will take water out of the top five global risks register and prevent us from requiring more water than the earth can supply. Doing so will deliver water security and resilience and help to enable the economies, people and environments of countries around the world to flourish.

Images:
Polution, extremes in weather and a growing population will have a major impact on our water usage.

Les Newby
Economic & Sustainable Development Expert

INTEGRATED CAPITALS, BETTER OUTCOMES

The three capitals model and the role of valuation

The dictionary definition of 'capital' is nearly a column long. But skip the small print, and what it boils down to is value and significance. Mention 'value', and most people instinctively think of money, of things that can be compared in worth, traded or invested.

Probe a little deeper and it is clear that our perceptions of worth go far wider than money. Our own insights as individuals, backed by masses of research, tell us that financial wealth is just one factor that matters to us, albeit an important one. Quality of life is also connected to health, security, family and social relationships, leisure experiences, learning and liberty and environmental quality. Whilst the mix of what matters most varies from person to person, research[1] suggests that once income passes a certain threshold (around $75,000 or £50,000) it makes little difference to happiness.

Perhaps when we look at price tags alone, we count but we do not really value. The same principles apply to decision making at a societal, governmental or corporate level. When decisions are made about what to invest in, what development option to choose or how to manage a resource, the economics drive the outcome – costs, benefits, returns on investment. Of course it is not quite so simple. There are regulatory constraints, public and consumer pressures and practicalities to bring into the equation; and for governmental bodies at every level from local to international – jobs and growth will usually be prominent concerns too.

Those involved in economic development will generally consider a range of factors that impact on competitiveness, employment and growth in their decision making – for instance land and property, transport infrastructure, skills and innovation levels. For simplicity, we will describe this whole bundle of economic assets, finance and employment as 'economic capital'. And most of the time – certainly historically and once again in a post-recessionary environment where growth rules the roost – it is economic capital that drives decisions rather than the less easily priced social and environmental factors that also shape quality of life.

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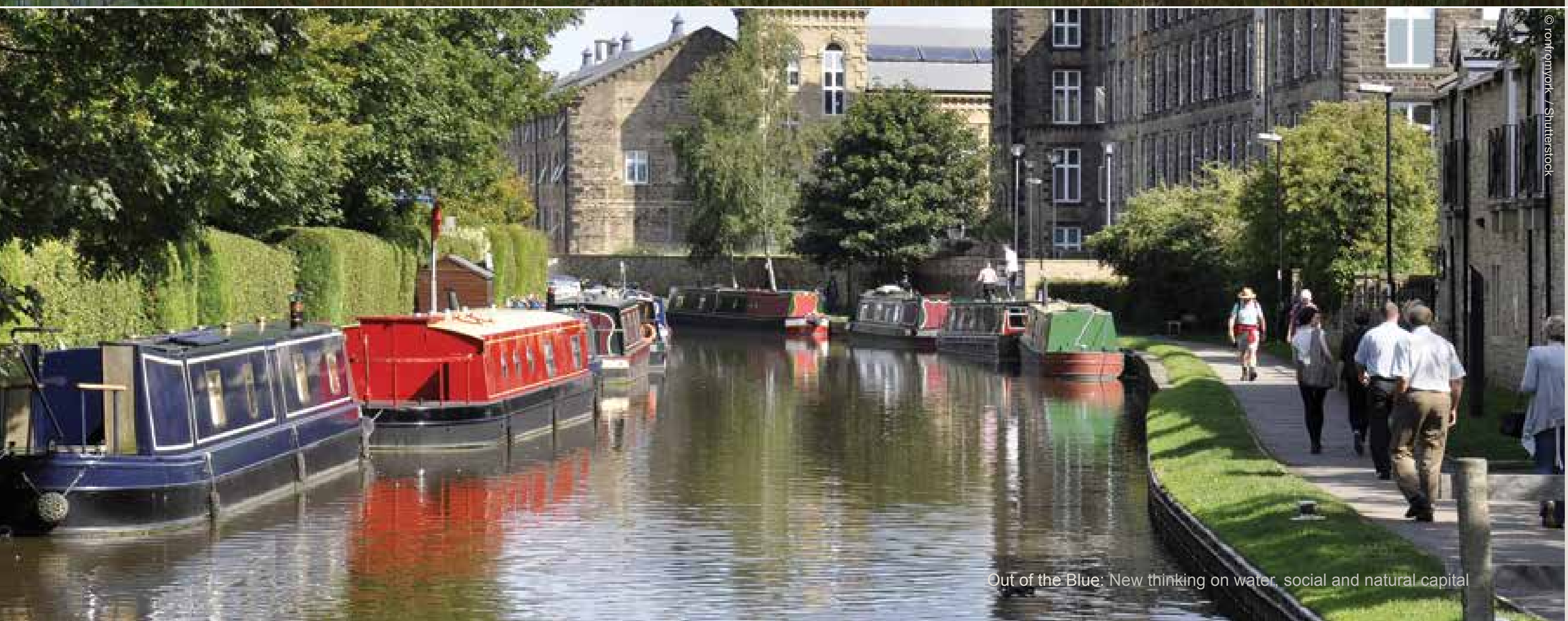
Economic Capital

Natural Capital



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Social Capital

That is true of water as much as any other resource. Whether we are looking at supply, treatment, flood prevention or other factors, economic capital is to the fore, translating into the bottom line of the balance sheet for corporations, and (once basic supply needs are met) into jobs, growth and investment for governments. Yet water clearly has huge impacts on other things we care about, but which are not valued financially.

Water availability and quality is a basic for good health; people take pleasure from rivers, lakes and canals and the leisure opportunities they afford; water affects habitats and biodiversity, it supports wider ecosystems services such as climate regulation; and the impacts of flooding on people, businesses and the environment are all too obvious. Clearly these social and environmental factors are important, but not always properly valued.

A three capitals approach?

Academics, campaigners and others are increasingly labelling the environment as 'natural capital', and aspects of quality of life and social relationships as 'social capital'. The ascription of the term 'capital' alludes to value and significance and makes clear that they are stocks which can go up or down as deposits or (perhaps more often) withdrawals are made.

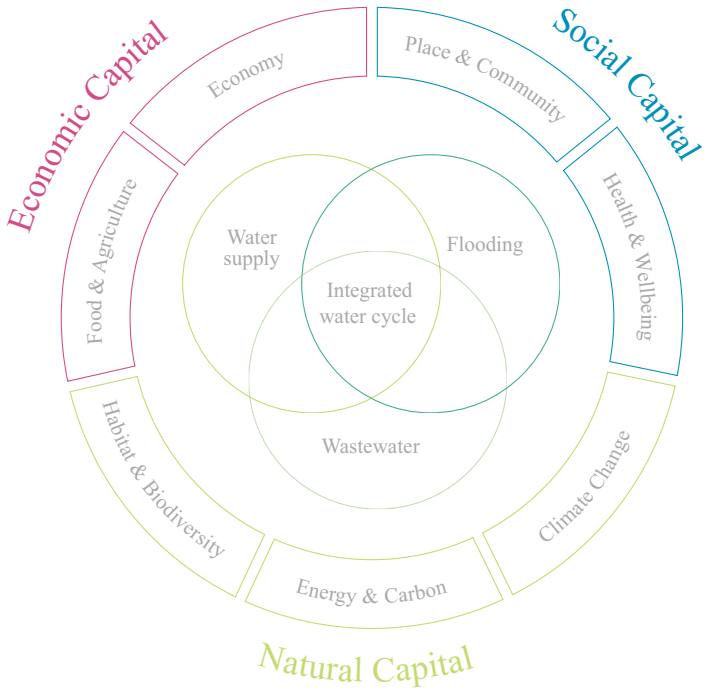

Figure 1:
A holistic view of water

The idea that there is more than one capital is nothing new. A number of academics, groups and institutions have sought to develop multiple capital models to influence thinking and policy over the past decades, often related to the goal of sustainable development. The table sets out some of the main models and their components. The various models do not agree exactly on terminology or the number of capitals. For example some choose to separate out social and human capital, others merge them. But by and large they share similar components and similar thinking. Which model is used is about preference more than right and wrong. 'Three capitals' has the benefit of simplicity, communicability and focusing attention on the main issue – the extent to which economic, social and natural capital are in balance and working together – rather than on the technicalities of definition.

So what does all this mean for water? As Anders Berntell's article in this publication points out, long term trends will make managing water well increasingly crucial.

Rising population and rising consumption levels means there will be less to go round; whilst climate change trends towards more extreme weather events will make both flood and drought more common. If carbon reduction was the headline resource issue of the last twenty years, water and its management will gain a similar status in decades to come.

Water's importance reflects the array of ways in which it is used and impacted upon, and the way in which it impacts upon people and wildlife. And as Figure 1 shows (adapted from that in Arup's 'Design with Water' brochure), these span, social, economic and natural capitals.

3 Capitals	4 Capitals	5 Capitals
Natural Capital	Natural capital	Natural capital
Social Capital	Social Capital	Social Capital
	Human capital	Human capital
Economic Capital	Manufactured capital	Manufactured (or 'Produced') capital
		Financial capital
Advocated by (examples of)		
Sustainable Economic Development Network [2]	UN Inclusive Wealth Report GES Review of the Economics of Sustainable Development	Forum for the Future [3] Global Environment and Development Institute

"A sustainable water future will require all three capitals - economic, social and environmental - to be valued and integrated"

All the three main aspects of integrated water management – supply, wastewater and flooding – connect to economic, social and natural capitals. Building a shared appreciation of this can underpin new collaborations and innovative, sustainable solutions[4]. But how far each capital is currently taken into account in decision making is less than ideal.

The economic imperatives driving water use and management are easily measured and well championed. Whilst economic capital is not terribly well defined in the literature or pushed as a concept, its power in determining courses of action is undeniable. Some elements of social capital, for instance basic supply of clean water or protection from life threatening floods, are taken for granted in the developed world at least. Whilst not always quantified in financial terms, threats to that – such as Australia's decade long drought or Superstorm Sandy in the US - tend to prompt strong, instinctive responses, as articles by Michael O'Neill and Debra Lam in this publication illustrate. But other elements of social capital, the leisure and aesthetic benefits of water environments for example, are less often accounted for.

The impact of water on the environment may be regulated, but the natural environment often appears a fringe concern compared to economic factors and the most pressing social ones. Whilst natural capital can serve a range of human needs and support the economy, these benefits can be overlooked. Too often choices are framed in terms of battle lines drawn and simplistically portrayed as much needed growth and jobs against an assortment of obscure bugs beloved only by the earnest ecologists who study them. The result? What Goliath would have done to David if the latter had forgotten his sling.

Price or Value?

A sustainable water future will require all three capitals to be valued[5] and integrated. Just how they are valued is a matter of contention. For some, 'valued' corresponds to better understood, appreciated and factored into decisions. But not priced. George Monbiot, for instance, argues that "*By pricing and commodifying the natural world – and then establishing a market in ecosystem services – accounting has the unintended consequence of turning the biosphere into a subsidiary of the economy* [6]."

Perversely, putting a price on nature could run the risk of devaluing it, with decision making through democracy exchanged for the mechanics of cost benefit analysis – itself not an exact science or one which has a track record in fully valuing the environment.

Others argue the reverse, that whatever democratic and decision making processes may be in place, they have repeatedly favoured the economic benefits that are valued – with the result that 60% of the ecosystem services assessed by the Millennium Ecosystem Assessment were classed as degraded or exploited. With a precautionary approach and robust, practical methodologies, valuation techniques could support better, more rounded decisions, including about water.

The argument about pricing has some way to run. But both of its sides raise questions about what would cause decision makers to give greater stock to social and environmental factors? Part of the answer is undoubtedly about awareness of future trends, understanding of the connectedness between capitals, and of the importance of distant and indirect impacts as well as costed ones close to home. Perhaps no resource has better potential to spark that change of thinking than water, where far sighted integrated approaches can protect environments, support businesses and jobs, and ultimately sustain life itself.

Professors Walter Menzies
Atlantic Gateway Partnership

TOP DOWN MEETS BOTTOM UP

The Mersey - the Atlantic Gateway for 21st century

"If anywhere in Britain can develop the critical mass and momentum to become an alternative growth pole to London it is the Atlantic Gateway"[1]

Now, in 2013, The Atlantic Gateway Partnership is established with its very clear mission to accelerate growth across the North West of England. It encompasses the two cities of Liverpool and Manchester, linked by the River Mersey and the Manchester Ship Canal. The business - led partnership themes its priorities around: growth, connectivity, infrastructure and sustainability[2]. And water is central to how it will deliver them, enhancing the environment, unleashing economic opportunity and regenerating communities.

The partnership works at a strategic 'top down' level – lobbying and influencing government to 'rebalance the economy'.

One priority, for instance, has been securing investment in the 'Northern Hub' initiative to improve rail capacity across the area. This is complemented by 'bottom up' work – enabling and encouraging action at the local level. One example is Port Salford Greenway, a green link between the Bridgewater Canal and the multi-modal Port Salford[3] – a major investment by The Peel Group. This will create a safe, green route for walking, cycling and recreation with clear economic, community and environmental benefit, through some of the most deprived areas of the city. The partnership's innovative Community Environment Fund has invested in this local, but valuable, initiative.

Atlantic Gateway – while working 'top down' in a strategic context – is intensely focused on specific projects and their implementation by partners. Strategies, policies and plans, however inspiring, are quickly forgotten if there is no action. It is the delivery of projects that makes the difference.

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"There is a growing mountain of evidence that successful cities enjoy quality environments, public realm and attractive hinterlands."

Recognition of the importance of 'top down' meeting 'bottom' up is a lesson learned from previous experience of partnership working in the North West within the landscape of the river basin, the Mersey itself and The Manchester Ship Canal. In 1983, Michael Heseltine, then Environment Secretary, adopted Liverpool as his crusade in the wake of the Toxteth Riots. He regarded the Mersey as vital to its regeneration:

"Today, the river is an affront to the standards a civilised society should demand of its environment." [4]

He was right. The Mersey stank with untreated sewage. Further up the catchment, the Ship Canal was so polluted with chemicals that it occasionally caught fire. Many derelict and contaminated watersides had negative value and were undevelopable.

Amongst his innovative initiatives was the Mersey Basin Campaign (MBC) – a unique, government backed cross-sectoral partnership. Its 25-year programme was focused on improving water quality, encouraging waterside regeneration and engaging all sections of society in the process[5].

MBC began its work in 1985. By 1999 it had become recognised worldwide as an exemplar of sustainable development in practice, as the inaugural winner of The World Riverprize – a decade ahead of the Thames.

By 2010 the Campaign had completed its mission and was wound up as planned. Fish had returned to the river. Waterside investment, development and regeneration was the norm. Liverpool's iconic waterfront was transformed. Spectacular change had taken place in many locations across the river basin.

For example, Salford Quays on the Manchester Ship Canal had been rescued from dereliction. The Quays had become a fitting setting for MediaCity UK[6]. The process underlined the benefits of cross-sectoral partnership working and marrying strategy with delivery.

There were important milestones along the way including:

- The privatisation of the water industry in 1989 which led to a significant increase in investment by the water company United Utilities.
- The Mersey Estuary Management Plan of 1995 - an innovative framework for co-ordinated action.
- The creation of the Environment Agency in 1996, focusing on better regulation and environmental management by industry.
- The North West Regional Development Agency and its multi-million pound investment in the Mersey Waterfront Regional Park, with its bold 2007 strategic framework.
- The multi-agency 'Adapting the Landscape' scenarios in 2009, addressing the challenges of environmental improvement at the landscape scale.

Underpinning all of this was the concept of sustainable development. Cleaning up the river basin was never conceived as a narrow environmental initiative – economic and community benefits were the ntended outcome.

By 2000, the chair of the regional development agency (NWDA) Lord Thomas of Macclesfield asserted:

"The North West was arguably the first region in the world to pollute the environment on a structured, grand, even imperial scale in the desire for economic growth. This new millennium will be an age when we can set our sights on reversing that process based on the principles of sustainable development." [7]

The demise of the regional economic development institutions and the regional planning regime has left a vacuum in some of the English regions. Austerity is a threat to holistic thinking and there is increasing risk of misguided quick fixes. The Atlantic Gateway, however, like the Mersey Basin Campaign, is a long term proposition. Sustainability is central to the thinking. Through the lens of global competitiveness, there is a growing mountain of evidence that successful cities enjoy quality environments, public realm and attractive hinterlands. In the race to attract talent, investors and visitors this is vital. The City of Liverpool exemplifies this – 20 years ago the only tourists were disaster tourists. Now the visitor economy is accepted as integral to the city's future. The regenerated waterfront is the single most significant place asset.

Complacency in the face of climate change is inexcusable, and within the Atlantic Gateway vigilance will be needed to ensure that there is no backtracking on investment on critical infrastructure such as flood prevention. By global and England standards, the area is extremely fortunate in water resources, which from a global investment perspective is a competitive advantage. However, the water company, United Utilities, must continue to be permitted by the regulator to make the right level of investment in renewing Victorian infrastructure to secure the system's resilience.

Detailed studies for Mersey Tidal Power[8] have confirmed its technical, though not its economic feasibility. As energy security becomes increasingly vital to the UK economy, the Mersey remains a real asset for future exploitation as a renewable energy resource.

There is much to be learned from other places with landscape scale ambition and the capacity to conceptualise and think long term while building confidence through tactical wins. Emscher Landschaftpark in the Ruhr[9] is inspirational in its scope, longevity and commitment to innovation. Thames Gateway Parklands[10] was the unifying greening dimension to the Thames Gateway.

A commitment in Atlantic Gateway's commencement business plan was Atlantic Gateway Parklands - now straplined: 'the landscape for prosperity'. Substantial progress has been made in securing support for this ambition. Its prospectus will be launched to local, national and global audiences in 2014.

"Cleaning up the river basin was never conceived as a narrow environmental initiative - economic and community benefits were the intended outcome."

River basin management is a marginal, technical and less than interesting concept to anyone outside the water and infrastructure industries and the green lobby. This is particularly the case in regions in which water supply is not perceived to be an issue and water quality has reached acceptable levels. No-one ever got out of bed humming to the tune of the European Water Framework Directive. For policy makers, opinion formers, influencers and the public at large there are many other fish to fry. The Mersey Basin Campaign survived all governments over 25years and achieved its objectives as it embraced sustainable development in the round. It would quickly have stalled had it presented itself as a narrow 'green' or more accurately 'blue' programme. The Atlantic Gateway Partnership is gaining traction and support as it constantly underlines the mantras that – accelerating growth is the aim, sustainable growth is the only option, top down and bottom up are sides of the same coin.


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A BANK OF WATER IN WALES?

Combining partners and capitals in practical projects

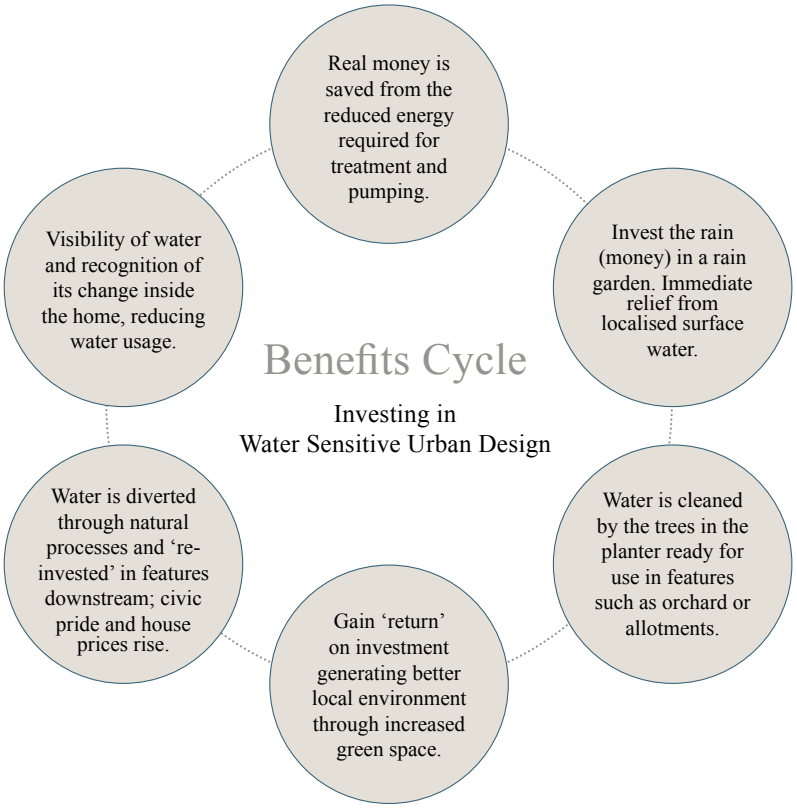
How valuable is water? We are at the beginning of a journey to try and quantify the value of water to society, taking what has traditionally been a free resource and 'pricing it'. This approach may be capturing one aspect of the value of water but fails to express clearly water's full potential for society and its wellbeing. What would happen if we considered water as money? As something that we can save, invest, reinvest, earn dividends from and, even create a profit from? A Bank of Water where the water itself can be reinvested just as we do our money – rather than channelling it into the ground as quickly as possible (akin to hiding it under our mattress).

For Water Sensitive Urban Design the currency would be rain water falling on impermeable hardscape. Traditionally this would be directed straight into sewers as swiftly as possible and then pumped and sent for treatment along with foul sewage in combined systems. Diverting this from the sewers into rain gardens, swales or planters enables it to be 'reinvested' in creating greener, healthier environments supporting local communities. Only then is it finally discharged into a local watercourse, surface water sewer or allowed to infiltrate into the soil - as depicted in Figure 1.

The 'three capitals model' (social, natural, economic) to water management is reflected in this virtuous investment cycle. It has an eye to the multiple benefits that can be triggered simply from mimicking the natural water cycle and retaining rain water at the surface prior to letting it slowly discharge.

Although the concepts behind this design approach are not complex, delivering projects that apply it in practice can be a challenge. They are visible, in the public realm and impact on the community. Hence planning and delivering them involves engaging with multiple stakeholders and satisfying a broad set of aspirations. Projects will not succeed without strong partnership working and local community buy in.

Figure 1
Benefits Cycle from Investing in Water Sensitive Urban



Right:
Greener Grangetown Visualisations,
Chris Baker, Arup

Case Study: Greener Grangetown
Feasibility study

A partnership was formed by DCWW, Cardiff Council and Natural Resources Wales (NRW) to develop a scheme for this socially diverse residential area in Cardiff, where surface water has been collected in a combined network and pumped eight miles to be treated - incurring energy and carbon costs.

Arup's feasibility study offers options to re-use surface water by 'greening' the existing streetscape and open spaces; developing community gardens, allotments, picnic areas and recreational spaces. The wider benefits include education, health, wellbeing, sense of place, and new cycle and walking routes linking the city to a regenerated and vibrant Cardiff Bay.

In Wales, a number of organisations have been grappling with this idea of using water as a catalyst for change. For each stakeholder the drivers change:

Dŵr Cymru Welsh Water aims to fulfil the objectives of its Rainscape initiative to separate surface water from combined systems, reducing flow in the combined sewers, which in turn reduces incidents of local flooding, treatment and pumping costs and releases capacity in the system.

Natural Resources Wales (NRW) – the new organisation formed from Environment Agency Wales, Countryside Commission for Wales and the Forestry Commission – seeks increased biodiversity, reduced flood risk and healthier places and people.

Local councils and Welsh Government, economic, social and environmental goals are all important. Sustainability initiatives include Cardiff Council's 'One-City' and the Welsh Government's 'One Wales: One Planet'.

Higher education establishments – opportunities to tie in research objectives to local projects and provide local technical expertise.

Other stakeholders (such as community groups), housing associations and the cycling charity Sustrans have ambitions for improving communities and amenities.

In a tight economic climate the reality is that organisations will need to work together to be able to afford to deliver projects. But doing so is not just about cost, it is also about addressing multiple issues and securing multiple benefits (see Figure 2).

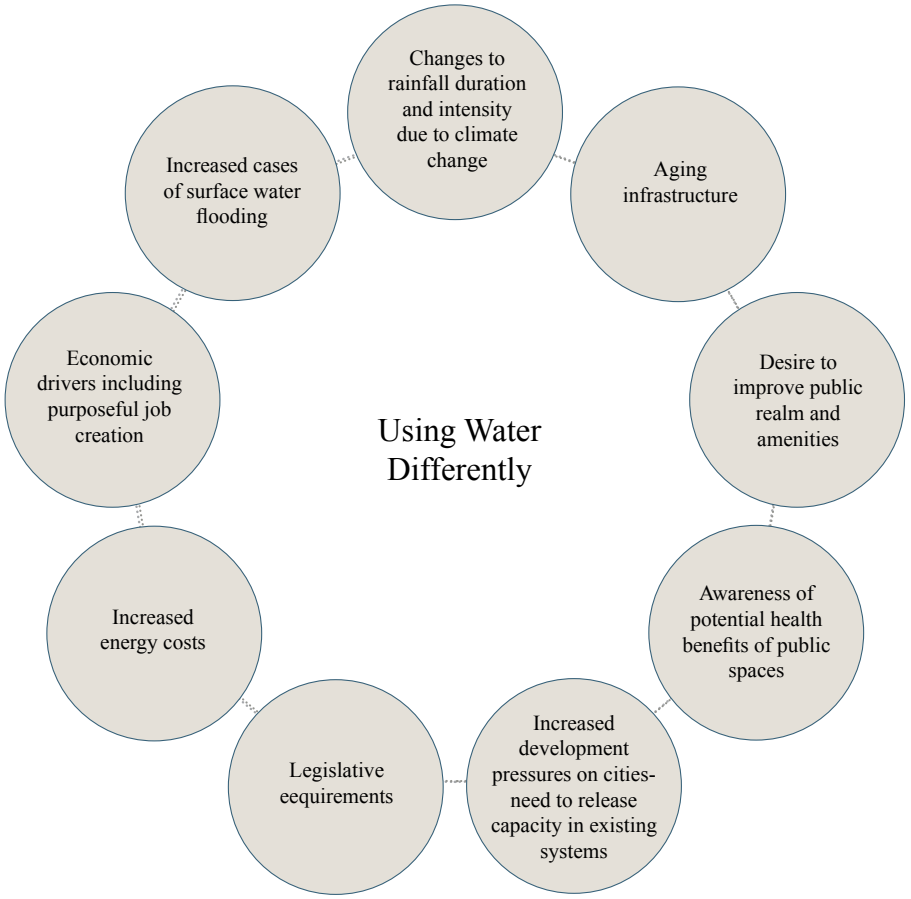


Figure 2
Multiple drivers for using water differently

"At Welsh Water, we have a lot of interfaces with Welsh Government, Environment Agency, Highways and Local Councils. A partnership approach to the development and implementation of WSUD is key to success."

Multiple stakeholders, new thinking

The projects demonstrate how imaginative scheme design can bring wide benefits. For instance, in Llanelli, the 20-year delivery plan will include measures such as dispersing surface water into parkland to create a feature instead of putting it into sewers. Towns will have more green areas and roadsides will have trees and places where water can infiltrate instead of going into combined sewers, and land will be released for development - generating income.

Individual schemes have different drivers, but there is a common thread of multiple stakeholder involvement and broad benefits. Without this level of collective 'buy-in' none of the projects would have succeeded. And besides partnership between organisations, it is important within them too, with different departments in the same organisation sometimes working together for the first time.

Formal Memorandums of Understanding between key stakeholders on two of the projects have been useful to legitimise the input from each party and clarify expectations. Multi-organisation steering groups have enabled issues to be highlighted and resolved and provided a forum for communication. One key factor is to ensure that attendees are empowered to take action to assist the project's progress. Legal issues over ownership and maintenance are frequently highlighted as hurdles for these types of projects, so discussions around ownership and maintenance were started early and followed up at every steering group meeting to ensure resolution.

Implementing WSUD on a larger scale, perhaps nationally, would also mean working with lots of institutional stakeholders. As Martin Hennessey, Director of Capital Delivery for Dŵr Cymru Welsh Water, explains:

"At Welsh Water, we have a lot of interfaces with Welsh Government, Environment Agency, Highways and Local Councils. A partnership approach to the development and implementation of WSUD is key to success."

Conclusion

Just as the 'bank of water' metaphor involves ensuring that environmental, social and economic factors all have currency, it brings together a wide range of stakeholders. Some are depositors, some are making withdrawals, other are managing flows. In Wales, innovative projects are bringing together these multiple partners and interests to address real problems and deliver practical solutions. New and imaginative thinking that realises the wide ranging value of water can provide multiple benefits not just for the key stakeholders, but the community at large.

Case Study: Maesteg
WSUD pilot

The Environment Agency Wales were keen to have a pilot WSUD scheme and funded a feasibility study at a site in Maesteg to address social, environmental and economic challenges. The Agency teamed up with multiple stakeholders who would benefit from the scheme in different ways:

Natural Resources Wales – water quality and habitats.

Dŵr Cymru Welsh Water (DCWW) – pollution control and reduced flooding from the sewer system.

Valleys to Coast Housing Association (land owner) - improved housing stock and streetscape environment.

Arup identified source control solutions as the most cost effective and suitable interventions for the site, including water efficiency in homes, attenuation ponds, swales, planters and community orchards. These helped to manage the flow of water at the location where run-off is generated and provide benefits beyond flood risk management – including amenity, water quality, carbon and economic improvements.

Case Study: Llanelli, Bury Inlet
Catchment modelling

Environmental issues drove this project, commissioned by DCWW, and which required a steering group involving the Environment Agency Wales and various departments in Carmarthenshire Council. The existing combined sewer network was experiencing considerable surface water infiltration and this excess water in the system led to overflow spills into the protected shellfish waters of the Bury Inlet.

Arup modelled the whole catchment and devised 181 possible green interventions to divert rain water. These were ranked on surface water reduction, flooding, environmental enhancement, societal benefit, ease of construction and carbon cost (using Arup's CO_2ST tool). The top 10 schemes are under construction and will reduce surface water entering the sewers by 25%.

"After 20 years, the investment around Llanelli will achieve the same outcomes as replacing sewers and building new storage. But it will also enhance the environment and provide green space amenities, and come at a fraction of the cost."

(David Evans, Associate Director, Arup)

Gordon Richardson
Associate Director, Environmental planning, Arup

Debra Lam
Consultant, City resilience, Arup

TRIPLE CAPITAL ENVIRONMENTAL PLANNING

The value of environmental economics and masterplanning

Conventional economic appraisal provides a coherent and well – understood methodology for defining commercial sustainability. By itself, however, it is only an approximation of value because focusing on financial parameters cannot directly capture external costs and benefits. Environmental economic theory provides a framework for valuing such non-market goods and services but, before these can be applied, the range of services that any given ecosystem might provide must be considered and defined. By combining ecosystem services assessment and environmental economics a better, more societally robust, set of proposals can be created.

In parallel with masterplanning techniques, the discipline of environmental economics has also progressed. In this article we look at how long-term masterplanning can take into account water-related environmental capital to deliver multiple benefits. We focus on two contrasting projects – gravel extraction at Down Ampney, Gloucestershire, and planning in New York State (NYS) following Superstorm Sandy and the NYS 2100 Commission Report. These illustrate the gains that comprehensive appraisal and multi-capital perspectives can offer.

Case Study: Down Ampney
From gravel extraction to Water Park

The 1,600ha Down Ampney Estate in Gloucestershire is underlain by the largest reserve of gravel in southern England in single-ownership. As part of the much larger Cotswold Water Park, this part of the Upper Thames Valley has produced high-quality construction aggregates for over 50 years and a number of companies presently extract several million tonnes per year. The Park covers an area of 40 square miles and encompasses over 150 lakes located between Swindon and Cirencester. The Down Ampney Estate sits on the eastern edge of the Park's Western Section and contributes to local and regional markets.

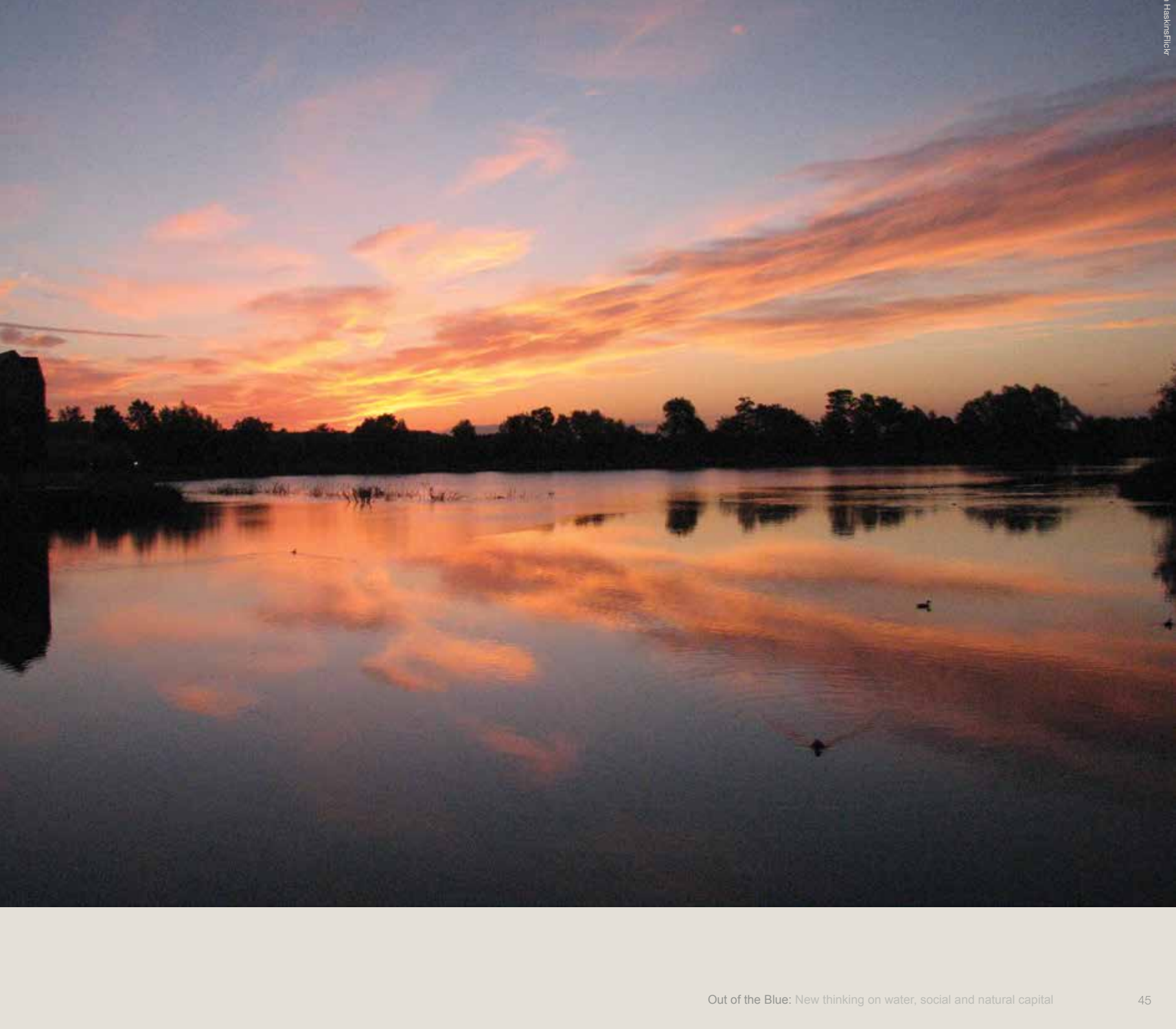
The water table in the area is high, and quarries are normally pumped dry and gravel extracted before naturally refilling with water once extraction is complete. Whilst wider recreational and environmental benefits were recognised from the outset at Down Ampney, early masterplan aspirations were driven by the value of the gravel – essentially a 'one capital' economics based approach. However, as time has moved on, potential social and environmental uses and benefits have been much better recognised.

Arup's brief, in 2008, was to develop a masterplan for the Down Ampney Estate, with a requirement to explore options for optimising returns from under-utilised farmland by capitalising on the firm's experience of large-scale land use planning. The Estate comprises a mixture of dairying activity, small-scale quarrying and other rural enterprises and contains several villages. The masterplan took the mineral resource and used it to underpin a range of proposals, including research facilities and field centres plus housing, leisure, farming and tourism. Gravel extraction was used to generate the wealth necessary to fund development, and to create a new landscape or, more accurately, waterscape, since removal of the mineral would leave a legacy of large, inter-connected water bodies. These would be sculpted over a decade or so, to shape a landscape for the 21st century and beyond.

Rigorous cost-benefit analysis was applied to the proposals, from the perspective of returns to the land owner and development partners. This demonstrated the project's feasibility in a traditional commercial context. These commercial elements extended beyond the gravel reserve, however, linking in to the area's promotion as the Cotswold Water Park, and its leisure and tourism opportunities.

In the five years since completion of the masterplan, environmental economics and valuation of ecosystem services have emerged as vital elements in the wider appraisal of projects and policies. These, if applied at the earliest stages of design, alongside social and economic factors, could alter the shape of the masterplan proposals and contribute to funding or planning support. The water bodies, for example, were acknowledged to influence the price of some near-by properties, since a fine view will always add value to a residential proposition. Ecosystem services evaluation would add to this the flood alleviation value of the lakes to downstream land and properties, their utility as heat sources and sinks, functionality as wildlife reservoirs, and ability to provide food, recreation, jobs, or other resources. Other, perhaps less tangible, values could also be ascribed to their functions in the carbon and nutrient cycles, microclimate, and climate change mitigation and adaptation. The water bodies' true value, to the landowner, society and nature would be fully identified and quantified, acknowledging the three fundamental strands of capital – financial, social and environmental.

Above and right:
Cotswold Water Park



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Case Study: New York State - NYS2100 Masterplanning for Resilience

The value of water bodies can extend to saving lives…or the reverse. In October, 2013, Superstorm Sandy ravaged the Northeast US coast with category 1 hurricane winds and violent, heavy rainfall, which together generated record high storm surges and flooding to the region, especially the New York area. It resulted in 72 deaths and an estimated US $50 million in damage. This came only 14 months after Hurricane Irene and then Tropical Storm Lee had hit the State within the space of a week in 2011.

Shortly after Superstorm Sandy, New York Governor Andrew Cuomo convened the NYS 2100 Commission, composed of local and federal government officials, nonprofit leaders, academics, and business experts. Its brief was to provide long-term recommendations to make the State's infrastructure more resilient. Arup received a grant from the Rockefeller Foundation to assist in the preparation of the NYS 2100 Commission report.

The NYS 2100 Commission report[1] recommendations were divided into five technical areas: transportation, land use, energy, insurance, and infrastructure finance, as well as overall cross-cutting recommendations. Effectively it set out a masterplan for long term resilience spanning physical infrastructure, the natural environment and financial systems. Tellingly, four of its five areas of recommendation involved water. These were integrated with wider aspects of city development such as new transportation systems, a new approach to energy, institutional co-ordination and integrated planning.

Whilst the true test of how far this masterplanning approach has taken hold will be its delivery, the importance of natural capital is writ large in the new

thinking. Recommendations on land use were centred on five action areas, all of which related to water:

- Protect coastal and Great Lakes communities.
- Reduce inland vulnerability to extreme weather events.
- Strengthen wastewater infrastructure
- Develop probabilistic hazards mapping and risk mapping.
- Strengthen land use programs, standards, policies, guidelines and procedures.

One of the major cross-cutting recommendations connected to this thinking was to 'adopt measures for promoting green and natural infrastructure'. Natural systems, such as wetlands, beaches, and dunes can serve as natural buffers against storm surges, or minimise local flooding. They can complement traditional heavy infrastructure, can be more cost-effective, and bring additional social-economic benefits.

While such promotion can be done through direct investment, new incentive programs and education, a corresponding and necessary feature for this to be accomplished is integrated planning. Ecosystem services operate at all scales, from project through to society. It is often hard to put such systems in defined governmental or political boundaries, especially since their benefits can be far-reaching. Costs and benefits may be borne by different generations, in varying proportions. Thus responsibility for the management and protection of natural systems needs to be shared and coordinated, and their incorporation in plans, policies and projects is a mark of innovation and foresightedness.

In Conclusion

Down Ampney Estate and New York are widely separated in scale and geography, but both illustrate important and emerging lessons. They expose the limitations of narrow, financially driven planning (whether missed opportunities in the Cotswold's or exposure to natural disaster in NYS) and the great potential of a wider, integrated approach based on 'triple capital planning'. That realisation can be fed by an evolutionary process of learning, or prompted by extreme climatic events as in NYS (and also in Australia – see Michael O'Neill's article on the response to the decade long drought).

Whilst appreciation of the value of natural capital is growing, environmental planning is a complex process. Perfect prediction of outcomes is rarely, if ever, possible. But through integrated planning and appraisal, informed decision-making, and engaged stakeholders, we will be able to implement cost-effective and technically robust strategies to make our communities safer, more resilient, and better places to live.

Right:
Devastation after Superstorm Sandy

Michael O'Neil
Senior Environmental Consultant, Arup

Tony Ware
Executive Manager, Turf Development and Environment, Melbourne Cricket Club

PLACING WATER AT THE CENTRE OF THE URBAN DESIGN PROCESS

Integrated water management at the Melbourne Sports Precinct

Melbourne is without question the sporting capital of Australia. The city's passion for sport dates back almost two centuries, and each year the city hosts numerous major national and international sports events. These include the Australian Formula 1 Grand Prix, the Australian Open Tennis Grand Slam, Boxing Day Test Match Cricket and the Australian Football League Grand Final.

Located in the city's CBD, the Melbourne Sports Precinct is central to sport – and life - in the city. It combines the Melbourne Cricket Ground and the surrounding Melbourne and Olympic Parks precinct, and has staged both the 1956 Olympic Games and the 2006 Commonwealth Games. In 2015 it will host the Cricket World Cup Grand Final, with a TV audience that could top 1 billion people. When the Australian Open tennis, cricket and soccer seasons are all in full swing daily, attendance at the precinct can reach upwards of 180,000 people, creating massive peak demand pressures. Sport is big business and at the heart of the city's identity, but it both depends and puts great pressure upon natural resources and infrastructure.

The decade long 'millennium drought' (which ended in 2009) affected almost the entire Australian continent. Severe shortages of water led to the panic building of massive desalination plants in most of Australia's capital cities as their water supplies approached critically low levels. Harsh, but necessary, water use restrictions in Melbourne meant that irrigation of parks and ovals was heavily controlled; fields browned, grounds became unusable by local sporting clubs and communities, fountains were switched off, cars were left unwashed and numerous trees died.

At the same time a quieter revolution in the way Australia manages its urban water resources was happening and decentralised and localised solutions were being explored. This revolution was being driven by thought leaders throughout the country who recognised alternative solutions to Australia's water problems. They saw that on both the demand and supply side a more holistic approach could have wide social, environmental and economic benefits while providing resilience for urban areas when the inevitable next drought occurs.

An exemplar of this approach was an Arup led Integrated Water Cycle Management Plan for the Melbourne Sports Precinct, where Yarra Park (which sits within the sporting precinct) could not be watered during the drought and was in a poor state. The plan mapped out a pathway to improve water efficiency in the precinct's stadia and deliver alternative water to the site through a combination of sewer mining [1], stormwater harvesting and a third pipe retrofit of existing stadiums. The study was commissioned by Sport and Recreation Victoria due to the various landholders and facility users involved, and responded to Government initiatives targeting reduced water consumption amongst Melbourne's top 200 water users. The final plan outlined a linked scheme sharing water across boundaries and delivering treated water to various users at the precinct.

The shift to placing water at the centre of the urban design process and using it as a catalyst to drive positive change continues to gain traction throughout Australia and globally. The link between water, its availability and presence in the landscape, and liveability is also gaining attention. It is now widely recognised that healthy green and blue infrastructure and landscapes have significant physical and mental health benefits.

Melbourne is pioneering new schemes and policies to value and safeguard natural resources. It has developed an innovative tree amenity valuation framework, which puts a price on criteria including removal and reinstatement costs, amenity value and ecological services, and has used this to value the inner city's 35,000 trees at $360 million. The city's Tree Policy[2] notes the asset is irreplaceable in the short term but a crucial element of the city's liveability; and its tree rescue package[3] responds to the finding that 40% of the city's significant trees could be in decline or dying after the drought.

The recently launched Melbourne Water Future roadmap[4] sagely notes that more water falls on the City (440 Gl) each year than it consumes (374 Gl) and that even more waste water (443 Gl) could be recycled to a high standard for a variety of non-potable uses such as irrigation and toilet flushing. The plan seeks to use these resources as the next major augmentation of the city's water supplies in preference to new desalination capacity or dams. It recognises the value of the city's rivers, streams and green space not just from a biodiversity and environmental perspective but also from a health and amenity viewpoint. The plan aligns closely with Arup's own design with water philosophy which places the water cycle at the core of urban design to yield multiple benefits.

In the same month in 2012 that Victoria's desalination plant entered its commissioning phase, the much smaller MCG Sewer Mine (the Yarra Park Water Recycling Facility) also began commissioning. History will dictate which plant added more value to the city. However the sewer mine now delivers its intended 600 kL a day of Class A water in summer for irrigation and 200 kl a day in winter for toilet flushing while the desalination plant lays idle. The MCG sewer mine and the overarching integrated water cycle management plan that spawned it is now considered by governmental decision makers as a 'proof of concept' of what can and should be done throughout the city. Whilst the cost of water from the technologies is higher than that coming 'out of the tap', it is significantly less than that from a desalination plant.

"The shift to placing water at the centre of the urban design process and using it as a catalyst to drive positive change continues to gain traction throughout Australia and globally."

Opposite page, left to right:
Desalination plant, MCG Sewer Mine, damage to eucalyptus tree, Yarra River Park


© Paul Vinten | Shutterstock


© Nicholas Grundy Photography


© Nyker | Dreamstime

Delivering the MCG plant was not a simple task. Beyond the engineering design challenges it was the regulatory framework that proved the most testing. Strict environmental and health controls added cost to the plant, protecting amenity values was crucial, and limits on the movement of water across boundaries and the ability to charge users for water challenged the economics. Persistence by a dedicated few pushed the project through these barriers and it now stands as a beacon of how this type of infrastructure can be retrofitted into a high density city environment with only positive impacts. The result of watching Yarra Park spring back to life has been inspiring for all involved.


© John Gollings

"Melbourne is pioneering new schemes and policies to value and safeguard natural resources."

Across the train tracks, Melbourne Park is the home of the Australian Open Tennis, which attracted over 650,000 patrons in 2010. The event injects $164 million into the Victoria economy, generates around 1,000 jobs, and raises the tourism profile of the city with almost 240 million viewers worldwide[5]. So crucial was the importance of an alternative water supply for the venue, another component of Arup's water master plan has been delivered as part of the early works package for the $363 million redevelopment of the precinct. The innovative stormwater harvesting scheme is now providing up to 45Ml per annum of treated water to the precinct for irrigation. The planned redevelopment of the Rod Laver Arena (Australian Open Centre Court) will include a third pipe to utilise this water for toilet flushing and wash-down. But already nitrogen, phosphorous and litter loads to the adjacent Yarra River have been reduced and new plantings thrive on the recycled water. The Australian Government saw value in the plant and contributed 50% of its $6 million construction cost through its 'Water for the Future' initiative.

A third and final stormwater harvesting scheme will hopefully be delivered in coming years in the area known as Gosch's paddock. Once this is complete, Arup hopes its vision of linking the three schemes together to provide a truly integrated and highly reliable alternative water supply source will be realised.

In the interim Arup continues to work with Victorian Government policy makers and regulators and water companies, sharing knowledge and planning to ensure streamlined and cost effective delivery that derives the highest possible societal and ecological benefits. The ability to point at real projects that operate successfully shows others what can be achieved and paves the way forward.

There is no doubt that the drought changed the way Australia views its water resources. Around the country communities banded together to significantly reduce their water consumption and, despite recent rain, consumption figures by households and industry remain near record lows in most cities. The length and impact of the drought and the realisation that it could recur have been enough to make water conservation and efficient supply a priority. In Melbourne, the urgency and obviousness of this need have meant that formal valuation methodologies have not been used in the way they have in the city's tree policy. Water efficiency has become common sense. Nevertheless, the city's thinking implicitly connects natural assets (such as water and Yarra Park) with social capital (sport and culture), which in turn supports extensive economic activity. It is a three capitals model prompted by harsh experience but now driven by enlightened long term vision.

Overpage and left:
Yarra River Park; Australian Open Tennis, Melbourne

Sarah Louise Fitton
Centre for Sustainable Development, University of Cambridge

Professor Peter Guthrie
University of Cambridge

FLOOD ALLEVIATION DESIGN

The importance of the social perspective

Over 5 million properties are at risk from flooding in England[1] – not just from rivers, but also from coastal waters, groundwater and failing reservoirs.

The UK Climate Change Risk Assessment[2] indicates the UK's vulnerability to extreme weather events. It predicts wetter winters and more heavy precipitation events, increasing the risk of flooding to many areas. In response, the UK Government announced £294 million of funding for flood risk management in 2013/2014[3]. Therefore significant spending on flood alleviation infrastructure will take place. In this article we argue that investment of this kind should attach much greater importance to the social perspective within scheme design. Social impacts need to be properly factored in alongside the technical considerations that most often dominate.

Flood risk management is not only critical for the protection of lives and properties, but also for economic growth. Flood alleviation schemes can unlock the economic potential of an area, attract investment and create employment. The local and national economic benefits are numerous[4].

The availability of funding indicates that the number of flood alleviation schemes designed and constructed is set to increase, and this will heighten protection from flooding and unleash economic potential.

Flood alleviation schemes must provide the protection required by the millions of homes, businesses and properties at risk. However, schemes should also meet the wider needs of the communities protected. This requires a design that considers the end user, not one that is solely focused upon the technical or economic aspects of the scheme. All too often flood alleviation design, and indeed infrastructure design in general, fails to consider the communities it serves.

This can lead to schemes that potentially:

– Harm the recreational and cultural value of the area;
– Reduce local amenities;
– Separate and divide a community; and
– Cause distress to residents.

There is a tendency in design to focus upon technical, operational and commercial aspects.

The complex nature of the infrastructure sector as a whole, including flood infrastructure, has been studied from a number of perspectives. However, most of the work has examined it from the perspective of how it is regulated, managed, operated and financed, or the technical aspects of the physical structures created[5]. Less attention has been paid to understanding the relationship between infrastructure and the end user, and that is reflected in the approach to design today.

The main purpose of flood alleviation schemes is to protect lives, properties and businesses from flooding. This is essentially the brief that the design teams responsible for creating a scheme are tasked with. However, this approach to design neglects the relationship between the scheme and the community, both from the perspective of the community as hosts of the physical structure(s) and as users of the services created. Flood alleviation schemes have the dual potential of protecting lives, properties and businesses, and enhancing the community's experience of an area. Aside from providing flood protection, well designed, socially considerate schemes can increase the recreational value of the area; create local amenities, enhance the environment and foster a sense of place and belonging in a community.

It is important to understand this perspective as whilst very the planning of schemes often focuses on technicalities and costs, in reality, the main driver for infrastructure development is to meet the needs of society. The case study example in Didsbury, Manchester shows how with thoughtful design and community engagement, schemes can turn what could have been a negative community impact into a positive one.

Case Study: Didsbury
Flood storage basin improvements

Situated in south Manchester, Didsbury Flood Basin supports recreational activities for the local community including allotments, a rugby and football club, a golf course and green space.

The Environment Agency proposed works to the flood basin in 2009 because it was not operating efficiently. However, what was believed to be the most technically viable solution meant the loss of amenity space for the groups who used it. Through consultation with the affected stakeholders and local residents, a more socially acceptable scheme was proposed that ensured recreational activities within the basin were not disrupted and the value of the area to residents and visitors alike was retained.

The scheme was commended by the Institution of Civil Engineers North West Awards 2102 in the Community and Small Projects Category for the way in which it used community consultation and engagement in developing a technically and socially successful scheme.

The interaction between infrastructure and end users has a number of characteristics[6]. For flood alleviation infrastructure, interactions are complex and different to those involving more self-contained facilities such as a water treatment plant or an electricity substation. Design considerations should include visibility to the user, the number and type of user interactions, how the flood alleviation service is delivered and the number of users dependent upon it. This is important as Britain's rivers, canals, reservoirs and coasts are salient recreational areas[7] and considerate flood alleviation design has the potential to deliver enormous environmental, social and recreational value. However, this cannot be achieved without considering the relationship between the scheme and the community.

The social impacts of flood alleviation schemes should be just as important as the technical details required to protect against flood events. There is a tendency within industry to envisage that understanding the social perspective of schemes will mean additional costs, resources and programme time. However, this is not always the case. Adopting a social perspective early in the design and decision-making process can result in more support and less opposition from stakeholders, which consequently avoids delays in programmes and the associated financial costs.

Whilst integrated scheme design (incorporating social, environmental, technical and economic factors) should be sought as good practice, there will inevitably be occasions where lower cost scheme options are weighed up against more socially favourable, but also more expensive ones. Financial valuation of social benefits could appear to be one way forward. Methods to calculate a social valuation of this sort are in their infancy, but some approaches have been developed such as the Social Return on Investment (SROI) methodology (see Alison Ball's article in this publication).

However, whether in relation to a flood alleviation scheme or infrastructure in general, valuation of social impacts is complex because it involves people's personal value orientations and judgements. Because of this, our view is that community needs and desires cannot always have a monetary value assigned to them; they are too subjective and unique. Adopting an integrated approach that builds in a social perspective from the outset is a less controversial and more appropriate way forward.

Therefore for future schemes design teams should;

- Design for normal circumstances, not just for the flood event. Design teams should consider the area from the perspective of the local community when a flood event is not threatening.
- Consider social as well as technical aspects of the scheme. The daily interaction between the local community and the scheme should be an integral consideration in design in order to enhance and maximise its value.
- Use engagement with the local community to influence design. Engaging with the community early in the design process will provide insights into the local context, the uniqueness of the area, the people who use it, and the area's recreational potential. All of this information can only be gleaned from the local community. Developing this understanding will go some way to ensuring the proposed design is welcomed, not just accepted, by the local community.

Considering the social perspective in design will create future flood alleviation schemes that not only protect from flood events, but also provide additional environmental, social and recreational value to local people, the wider community and future generations.

“Arup engaged with tenants to ensure their support and to identify energy use behaviours and measure the social impact of the retrofit programme.”

Alison Ball
Associate, Environment and Sustainability, Arup

Phill Aspden
Consultant, Environment and Sustainability, Arup

COMMUNITIES COUNT

Energy and water retrofit and social value

Refurbishing housing stock will be key to meeting the UK's ambitious carbon reduction target of 80% by 2050[1]. The UK's housing stock is amongst the least energy efficient in Europe, and is responsible for nearly a quarter of the nation's annual carbon emissions. So there is currently much focus on the need to energy retrofit dwellings to bring about carbon savings, and also to tackle fuel poverty.

Most home retrofit schemes go no further than energy. And while such initiatives can have positive environmental, social and economic benefits for householders and communities, rarely do they attempt to comprehensively measure these benefits. This article discusses one scheme that used an innovative methodology to do just that – retrofit of the New Barracks housing estate in Salford by Salix Homes – and how this approach can be applicable to water. It further explores the potential for whole home and community retrofit that also includes energy micro generation and water. Some retrofit schemes are now starting to include installation of simple water efficiency devices and advice provision into existing energy efficiency and fuel poverty schemes. The authors consider that there is potential to expand both the quantity and ambition of such schemes and to better understand and articulate their social, environmental and economic benefits.

Salix Homes – innovative approaches and social return on investment

In 2011, Arup worked with Salix Homes (an 'Arm's Length Management Organisation', managing council-owned properties in Salford, Greater Manchester) to measure the social return on its investment in an estate wide low carbon retrofit scheme.

Salix Homes had identified that its Decent Homes programme, whilst aiming to improve housing conditions on a large scale, did not directly address carbon emissions. _They recognised the potential to deliver greater benefits to tenants (and itself as landlord) on the New Barracks Estate by combining major improvements in housing decency standards with an ambitious low carbon agenda.

A standard approach to retrofit would usually focus on tracking the direct outputs only, i.e. those material improvements to the property, and the predicted carbon emissions saved over time. However, Salix Homes wanted to identify and measure the social and economic outcomes of the retrofit programme, not just its environmental (carbon) benefits.

Salix Homes worked with Arup to apply a new holistic approach to retrofit, not previously used by other social housing projects. Arup provided advice on energy retrofit options for four property archetypes and on the impact associated with changes in tenants' energy use and behaviours after the retrofit – the 'social return on investment'.

Practicalities

Rather than focus solely on CO_2 savings, Arup appraised each retrofit technology in terms of energy cost savings, capital cost per kg CO_2 saved, and capital cost versus running cost savings. This gave insight into the best retrofit options to reduce carbon emissions and fuel poverty.

The New Barracks Estate properties were typified by inadequate heating systems (boilers typically 68% efficient), poor or inoperable controls, limited insulation (in roof spaces where present), and mould growth due to surface condensation. Windows were generally single glazed. Ventilation to the bathroom and kitchen was through (often inoperable) wall mounted extractor fans.

Arup used the New Economics Foundation's Social Return on Investment (SROI) methodology[2] to articulate and measure the environmental, economic and social value resulting from the programme and associated investment.

This systematic, integrated and evidence based methodology identified, mapped and reported the social value created by the retrofit on an estate wide basis – a technique rarely, if ever applied in similar housing projects elsewhere.

The project simultaneously capitalised on opportunities to upgrade the fabric of housing whilst engaging and educating tenants about energy saving. Using the SROI methodology, it articulated, measured and monetised the resulting social, environmental and economic impacts of the low carbon retrofit.

As part of the initiative, Arup and Salix Homes also pioneered a comprehensive Measuring Change Programme involving in-depth tenant engagement and primary data gathering. The programme contributed hugely to the project's success by gathering and analysing qualitative and quantitative data on pre-retrofit energy use behaviours, comfort, energy usage and expenditure. It further elicited tenant opinions about the retrofit process prior to and after the works were completed.

The final retrofit programme overcame these inadequacies by providing tenants with:

- New boilers (with modern control systems)
- Double glazing
- Internal insulation
- Installation of mechanical ventilation systems with heat recovery
- New bathrooms
- New kitchens
- Re-wired properties
- New front doors

Arup engaged with tenants to ensure their support and to identify energy use behaviours and measure the social impact of the retrofit programme. It made presentations to tenants' groups, undertook in-depth interviews with tenants and completed estate wide benchmark surveys. This enabled household energy data and energy use behaviours to be established, and assessment of the changes the retrofit had made to tenants' lives, energy spend and carbon savings.

The benefits were wide ranging and included:

- Savings on gas bills
- Improved comfort levels
- Increased value of housing stock
- Reduced property maintenance costs
- Reduced CO2 emissions
- Improved reputation of Salix Homes
- Revenue for suppliers and installer of retrofit measures – supporting jobs and local economies
- Increased central government tax receipts – as VAT on energy is lower than VAT on other goods and services, which it was assumed tenants would spend the money saved on instead

Case Study: New Barracks Estate, Salford Retrofit project

Salford borders Manchester in North West England and is one of nation's most disadvantaged areas. The New Barracks estate is in the Ordsall neighbourhood where:

- 54% of households are income deprived, 28% benefit dependent
- 15% are lone-parent households well above average
- Average household income is approximately £20,000 – compared with £30,900 across Salford
- Only around 55% consider themselves 'in good health'
- Over 15% claim incapacity benefit or disability living allowance

The housing retrofit scheme targeted 78 Edwardian terraced properties in the area, with poor energy performance.


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So what difference does it make?

Tenants felt wide ranging benefits from the project and there were environmental benefits too. Perhaps the biggest change for tenants was the impact on gas bills. Pre-retrofit household energy use and expenditure averaged £624 spent on gas per year. Following the retrofit programme that reduced by £353 per year (after accounting for inflation) – meaning bills were more than halved in an area with real fuel poverty problems. Gas savings for the 12 month period post retrofit occupancy equated to a 47% reduction in properties' CO_2 emissions.

The post retrofit Measuring Change tenant survey (September 2011) further found that 65% of respondents reported big improvements in terms of draughts, whilst 31% reported some improvement. Changes in damp and mould both showed similar patterns, with 50% of respondents noticing a big improvement. Similarly, for ventilation the majority of tenants reported a big or some improvement (32% and 40% respectively).

At headline level, the study showed the combined changes meant that for every £1 invested in the retrofit programme society will benefit from a predicted return worth £1.58, spread across a range of stakeholders and social and environmental returns.

The SROI study concluded that over a 20-year period the monetised value of benefits to all relevant stakeholders was £3.43m, giving a total social value added (difference between the investment and the total social benefits) of £1.51m. Expressed as present value, after discounting, the benefits were calculated to be £3.05m, giving a net present value added of approximately £1.12m.

Through investing in a comprehensive approach, Salix Homes enhanced the value created by their retrofit project. They were able to demonstrate this through a number of different methods, across each and every stakeholder group. The resulting success of the project on the New Barracks Estate created a blueprint for this type of approach which could be replicated on future projects and expanded in scope.

Opportunities for community scale energy, landscape and water retrofit

Reaction to the climate change and fuel poverty agendas has meant that much attention in housing retrofit has been focused on energy performance in individual homes. As such, the space between buildings is rarely considered. This represents a missed opportunity for integrated works, with multiple benefits across different areas, impacting positively on a wide range of stakeholders. It is possible that the approach Salix Homes adopted to energy retrofit and measurement of its benefits might be adapted or extended to enable this type of 'landscape retrofit', in combination with more traditional material building retrofit.

Energy efficeincy issues:
Inadequate heating systems, water usage and mould growth from condensation.

Equally, the reach of retrofit could be extended to combine wider energy measures with water saving. For instance it could explore the feasibility of installing smart meters and small scale renewables such as solar power and local combined heat and power production. Water efficiency measures could include smart water meters and the disconnection of downpipes and grey water recycling, while sustainable urban drainage system based landscape retrofit could create habitats and amenity.

Moving up from the household scale, community-scale decentralised treatment for surface water and industrial/domestic grey water could be considered, as well as the possibility of sewer mining for light industry, landscape maintenance and localised food production.

Planters, swales, bio-retention ponds, permeable paving and kerb drainage could make use of the existing streetscape and enhance open spaces. These features could be used to develop community gardens, allotments, picnic areas and recreational spaces.

The aim therefore could be to retrofit both buildings and the landscape space around them in an integrated way. That would deliver social, environmental and economic benefits including reduced storm water runoff and flooding, water and energy conservation, food growing, increased biodiversity, carbon capture, play, improved public health and job and training opportunities. Such an approach would capitalise on the planning and householder engagement that is required for any retrofit, improving cost effectiveness and minimising disruption.

Such a comprehensive retrofit to properties and urban infrastructure would bring wider neighbourhood benefits including education, health, wellbeing and sense of place. Finally, as demonstrated through the SROI study at Salix Homes, the benefits of stakeholder engagement and impact measurement should not be forgotten. Both were used to focus effort and resources on the measures which would have the greatest social, environmental and economic impacts. They helped to align objectives and delivery and provided valuable feedback which will influence future programmes. The learning points and approaches used have great future potential, and that extends to water as much as to energy.

Headline Costs and Impacts (based on 20 year period)	
Total Investment	£1,928,775
Quantified socio-economic benefits (not discounted)	£3,281,609
Quantified environmental (carbon) benefits (not discounted)	£154,034
Present value of benefits (discounted over 20 yrs at 3.5%)	£3,052,500
Net present value added (benefits minus investment)	£1,123,725
Household/Tenant Benefits	
Average reduction in gas bills	Reduction of £353/yr (down from £624)
Draughts	65% saw a big improvement
Damp and mould	50% was a big improvement
Ventilation	32% saw a big improvement
Estimated carbon reduction per property	47% reduction

John H. Matthews
Conservation International

THE CLEAN ENERGY REVOLUTION

The convergence of clean energy and new approaches to infrastructure and freshwater ecosystems

The push for 'clean energy' is driving a new set of pressures to build more and larger dams. Global concern about the sources of climate change – human-derived greenhouse gas emissions – has revitalized interest in low carbon sources of energy in place of carbon-intensive fuels such as coal and natural gas. Hydropower is one of the most important 'clean' methodologies, for many reasons. The technologies needed to generate electricity from hydropower dams are well-known and straightforward to construct and operate. The payoff for the investment required in developing hydropower is high relative to many other energy sources, and large dams can – at least in theory – deliver a lot of power for very long periods of time. The oldest hydropower dams in North America and Western Europe date to the 1880s.

The Platinum Era of Dam Building?

Perhaps most importantly, the regions that have the fastest growing energy demand are also the areas with the least developed hydropower potential. Africa has tapped less than 10 percent of its potential, while Asia is approaching 25 percent and South America about 34 percent. In contrast, Europe and North America have exploited more than 70 percent of their hydropower potential. Of course, dams are not new. Humans have been building water infrastructure for flood control, agriculture, navigation, water supply and storage, and water quality and treatment for thousands of years. There are more than 48,000 large dams globally (i.e. over 15 metres or 49 feet), with a total of about 845,000 dams, concentrated in the most developed countries. A high proportion of these are used, at least in part, for hydropower generation.

Reflecting broader trends, the World Bank's new president Jim Yong Kim has shifted investment priorities to large hydropower investments to reduce the rate of additional climate change, particularly to so-called 'mega dams' in countries like the Democratic Republic of Congo and on the Zambezi River in Southern Africa, among others. Smaller (but still large) hydropower facilities are under construction globally. For instance, recent estimates suggest that more than 300 hydropower facilities are in process in the Himalayas, while the Andes have over 150 dams in development. At the same time, some countries are exploiting small and micro-hydro resources aggressively, with more than 5,000 small hydropower facilities being deployed in Austria alone. The so called 'golden era' of dam building ended by the 1960s in most of the world, but we appear to be entering a new time of accelerated growth – a 'platinum era' of dam construction – as climate change fuels a transition to more extensive, and larger hydropower facilities.

Climate Manages Us; We Don't Manage Climate

However, the engineers, decision makers, communities, and industries waiting for this clean energy have made a large assumption: the water necessary to generate electricity will be there at the right time and in the right quantities. much water at the wrong time could lead to dam damage and failure, flooding, and the erosion of human and ecological resources.

> "The most dangerous assumption, normally unspoken, is that climate is fixed and stable"

Too little and the needs of energy users are not met, economic growth and investments made with the assumption that power would exist are threatened; ecosystems are likely to lose with increasing human water demands.

The design of water infrastructure like hydropower dams represents a whole series of assumptions about climate, and these assumptions - about how water changes over decades, even centuries - can be dangerous if they are wrong or inflexible.

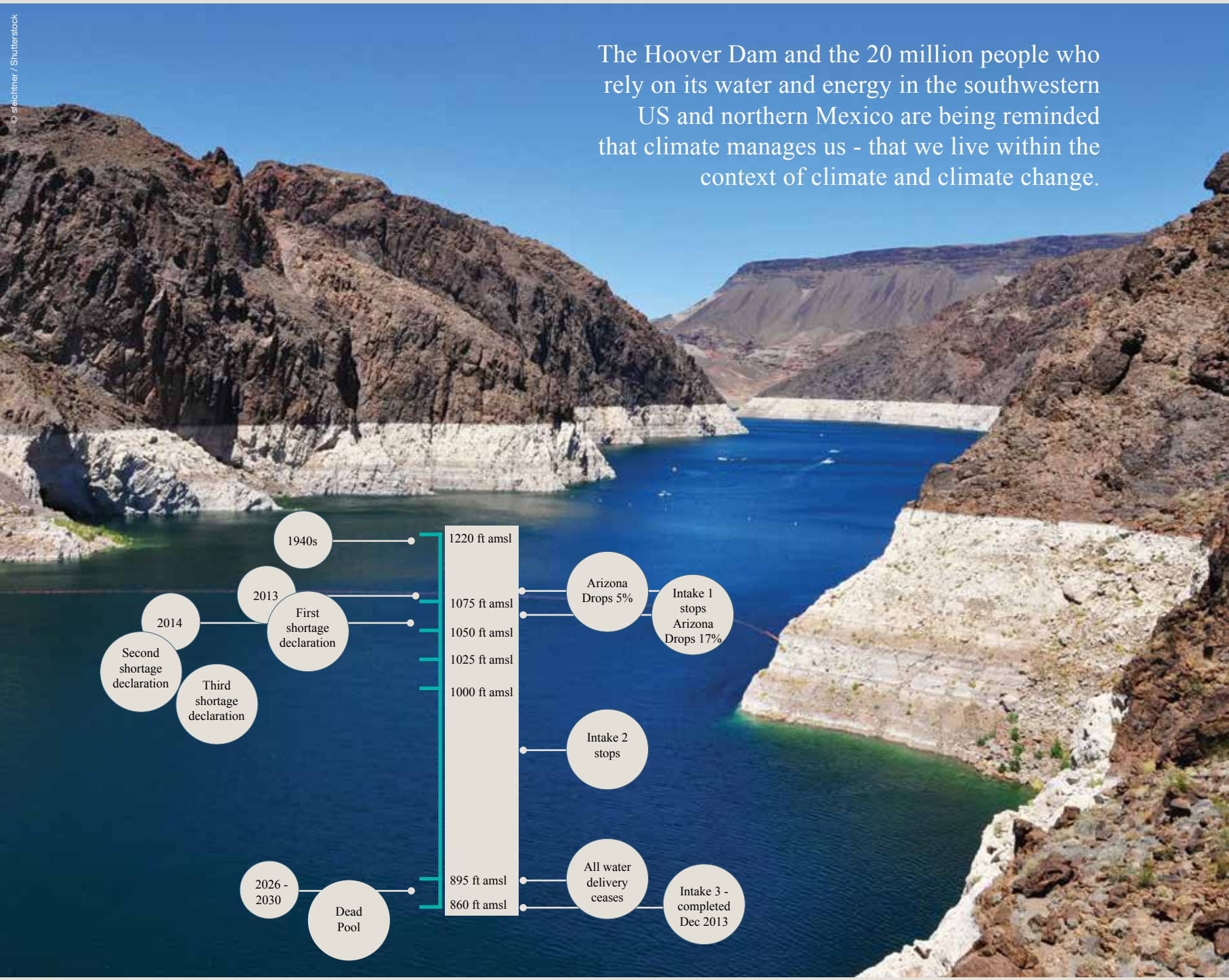
The most dangerous assumption, normally unspoken, is that climate is fixed and stable. Instead, observational and projected data suggest that we are entering a period of 'transformation' where fundamental ecological and hydrological qualities shift and places that have seemed familiar become strange and unfamiliar. Areas like the Murray-Darling basin in Australia or the high Andes show clear signs of unprecedented water stress. This is climate change beyond simple alterations in flooding and drought cycles. Asia's Tibetan plateau is a grassland that is becoming profoundly altered, capable of supporting quite different species, livelihoods, and industries, and losing many of the species, livelihoods, and industries it has supported. And where these regions lead, the rest of us will soon follow.

The risks are already manifest in several regions, where climate impacts and the process of transformation are well advanced. As the adjacent figure shows, the reservoir behind Hoover Dam is expected to fall below the primary water supply intake for the city of Las Vegas in 2014, triggering automatic demand drops downstream. Within a few years, local water managers are predicting that water levels will fall below the next lower water supply intakes, which coincides with the loss of hydropower generation and the start of even more severe limits to downstream water consumption.

Current projections suggest that the reservoir will reach 'dead pool' levels (effectively empty, leaving the poorest quality water) by the 2030s. The Hoover Dam was built in the 1930s, with about forty years of hydrological records for its design – assuming that these were normal, sustainable flows for the Colorado River. Instead, they were among the wettest of the past millennium.

The intervening decades suggest the region is transforming into conditions more comparable to the average of the past few thousand years.

The Hoover Dam and the 20 million people who rely on its water and energy in the southwestern US and northern Mexico are being reminded that climate manages us - that we live within the context of climate and climate change.



Climate and Hydropower: Finding baselines for freshwater ecosystems?

Current trends make sustainable management of freshwater ecosystems particularly challenging, both philosophically and practically.

The modern environmental era began near the end of the golden era of dam building. The burst in construction made clear that the impacts on lakes, rivers, and wetlands from water infrastructure are mostly negative if not profound and irreversible. Many of us saw rugged rivers we knew suddenly transformed into a reservoir, scarred by construction, harnessed into regularity. From an ecological science perspective, structures such as hydropower facilities - even with mechanisms such as fish ladders or soil flushing mechanisms - often modify critical hydrological and biological processes like temperature, sediment flows, and connectivity across river systems. Dams occasionally collapse and on rare occasions are dismantled, but for the most part dams represent a new and permanent baseline for an ecosystem. For environmentalists, a new dam often means adjusting to a diminished system – a shadow of what was there before.

"Current trends make sustainable management of freshwater ecosystems particularly challenging, both philosophically and practically."

In contrast, to ecologists climate change represents an old, recurrent force that churns species – where they live, when behaviors occur, how species interact with each other and with physical processes, the expression and selection of genes and evolution. During accelerated climate change periods such as ours, baseline standards have limited usefulness. They tell us something about an 'old normal' but their relevance to some emerging normal is harder to estimate. Ecology has limited abilities to be able to predict future states. The intersection between the diminished baseline of a dam and the shifting climate impacts is even harder to define.

From engineering for the old climate to eco-engineering for new climates

The convergence of a proliferation of new dams and the recognition that transformation is in our (near?) future present profound changes for how we organise our societies and economies, and how we manage other species and natural resources more broadly. They imply a more comprehensive view for sustainability and living and designing with water and with future climates. What do these futures look like? How is this vision becoming expressed? How do economies develop in a way that can encompass many uncertain futures – economic, ecological, climatic?

Regions such as Bogota, (pictured left), the capital of Colombia, have begun to face these shifting conditions by changing land-use patterns for hydrologically and climatically sensitive zones, reducing pressures on these regions, and beginning to think of the natural landscape as a new form of dynamic water infrastructure, to be managed humbly. Groups such as Conservation International have

been engaged by local and national governments to address risks and leverage new opportunities. These are admirable, progressive changes.

A complete vision may take some years to form, but we are clearly beginning to think about multiple futures - wetter and dryer, multiple transformations, and increasing flexibility. Can we build dams to be reprogrammed like software, capable of operating under multiple climate conditions?

Can we design dams that can be built in stages, over decades, so that we can avoid locking ourselves and our economies into conditions that no longer exist? Can we even design dams that can be dismantled, removed, or repurposed if the climate moves beyond their parameters? These represent an unfamiliar and mostly unexplored but exciting approach to building, designing, and managing water infrastructure within emerging boundaries, and taking into account communities and ecosystems as well as energy and economies.

Stuart Orr
Head of Water Stewardship, WWF

RESPONSIBLE BUSINESS

Responsible business engagement in water management

For many years now, governments and international development agencies have formulated and implemented public policy on water issues. That includes the most suitable principles and most effective approaches to manage and regulate the development and use of water resources (rivers, aquifers, dams, etc.) and associated water supply and sanitation services.

The typical position of the private sector (particularly companies that use water in production) has been to resist increased regulation. The extent of their cooperation has largely been limited to providing financial or management expertise on a contract basis or in partnership with government. The underlying assumption was that, with appropriate management, there would be enough water of adequate quality to service economic production and to meet people's basic needs.

In the past decade, this paradigm has shifted. Governments now wrestle with significant trade-offs and costs in public water management, while companies have experienced how water issues can affect the bottom-line.

This is reflected in the responses of the 58 companies reporting to the Carbon Disclosure Project's Water Disclosure initiative in 2012. 53% of these companies state that they have experienced detrimental water-related impacts in the last five years; 68% have identified water as a substantial risk to their business[1]. These are not insignificant companies, together representing a market value of US$2.49 trillion- equivalent to the GDP of a G5 country. They collectively abstract more than 1,500 billion litres of water per annum, equal to 0.6 litres per day for every person on the planet[2].

These reported water related impacts and risks reflect externally-imposed uncertainty and create vulnerability. Companies are feeling the heat through failed management systems, deteriorating water infrastructure, weak governance and poor monitoring and regulatory frameworks. The result is that the private sector now places water near the top of the global risk agenda[3]. The general malaise of government delivery on water in many parts of the world is challenging company operating performance, creating cost pressures, and making reputations increasingly vulnerable[4]. Corporate risks relating to water are categorised in Figure 1, taken from WWF's 2013 Brief on Water Stewardship[5].

This heightened interest in corporate risk has generated a new set of jargon, with "stewardship" topping the list. In corporate circles, stewardship has come to represent how some sectors and companies are defining their role in relation to water management challenges. Stewardship initiatives reflect a shift in priorities wherein company participation in collective action on water policy (e.g. working with other sectors such as government) is more rigorously explored[6]. While engagement in water policy-related processes at the local, catchment or national level may reduce water related risks, it introduces other uncertainties and challenges, particularly as water management is not a mandate or core business element for most companies.

The water risk literature for business has rated sectors and companies in order to assess costs, profits, and future growth. This literature has delved into risks facing the insurance sector, business operations and financial institutions to name a few[7]. There are now also tools that enable companies and investors to get a coarse understanding of water risk. However, company motivations differ, with variations as to the buy-in, urgency, awareness, sector and location. While there are a lot of interested companies wanting to do more than Corporate Social Responsibility (CSR), the complexity of water issues confounds even the most aware. The more progressive companies are taking the time to estimate risks and costs and weigh up actions that make sense; building long-term strategies that challenge their operational managers to beyond limited considerations of plant efficiency.

Figure 1
A categorisation of Water Related Corporate Risks

	Physical Risk	**Regulatory Risk**	**Reputation Risk**
Basin-related Risk linked to location	Water quantity (scarcity, flooding, droughts) and quality (pollution) within the river basin and the impacts this mighth have on society and the environment.	Strength and enforcement of water regulations and the consequences of restrictions by public institutions; either felt through direct regulatory action or from neglect, blockages or failure.	Perceptions around water use, pollution and behaviour that may have negative impacts on the company brand and influence purchasing decisions. Public perception can emerge rapidly when local aquatic systems and community access to water are affected.
Company-related Risk linked to behaviour	Water quantity and quality issues related to the performance of the company and the supply chain.	The potential for changes in pricing, supply, rights, standards and licence to operate for a particular company or sector.	When the actions of the company are poorly executed, understood or communicated with local stakeholders and where perceptions and brand suffer as a consequence.

Corporate Responses to Water Security Threats in South Africa

As an example, Sasol, a global integrated energy and chemicals company mainly based in South Africa, recognised that due to water-stressed conditions, water security was becoming a material challenge to its operations in the Vaal River system. Studies by the Department of Water Affairs indicated that water shortages in the area could arise in the absence of significant action. Sasol uses about 4% of the catchment yield; municipalities use approximately another 30%, losses from which can be as high as 45% due to the aging infrastructure.

> "The domain of policy and regulatory capture is of particular concern, where some fear that water will be unfairly allocated to the already powerful."

The company realised that by working beyond the factory fence, bigger advances could be achieved in enhancing water security in the catchment area, and at a lower financial cost. That led them to approach municipalities to implement water conservation initiatives that would make a substantially greater contribution to improving water security than what would have been realized by focussing only on enhancing water management in its internal operations. By investing in the municipality as opposed to their plant, Sasol obtained higher water saving rates, accrued the benefits they were seeking in water supply, and contributed to the wider community's water supply through improved municipal works. All at a fraction of the cost of using internal technology implementations alone.

Sasol's engagement with the Emfuleni Municipality freed up water and eased supply to all users in the catchment area while supporting the government in reaching its water savings targets. Their corporate risks led them to explore water management practices external to their operations, with enhanced environmental and social impact as a result and long-term financial returns.

While these advances may seem a drop in the ocean, they indicate the potential for changing mindsets within companies. The water community too can explore a different role for companies in addressing shared water challenges. There is tremendous potential around improving efficiencies, but it remains essential to define the roles and responsibilities and intent of concerned companies like Sasol, in order to determine how their actions outside of their factory walls will result in the right mix of public and private benefits[8].

Private Sector Influence on Water Governance

The domain of policy and regulatory capture is of particular concern, where some fear that water will be unfairly allocated to the already powerful[9]. Ironically, it is in those areas with the greatest potential for private sector growth – emerging markets – where the vulnerability to policy or resource capture is the greatest, mainly because of weak and often dysfunctional water institutions. These same areas are often where most is at stake in terms of human welfare and biodiversity conservation.

The form that engagement activities take will depend on the sector's ability to influence policy makers and whether the company or sector is a strategic partner

of government (energy, water provision) or a manufacturer of goods. While there are compelling arguments for businesses to address the risks they face from water restrictions by engaging on water governance, there are potentially new risks from not approaching challenges in the correct way. The importance of water to the environment and communities, as well its relevance to food and energy security issues, means that water policy and its implementation is ultimately a government responsibility. The CEO Water Mandate's Guide to Responsible Business Engagement with Water Policy[10] sets out five principles that should guide company action beyond the fence-line.

Principle 1: Advance sustainable water management.

Principle 2: Respect public and private roles.

Principle 3: Strive for inclusiveness and partnerships.

Principle 4: Be pragmatic and consider integrated engagement.

Principle 5: Be accountable and transparent.

Conclusion

Stewardship is about guiding and supporting government policy, not supplanting it, and certainly not thwarting or undermining its implementation. A key challenge for water stewardship is to broaden the discussion of water problems from sector – or business – specific concerns, in order to develop a common understanding of the challenges and drivers of water problems across government, the private sector, civil society and communities. The private sector's evolving concern may prove to be the catalyst that sparks the public sector to act, thereby adding significant emphasis to the very issues that compel us to work on the better management and governance of water resources.

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MEASURES THAT MOVE

Value transfer applied to ecosystem services in the Humber Estuary

Why should we put values on the environment? Environmental valuation is increasingly recognised as an important tool for representing the value of natural capital and ecosystem services to society. It is integral to the UK Government's commitment to an ecosystem approach to environmental decision-making. Through the use of a common monetary metric, it provides a means for including environmental values in policy appraisal. It can also help inform our understanding of the synergies and trade-offs between the ecological value of a landscape and market-driven development.

The lack of a direct market for many environmental goods and ecosystem services means that they are often undervalued in decision-making[1]. This is because the benefits of these services tend to accrue to the general public, rather than to landowners[2]. Environmental valuation has the potential to remedy this by creating artificial or alternative markets that estimate the value of such non-market resources. For example, the value of a National Park could be assessed by considering how much visitors are prepared to pay to travel there, using the travel cost method. Likewise a component of the value of a peatland conservation site could be inferred from the increase of house prices in its vicinity, through a technique called hedonic pricing. An ecosystem services framework goes a step further by providing an understanding of the functional values provided by the natural environment. The economic value of the peatland site would therefore take into account its contribution to a range of ecosystem services including water retention, carbon storage, nutrient cycling, environmental settings and recreation.

The role of value transfer techniques

Environmental valuation can be a time – and labour - intensive process, especially where an environment provides a wide range of non-market ecosystem services. This has led to considerable interest in value transfer techniques[3], whereby economic values for environmental goods or services for one location can be transferred to another location for use in policy decisions.

In order to assess the value of environmental costs and benefits relating to a specific policy or proposal, decision-makers need to have both an estimate of how much the goods or services provided will change, and an estimate of the value of a marginal (per unit) change in this provision. One example where knowledge of such changes and marginal value can be useful is in assessing the value of landscape change over time. Value transfer is already used widely in policy appraisal in some environmentally-related decisions, such as the valuation of the health effects of air pollution and the valuation of transport noise[3]. However, it has been applied much less widely in other areas such as terrestrial and marine biodiversity, landscape and recreation.

The relationship between biodiversity, ecosystem functions and ecosystem services

Despite much work on the relationship between biodiversity and ecosystem functioning, the translation of ecosystem functions into services and benefits remains, for the most part, poorly quantified. Approaches commonly focus upon a single link in the chain of ecosystem service provision, for example, either studying the relationship between biodiversity and ecosystem process rates, or valuing service provision to mankind (Figure 1).

Ecosystem services in coastal wetlands and the Humber Estuary

Coastal wetlands constitute some of the most highly valued and productive ecosystems on the planet. They provide services that are integral to the maintenance of life on Earth, including nutrient cycling, carbon storage, and regulation of greenhouse gases. Furthermore, they are extensively used by people, for recreation and cultural amenities, food supply and the provision of raw materials.

A range of economic valuation techniques have been applied to ocean and coastal resources[4]. Here we demonstrate how value transfer can be applied to ecosystem services in the Humber estuary.

The Humber is one of the largest estuaries in the UK. It is a shallow, macro-tidal estuary of high turbidity. Maximum tidal range is 7.2m and the estuary is 15 km at its widest. The surrounding land is predominantly high-grade agricultural land, but it includes urban areas such as Hull and Grimsby and is economically important (see Rory Canavan's article in this publication). Extensive land reclamation has drastically reduced the intertidal area, from 550,000 ha prior to reclamation to the current 11,000 ha. Over 33,000 people live on reclaimed land, below the level of high spring tide[5].

The estuary provides extensive wildlife habitat and is of international importance for waders. It harbours benthic fauna which provide the basis for wader food supply, and it is an important nursery habitat for fish. Surveys routinely record 16 species, those caught commercially include sole, plaice and cod, and the migratory species supported include salmon and trout.

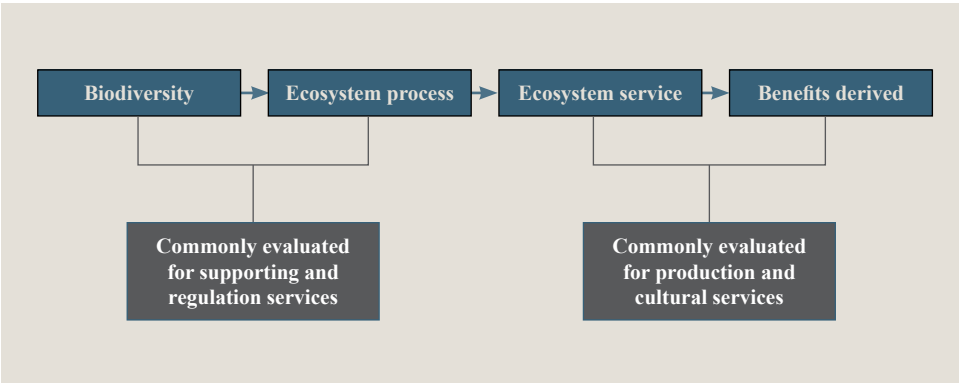

Figure 1:
Simplified model showing the flow of ecosystem services from biodiversity through to benefits

A framework of ecosystem service provision for the Humber

Here we highlight three types of ecosystem service, following the classification in the UK National Ecosystem Assessment:

– provisioning services (food provision);

– regulating services (nutrient cycling); and

– cultural services (recreation)

Figure 2 sets out how habitats and ecosystems processes in the Humber support these services and the benefits that are derived from them.

The role of biodiversity varies for different services. In the case of food provision and recreation, it provides direct benefit to mankind. However in relation to nutrient cycling, biodiversity drives coastal productivity through its underlying support and maintenance of other services – so its benefits are indirect and less easily quantifiable (although arguably the most valuable).

The valuation exercise described is only partial and many aspects of ecosystem service provision are not covered. For example, the function of sediment biota is highly complex and ranges far beyond that of nutrient cycling. Moreover, only one aspect of nutrient cycling is considered (macrofaunal sediment bioturbation). Finally, nutrient cycling involves all biotic components of the ecosystem, such as microbes, which are excluded.

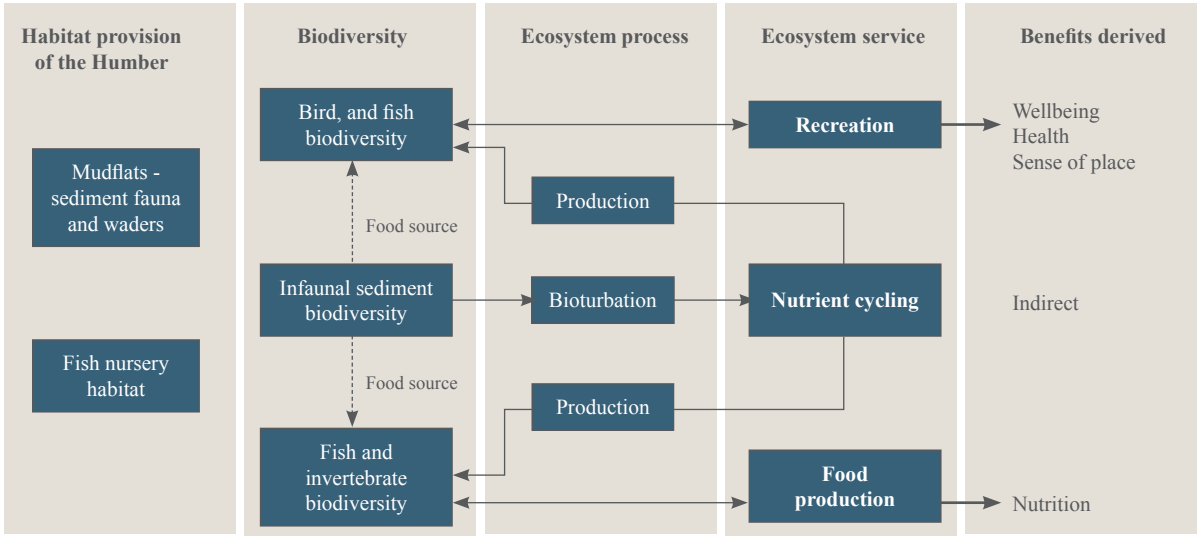

Figure 2: Linkages between biodiversity and the provision of services to mankind in estuarine systems

The economic values of Humber estuary ecosystem services

Literature review provided a range of values for food provisioning, recreation and nutrient cycling, mostly based on overseas studies. Values can be extremely wide-ranging. For example, the value of recreational fishing in similar habitats in the USA ranged between £1.50 – £1,500 per ha, based on nine studies. For the Humber, birdwatching emerged as the most valuable use, followed by commercial fishing and then recreational fishing (Table 1). The benefits transfer approach allows these values for ecosystem services to be used to estimate the value changes that would stem from future changes in land use in the Humber. For example, an increase in birdwatching area of 1 ha would on average equate to an increase in value of £ 425 per year, while a 1 ha increase in recreational fishing would be worth £ 125 per year.

Sources of error in value transfer

Whilst the value transfer approach allows economic values to be derived for a site in the absence of primary valuation studies there, the technique does involve numerous potential sources of error:

–**Value uncertainty**. Valuation relies on people's ability to meaningfully express values and preferences in monetary terms - thus it is by no means an exact science and has received widespread criticism. Nevertheless, economic valuation is the sole available means of quantifying the value people place on ecosystem services, which may otherwise not be valued at all in decision-making.

– **Transfer error.** Any errors made in the original study are retained and exaggerated when transferred to a different site. Consequently, the accuracy of benefits transfer is dependent upon the robustness of the underlying data and the similarity of the characteristics of the source study site and the site findings are applied to.

– **Inter-reliance of habitats**. An ecosystem service may be delivered by a number of different habitats. Similarly, a single habitat may contribute to a range of ecosystem services. These habitat-service relationships may also vary with site based factors. Hence the standard benefits transfer approach can over-simplify complex environments. One solution is 'function value transfer' (rather than the standard unit value transfer), based on understanding of site based variables affecting ecosystem service. However this approach requires considerably more detail, which is often unavailable.

– **Scale-dependence.** Assumptions regarding scale-dependence become relevant when unit values are extrapolated over larger areas. In the calculations above, we assumed a linear relationship between value and area. Thus each unit area of wetland is of equal value and the marginal value is independent of the capital stock. This assumption is unlikely to be met. For instance some studies suggest that unit benefits and values reduce as the area of a site increases.

– **Exclusion of other potentially significant considerations.** These could include changes in habitat quality or density of food resources. Habitat quality is thought to be highly significant in determining the level of ecosystem service provision, and the use of habitat area (or stock) alone is likely to be a poor surrogate for estimations of value that incorporate quality and biodiversity.

Service	Wetland use	Habitat area for service provision (ha)	Per unit value (£ per ha per year, 2009)		Service value for Humber (£ per year)	
			Range*	Average	Range*	Average
Recreation	Recreational fishing	19,551	33 - 470	125	651,194 – 3,010,860	2,447,121
	Birdwatching	11,000	185 – 975	425	2,036,295 - 10,729,111	4,674,221
Food provision	Commercial fishing	19,551	38 - 1970	273	740,305 – 38,509,587	5,332,941

Table 1:
Estimation of economic values for service provision on the Humber
* Range is based on upper and lower 90% confidence limits

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Conclusion

Economic valuation of the natural environment remains controversial. However, in the absence of such values, many of the benefits provided by the natural environment are likely to be undervalued in the decision-making processes. Value transfer provides a way of attributing economic values to ecosystem services and benefits in localities for which primary data is lacking.

There are problems with this approach because economic values are inherently context-dependent, and there is a need for better understanding of where inaccuracies are most likely to occur. Nevertheless, an increased emphasis on an ecosystem approach to environmental decision-making means that the need for value transfer is likely to grow. Value transfer should not be taken as a reliable means of delivering absolute values, but it can help to convey the importance of natural environments in monetary terms, and thus provide a means for incorporating biodiversity and ecosystem services more formally into strategic and local planning decisions.

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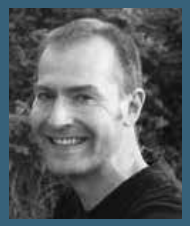
The James Hutton Institute

Professor Robert C. Ferrier
The James Hutton Institute



Jon Rathgen
Water Industry Team, Scottish Government

SCOTLAND
THE HYDRO NATION

The role of ecosystem services in meeting Scotland's Hydro Nation Challenge

The Hydro Nation Challenge and the Water Resources (Scotland) Act

In December 2010, the Scottish Government announced its intention to develop Scotland as a Hydro Nation. This is a 'nation that manages its water to the best advantage, employing its knowledge and expertise at home and internationally'[1].

The Hydro Nation challenge is to place Scotland as a world leader in:

(i) the governance of water resources, partnering with other nations in developing their water governance framework;

(ii) the performance of its water industry and its transformation to low carbon sustainable approaches;

(iii) the role that its research community takes in international research programmes; and

(iv) the value of its water resources for the economy.

As part of this challenge, the Water Resources (Scotland) Act (2013) places a duty on Scottish Ministers to:

(a) take such reasonable steps as they consider appropriate for the purpose of ensuring the development of the value of Scotland's water resources, and

(b) do so in ways designed to promote the sustainable use of the resources.

The role of ecosystem services

In 2012, Scotland's Centre for Expertise in Waters (CREW), an independent government-funded 'knowledge hub' supporting the Hydro Nation initiative, summarised current academic perspectives and evidence on the value of water resources in Scotland to support the development of the Act[2]. This analysis highlighted that freshwaters not only provide society with goods that are critically important to human wellbeing, such as clean water and energy, but also other services that are less tangible but equally important to humans. For example, water environments support recreational activities and they have great cultural significance. Natural hydrological processes underpin flood protection, flows can dilute the impact of polluting activities, and the different forms of water bodies support diverse wildlife and biodiversity. All these benefits are the so-called 'water ecosystem services'.

The way nature works and delivers services is complex, and often generates trade-offs. This means that not all services can always be realised at the same time. Moreover, changes in the condition of freshwaters can lead to significant changes in how ecosystems function, which in turn affects the provision of these services and the associated benefits. Water ecosystem services are threatened globally by climate change, abstraction, pollution, invasion of alien species, land conversion and agricultural practice.

In Scotland, there has been considerable change in ecosystems and the services they provide over the past years. The delivery of some services, such as the provision of food and energy has increased considerably. However, other ecosystem services have been negatively impacted (e.g. habitat loss and changes in nutrient storage and cycling). Understanding the value that society places on water ecosystem services is necessary to make optimal decisions about their current and future use and conservation.

The predominant framework used to interpret and measure the value of ecosystem services is that of neoclassical economics, which associates wellbeing with human welfare measured in monetary terms. A range of methods have been developed to estimate the monetary value of water ecosystem services, such as hydropower, angling, flood risk mitigation and recreation, as well as 'non-use' values (related to the mere existence of an ecosystem or asset).

Monetary valuation does not mean putting a 'price' on water, but using monetary units as a metric to measure the welfare or benefits associated with natural resources. The advantage of measuring value in monetary terms is that it allows comparison of the benefits associated with water ecosystem services with the costs of ensuring their provision, providing economic efficiency criteria for decision-making. However, many criticise this approach, arguing that the reality of human wellbeing is more complex than just money and voicing moral concerns about the risk of monetary valuation reducing nature to a tradable commodity (see Les Newby's article in this publication for a summary of the debate). Acceptance that not all values can be monetised is gaining consensus and alternative, non-monetary frameworks that try to quantitatively or qualitatively analyse the value of natural resources are being developed.

The evidence provided by the CREW analysis resulted in the amendment of the Act in its final parliamentary stage through which it was established in statute that 'the reference to the value of water resources:

(a) means the value of the resources on any basis (including their monetary or non-monetary worth),

(b) extends to the economic, social, environmental or other benefit deriving from the use of the resources, i.e. to the full range of ecosystem services.'

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Challenges ahead

The challenges for the development of Scotland's vision for water ecosystem services relate to two broad areas[3] – the valuation of ecosystem services, and how those values are used.

How to accurately assess the value of water ecosystem services

Although monetary valuation is well established as an academic discipline, methodological boundaries impose limitations for 'real life' applications. The critical challenge lays in the development of models capable of reflecting the natural process of service delivery, and how to link this to the way people perceive and value those services. Valuation needs to be based on ecological indicators, but there is a degree of uncertainty about the outcomes of water interventions in terms of 'final ecosystem services'. To deal with this obstacle, valuation techniques need to account for ecological spatial issues, time lags, risks and uncertainty. Moreover, applying valuation techniques is expensive, so cost-effective alternatives are needed, such as the so-called 'value transfer technique' (as discussed by Catherine Baldock and Piran White elsewhere). Furthermore, current research on the assessment of non-monetary values needs to be continued, for example, on issues related to equity and plurality of values.

Left:
The Hydro Electric Power Dam at Loch Lyon in Scotland

How to 'use' the value of water ecosystem services

Methods for incorporating non-market values into cost-benefit analysis have been developed. But these become more complex when additional issues such as distributional effects and equity considerations need to be incorporated. For example, evidence suggests that the implementation of the Water Framework Directive might be beneficial for society overall, but that it places most of the cost-burden on the agricultural sector[4]. Further investigation is also required into how best to link ecosystem services values into green accounting frameworks (such as the ones currently being promoted in Scotland[5]), particularly in relation to incorporating less tangible services, such as flood regulation or cultural values. Additionally, further work is needed regarding how to include non-monetary values in decision-making frameworks and indices of prosperity.

What does this mean for the Scottish water industry?

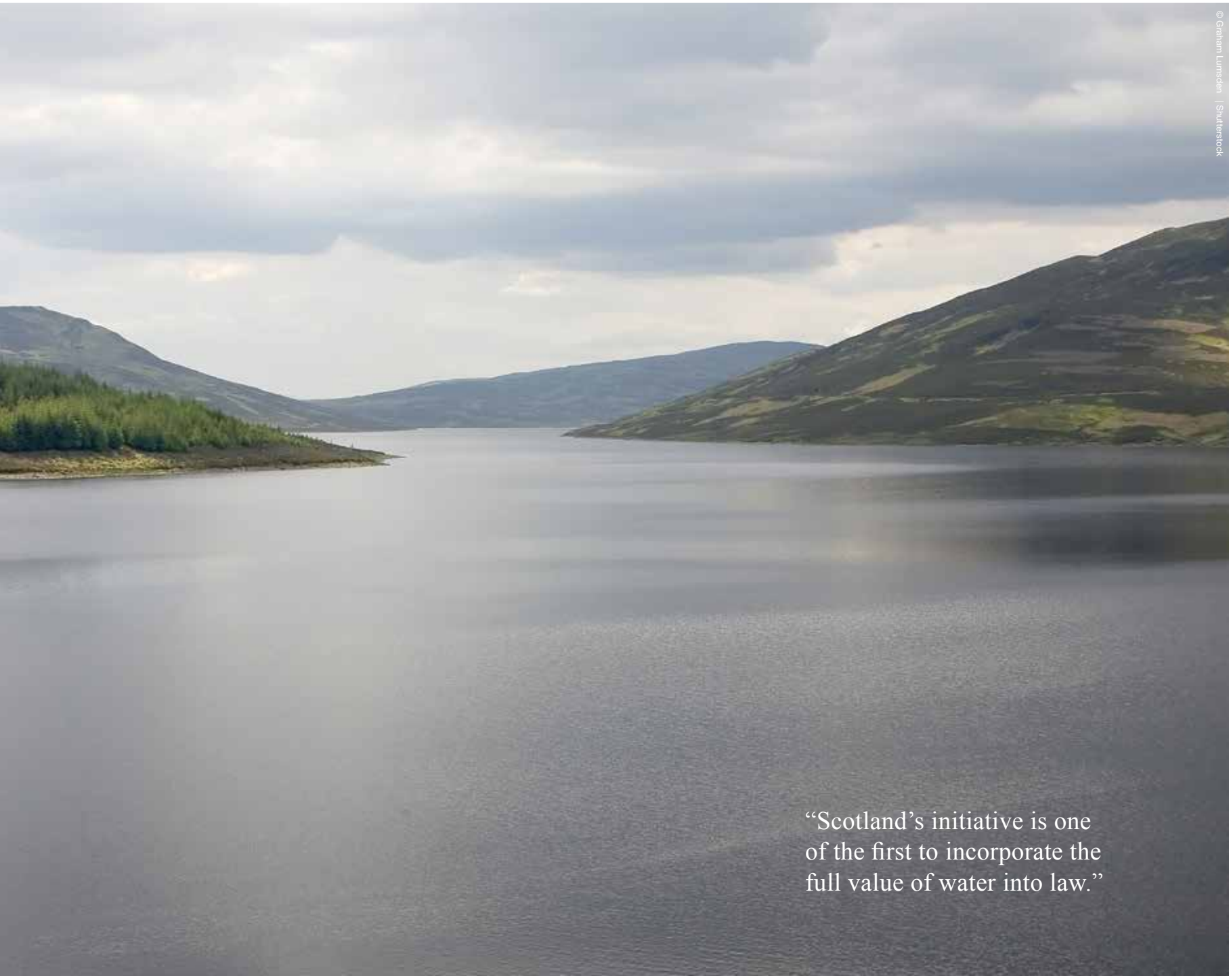
Despite the clear importance given to the water industry in the Hydro Nation vision, the Water Resources Act is not very specific on mechanisms to enrol the industry in the commitment to develop the value of water resources. The Act provides for Scottish Water to 'do anything' that it considers will assist in this goal[6], Part 4-Section 28 of the Act enables Scottish Water to 'enter into voluntary agreements with the owners and occupiers of land, or with local authorities for the carrying out of activities that [it] considers will help protect or improve the quality of raw water'. Although probably not originally intended with this specific purpose, this can be interpreted as an entry point for the establishment of Payments for Ecosystem Services schemes, whereby land managers are paid for changes in practice that lead to reduced water pollution. A pilot PES-like programme promoted by Scottish Water already exists in several catchments[7]. However, further and clearer guidelines, and very importantly, output-based monitoring mechanisms, are still required.

It is important that industry commitment extends beyond Scottish Water. There is increasing recognition of the importance of water ecosystem services for business, but so far, proactive actions towards using a water ecosystem services approach are limited to a small number of companies[8]. Research findings suggest a number of avenues to reverse this situation: further engagement and information sharing with businesses; promotion of sector-specific water ecosystem services stewardship guidelines and standards; and development of science-based water footprint assessment guidelines and measurement tools for business [9].

Conclusions

Scotland's Hydro Nation initiative represents one of the first examples of the incorporation of the notion of 'value' of water resources into legislation. The Water Resources (Scotland) Act also extends this to non-monetary values and to the full range of ecosystem services delivered by water systems. This provides an enabling framework for the water industry to engage in more sustainable and socially beneficial management of water resources. However, for this to become effective, specific mechanisms to promote the active engagement of Scottish Water and other businesses need to be encouraged.

Right:
Loch Errochty Hydro Reservoir in Perthshire, Scotland



"Scotland's initiative is one of the first to incorporate the full value of water into law."

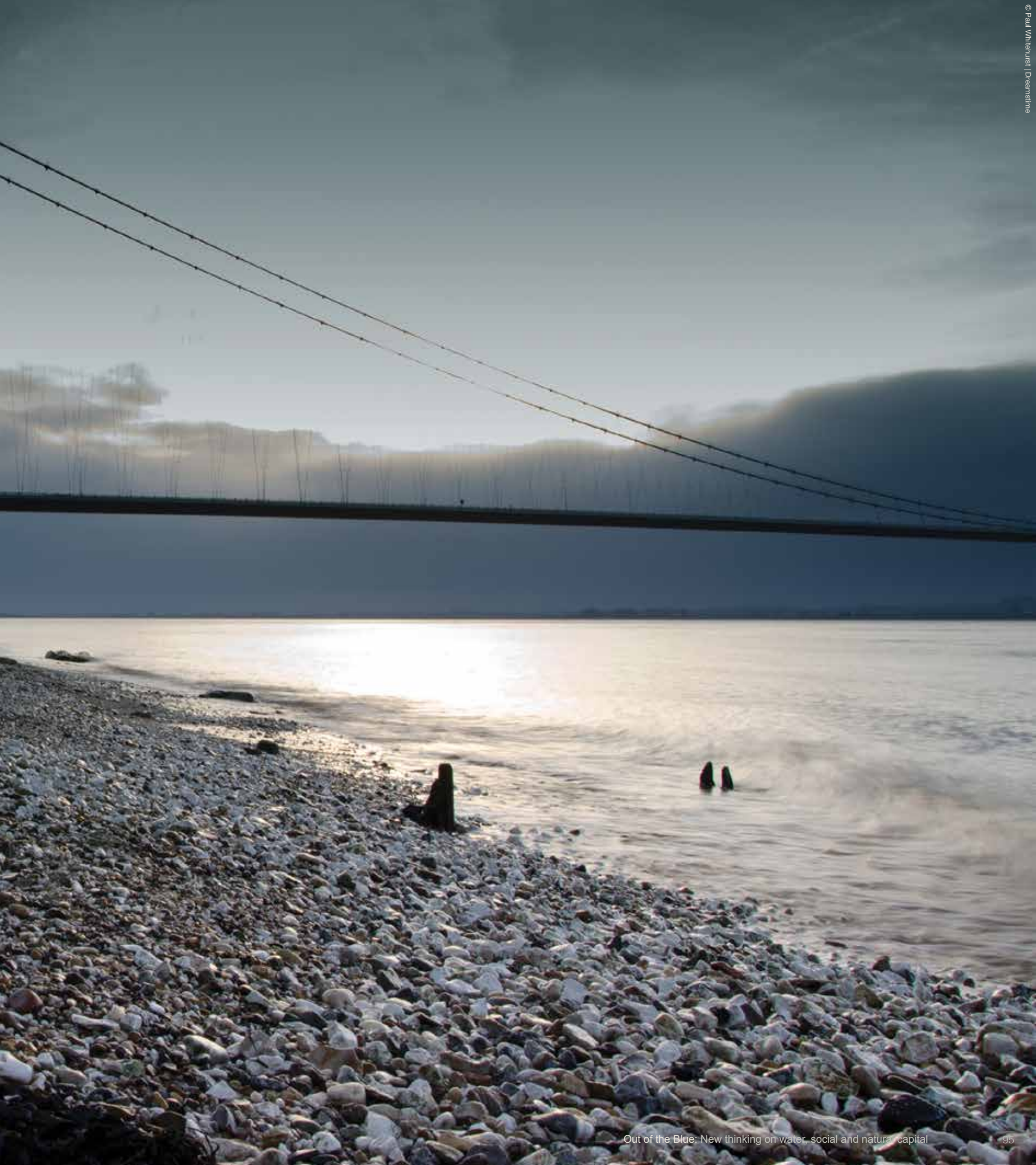
Rory Canavan
Associate, Ecology and Sustainability, Arup

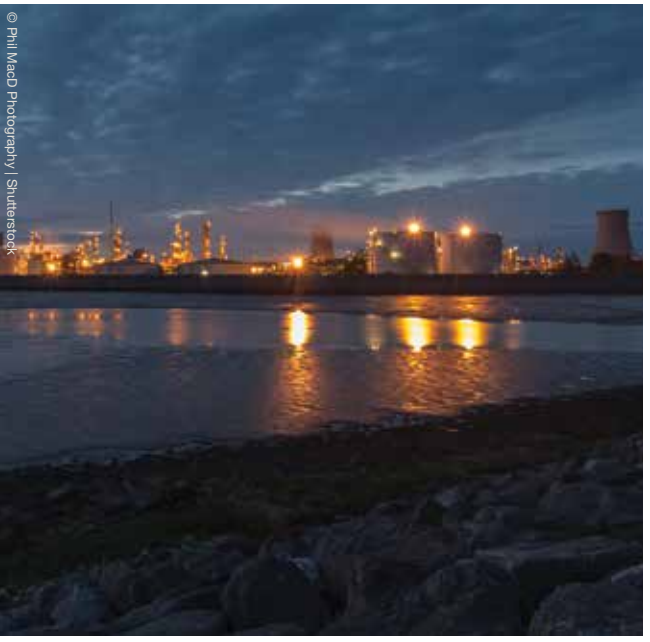
Dr Sue Manson
Flood and Coastal Risk Management Advisor (Humber), The Environment Agency

BRIDGING THE ECOLOGY-ECONOMY DIVIDE

Managed realignment in the Humber Estuary and valuation of ecosystems services

The economic and social importance of the Humber Estuary and its ports cannot be overstated. It is the UK's busiest trading estuary handling 16% of the country's seaborne trade, and the 5th largest in Europe. The Humber Ports are a vital part of the economy, employing around 15,000 people.





The Estuary's environmental importance is equally impressive and its long list of designations include those as a Special Protection Area (SPA) and Special Area of Conservation (SAC) under the EU Habitats Directive and Birds Directive; as well as a Ramsar Site and a Site of Special Scientific Interest (SSSI). These areas encompass all the intertidal habitats present within the estuary and span approximately 10,000ha.

Whilst the Estuary's economic and environmental assets are considerable, so is the potential for conflict. Difficult choices can arise where economic opportunities – currently including major developments in the offshore wind sector – require or impact upon land that has ecological value or which faces pressures such as flood risk. Given the area's high unemployment, many decision makers will see jobs and growth as the priority. Mechanisms are needed that allow jobs and economic progress whilst also valuing and maintaining environmental qualities.

Natural capital and the Ecosystems Services approach

In addition to providing economic, cultural and ecological benefits to communities, estuaries deliver invaluable natural capital or Ecosystem Services (ES) functions (see box). These include cycling and movement of nutrients, purification of water, maintenance of biodiversity and biological production[1]. They also act as buffer zones; stabilising shorelines and protecting coastal areas, inland habitats and settlements from flooding. When flooding does occur, estuaries often act like huge sponges, soaking up the excess water.

One method of valuing the societal benefits from environmental assets - and policies or land management options that support them - is through applying an Ecosystem Approach. This brings together consideration of natural, economic and social sciences into a single methodological framework. It combines this holistic perspective with an accounting exercise that seeks, in economic terms, to understand the change in value that might arise from a management intervention, investment or impact – such as the creation or destruction of assets.

Flood risk, the Humber and managed realignment

Estuaries are some of the most heavily used and threatened natural systems globally[2], and deterioration due to human activities (e.g. coastal squeeze or development pressures) is intense and increasing. The Humber Estuary is no exception. One of the key issues it faces is rising sea levels, partly as a result of climate change. This is leading to greater pressure on sea defences and the widespread flood risks to low lying land.

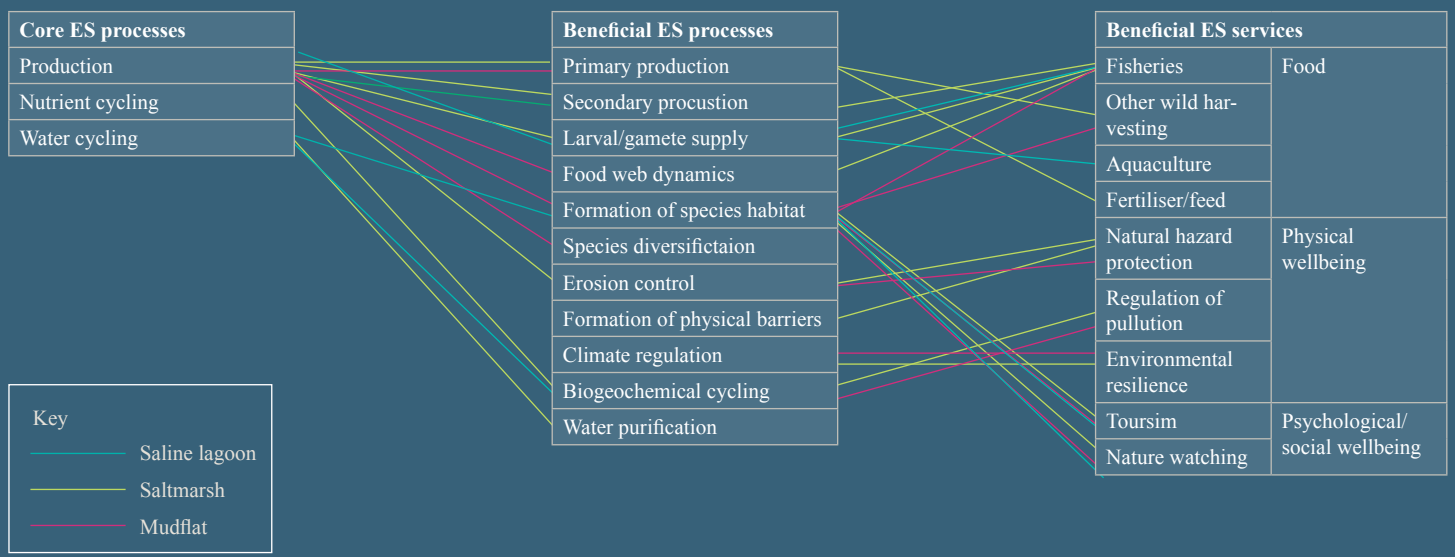
Within the Humber area, almost 400,000 people live in the floodplain whom are currently protected by embankments. Higher sea levels have serious implications for flood defences and require consideration of either traditional responses such as heightening/reinforcing or building new hard defences; or alternatively an approach that works with natural systems, e.g. managed realignment.

Managed realignment is the process of deliberately setting back the line of coastal defences to a new line inland of the original. This promotes the creation of intertidal habitat on the land between the old and new defences. The pressures on the sea defences are reduced which has economic benefits, and the range of ecosystem services are maintained and potentially enhanced. Four such schemes have been undertaken in the Humber Estuary since 2003, creating 519ha of (mostly) intertidal habitat.

Ecosystem services defined [1]

Ecosystem services (ES) are defined as 'the benefits which people derive from nature' or more precisely 'the aspects of ecosystems, utilised actively or passively, to produce human well-being.' The field of ES aims to classify, describe and assess these natural assets, their demand and supply functions, quantification, valuation and management. ES are currently categorised as the supporting, provisioning, regulating, and cultural services generated and ensured by ecosystems.

Figure 1:
Intertidal habitats ecosystem services - processes and benefits [5].



Valuing the ecosystems services on the Humber Estuary

In England, the Environment Agency has lead responsibility for flood prevention and environmental protection and is expected to take into account economic factors in discharging that role. It commissioned Arup, in collaboration with ABP Marine Environmental Research (ABPmer), to inform how it manages this balance in the Humber.

The work involved reviewing the benefits of managed realignment schemes in the UK; reviewing ecosystems services (ES) valuation methods; and critically evaluating how far such methods could assist the EA with the economic appraisal and promotion of managed realignment schemes with stakeholders in the Humber. It was further tasked with recommending how such an approach might be developed and implemented on future schemes.

The project was part of a wider Environment Agency strategy of adopting an ecosystem approach within its work, in line with the principles set out in the government's policy on the natural environment (e.g. Natural Environment White Paper[3] and the Ecosystem Approach Action Plan[4]).

Most managed realignment schemes replace productive agricultural land, and local landowners and farmers frequently contest how far this change of land use is appropriate. However, the schemes create new saltmarsh, mudflat and saline lagoon habitats that provide a distinct range of ecosystems services of direct benefit to people and society. Figure 1 summarises the beneficial ecosystem processes and services provided by intertidal habitats.

The other facet of an ES assessment is economic valuation - which is important for cost-benefit analysis. The case for ES valuation in decision making is based on the view that typical cost-benefit approaches overlook environmental impacts since these cannot be measured in monetary terms. A failure to value such resources gives them an effective 'zero' price in economic assessment.

The UK government 'Green Book' guidance on assessing projects and proposals makes clear that wider social and environmental costs and benefits for which there is no market price should not be ignored in economic assessment simply because they cannot easily be costed. By assessing environmental impacts and interpreting the value of ES in monetary terms, a convincing case for the conservation of habitats [6] can be put to decision-makers and other stakeholders.

In the Humber, the study identified a number of significant risks in progressing to economic valuation. These included the limitations of the information being considered for benefits transfer, associated risks from double counting, and inaccurate estimation from the use of bundled or aggregated values including willingness to pay figures and habitat value proxies.

Taking these into account, three options were identified for ES valuations:

1. Full evaluation of marginal values based on existing data, guidance and information only;

2. Full evaluation of marginal values based on existing data/ information, with key evidence/information gaps filled;

3. Full evaluation based on a comprehensive study, with all evidence/information gaps filled for the critical relative changes identified, including willingness to pay studies.

There is a genuine risk that Option 1 would seriously underestimate the ES value of the Humber managed realignment schemes. In contrast, Option 3 presents difficulties in terms of quantifying people's willingness to pay for the 'non-use' values of high quality natural habitats. These can significantly contribute to an environmental asset's value (alongside more readily-quantifiable 'use values'). However, studies to calculate willingness to pay [7] can be expensive if they have the academic rigour needed to withstand scrutiny.

For these reasons Option 2 was the recommended approach – essentially a middle option balancing thoroughness and practicality. However, even with the information gaps filled, the tools and guidance currently available are not sufficiently well-developed to allow an assessment to be conducted rapidly and cost-effectively. Methodological development work is required to make this approach fully applicable to realignment schemes on the Humber. A stepped approach is recommended based on The Economics of Ecosystems and Biodiversity (TEEB) methodology. Catherine Baldock and Piran White's sister article to this one, focusing on value transfer in the Humber estuary, discusses a further approach to overcoming some of the difficulties of valuing ecosystems services.

The Environment Agency role and moving valuation forward

The Environment Agency has embarked upon a path that will establish ways to fill the evidence gaps necessary to enable Option 2 to be undertaken. Work has been commissioned to understand the evidence base for fish in the Humber and to fill evidence gaps on fish within existing managed realignment sites.

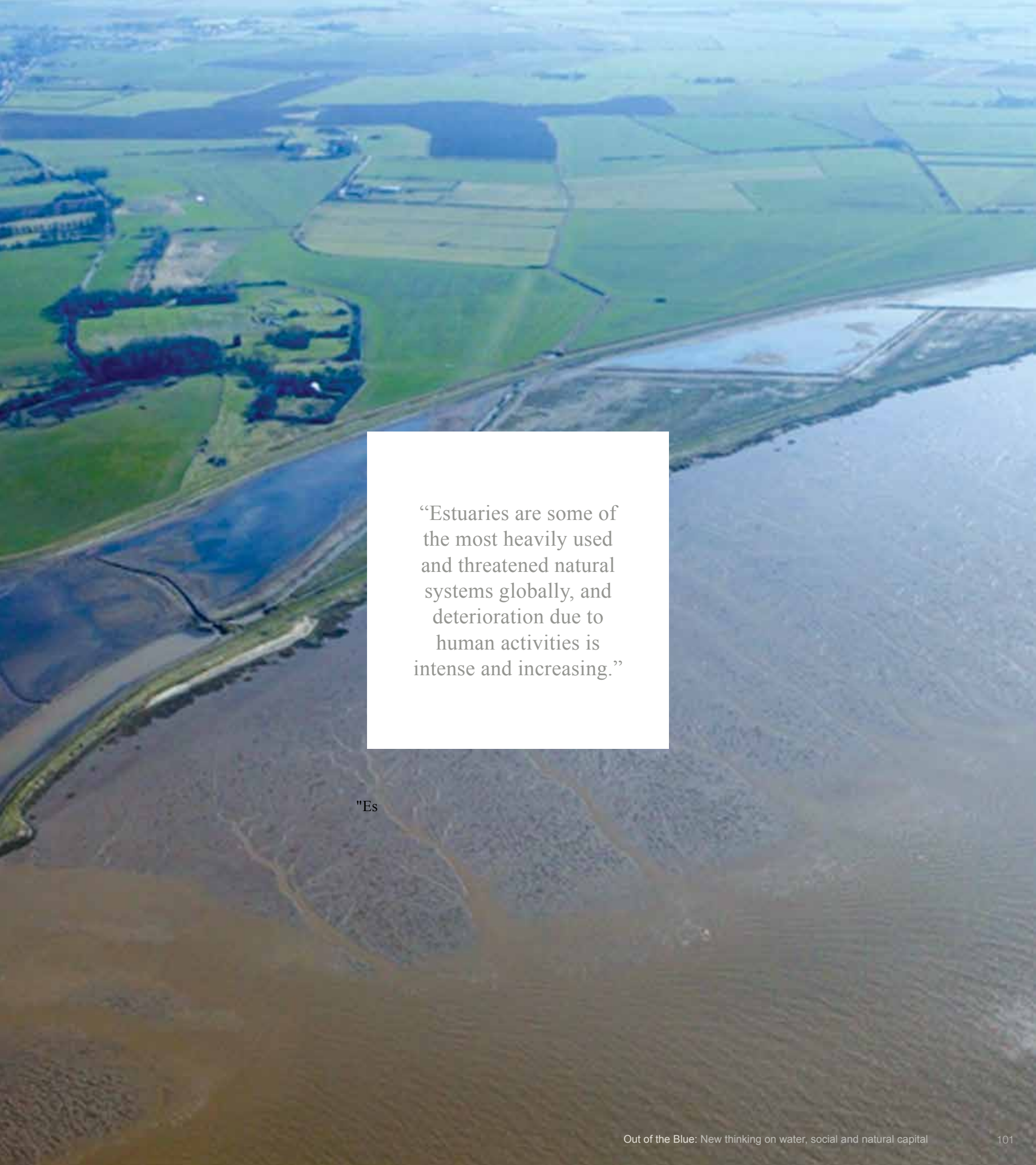
That will allow these to be included in an Ecosystem Approach to valuation. Additionally, the Environment Agency has begun a pilot project which is developing a methodology to undertake Ecosystem Service valuation in flood defence projects, and it has been developing an approach to assess the importance of ecosystem services via the Tidal River Development (TIDE) EU INTEREG IVB project[8].

The work by Arup identified both high and lower priority evidence gaps that need to be addressed. The main outstanding priority gap is willingness to pay, but this is a complex matter that cannot be easily addressed. The evidence gaps around carbon sequestration and air quality regulation may be partially addressed by work being undertaken in Essex that could potentially be utilised as a proxy on the Humber [9].

The ES way of thinking, and the threat to sensitive intertidal ecosystems from sea level rise, needs to be at the forefront of the debate amongst the authorities responsible for promoting and approving managed realignment projects. On the Humber, like most other large estuaries, ecosystem functioning is inherently complex. Many data gaps exist and management decisions affect a multitude of societal groups[10].

Conducting a robust and transparent valuation for as full a range of ecosystems services as possible has clear benefits in terms of business case development.

The study for the Environment Agency concluded that high level ES assessments, using existing quantitative and qualitative evidence, should form a component of the consultation process adopted by the Agency and their funding partners. That assessment should also facilitate the determination of trade-off risks and opportunities for synergy between ecosystem services.



"Estuaries are some of the most heavily used and threatened natural systems globally, and deterioration due to human activities is intense and increasing."

"Es

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