

The Water Story

1. The way we treat water today will shape all our futures. What changes can you make to improve the water we rely on?

Water plays an important role in the global environmental system and is fundamental to human health and the economy. It has a unique and important part to play in the terrestrial, marine and atmospheric environmental systems. Looking after our water resources requires both catchment-scale thinking, and thinking beyond catchments due to physical water transfers and virtual water transfers via water footprints. All the major components must be considered and not one in isolation: the atmosphere, oceans, ice, subterranea and land surface. We need to view water not only as a resource (drinking, fishing etc...) or a threat (flooding) but as a fundamental part of the environmental, biological, sociological, health, wellbeing and economic systems.

iCASP is an ambitious and exciting NERC-funded programme to generate benefits for Yorkshire by applying environmental science to catchment challenges. It provides an alternative and complementary model to the catchment partnership approach in that it works at the interface between academia and practitioners. Our base is the fluvial component of the Yorkshire Ouse Drainage Basin including the catchments of the following rivers: Aire, Calder, Derwent, Don, Nidd, Ouse, Swale, Ure, Wharfe and the additional catchments of the Esk, Hull and East Riding, effectively encompassing the vast majority of the Humber River Basin Management Plan area. This catchment area, like other parts of the UK and across the world, is facing some complex and costly challenges: flooding and drought, soil and water degradation, loss of agriculturally productive land and important ecosystems. However, there are also high levels of regional investment, including cities such as Leeds with development of the South Bank and a new flood alleviation scheme, and in programmes of natural flood management and peatland restoration in upland areas.

By working as the interface between academic and professional partners this programme sets out a model whereby opportunities to translate existing environmental science can be translated to address specific knowledge needs, problem solve and leverage a better return on investment. We have been able to deliver multiple benefits by working with catchment-wide partnerships and taking an integrated water and land management approach.

Examples of successful or developing projects include development of green financing enterprises; development of new tools to better link flood forecasting with impacts on rivers and different land management practices; decision-support tools that allow different area-specific flood/drought management scenarios to be evaluated; and raw water management approaches that reduce the cost of water treatment. All will have different, and often multifaceted, impacts on society and the wider environment so another important aspect is the documentation and evaluation of the projects implemented as part of the work programme, measuring the changes that they contribute to the

regional, and national, economy as well as the growth of the academic / professional partner model through leveraged investment, job creation and wider societal / environmental benefits.

We think that we can learn from the narrative developed to deliver the second update to the River Basin Management Plan (RBMP2). Very little consideration given to estuarine waters and even less for coastal waters. This was apparent through lack of support for monitoring and data, lack of funding and investment in coastal projects (it is not just about bathing water) and a lack of foresight to work collaboratively on the coast. The creation of a coastal catchment partnership for Yorkshire is a recent welcome development that must be supported locally and around the country. Our response to the question on monitoring and target setting discusses this further. It is important not to lose sight of the message the story is telling you. Protecting vulnerable aquatic species is an important part of that water story and its role in delivering the DEFRA 25 year plan. In RBMP2 the presence of a critically endangered species in Yorkshires, the fresh water pearl mussel, was unable to directly benefit from expenditure of WFD money because it was not included in what the WFD defined as a protected site. Furthermore, the few remaining individuals within this population live in water classified as being at Good Ecological Status that were repeatedly deemed ineligible for funding (until the advent of the Water Environment Grant). Allowing important aquatic species to become extinct does undermine the good intent and we would welcome efforts to champion flagship species that the public could rally around to help provide the focal point to the back story we are all working on.

Our response to the story and subsequent questions are based upon lessons from the iCASP programme - its projects and the partnerships we have built up.

Climate and Biodiversity Crisis

2. What more can we do to tackle the impacts of climate change on the water environment and what additional resources (including evidence, targets, tools and additional mechanisms/measures) do we need to do this?

Much more research on managed environmental flows is needed (e.g. from reservoir systems) and their ecological impacts.

The tools and techniques for tackling climate change are now largely well known. What inhibits progress towards reducing the impacts are socio-economic factors plus the human condition. The demand for housing, technology, food, etc... all places demands upon the water environment and issues of carrying capacity have to be considered. The demand for housing for example has resulted in increased pressure upon local authorities to develop upon flood plains, which in turn reduces storage capacity and increases runoff and contributes to increased flood risk and expenditure for flood risk management authorities.

A new report from the Climate Coalition, Home Truths: How climate change is impacting UK homes is noted and was released earlier this year. iCASP, working in collaboration with the Priestley International Centre for Climate, contributed to two chapters – one on the climate science focusing

on the increased risks of flooding and droughts and the second suggesting ways in which we can work with natural processes to improve the resilience of households.

The 'Home Truths: How climate change is impacting UK homes' report (<https://www.theclimatecoalition.org/home-truths-report>) highlights a range of actions that can be taken to tackle issues of climate change impacts on our homes; from decarbonising our homes to reduce emissions to improving the resilience of households to the impacts of climate change. Suggested actions don't just happen in our home, for example peatland preservation can not only sequester carbon helping reduce total emissions, but also reduce surface water runoff and in turn reduce flood risk.

iCASP's first project helped organisations in Yorkshire to understand how they might use the UK's new climate change projections in 2018 (UKCP18). Organisations such as water companies and local authorities draw on these scientific assessments of the changing climate when they make long-term risk management decisions. The UK projections updated in 2018 with more local detail and information on climate extremes and uncertainty. The case studies allowed organisations, including Yorkshire Water, the National Farmers' Union and Leeds City Council, an opportunity to rehearse ways of using the updated information in their operations and strategy development. In turn, the project partners gave feedback to the Met Office on their needs from the new information and how it is presented.

Building on the success of this project, a one day UKCP18 forum was held from different sectors of the regional economy who need to use UK climate projections for resilience planning and long-term business strategies. Promoting engagement of this kind with projections may enable more organisations to better understand the impacts they need to plan for and engage with tackling behaviours that are contributing to climate change.

3. What can we do to address this biodiversity crisis and meet the 25 Year Environment Plan targets for wetlands, freshwater and coastal habitats and wildlife?

A more efficient and interdisciplinary management process and use of resources, as outlined in question 2 above, would benefit improved biodiversity.

All our wetlands should be in excellent condition – we need to invest in restoration and protection.

Space for managed retreat in coastal areas is required so that habitats can move inland and not be squeezed out.

Integrated catchment solutions are required to tackle freshwater issues in the 25 year plan.

We need to move well beyond the short-termism of the 5 year AMP cycle that incentivises water companies to only invest and think about short-term actions.

Many local authorities are keen to deliver multiple benefits through projects that include Blue Green Infrastructure. However, there are barriers to the effective valuation of green blue infrastructure (GBI). Parks, open spaces, playing fields, woodlands, street trees, allotments and gardens, as well as rivers, canals and ponds are all examples of GBI. Their presence can improve biodiversity as well as

enhance property values, flood protection, air quality and overall health and well-being, but planners and developers struggle to make a persuasive business case for investment in them.

iCASP have been working with academics and local authorities to develop a clear, practical, and rigorous approach to GBI cost-benefit analysis that is ready for HM Treasury approval. Unfortunately, existing tools are unsuitable for this purpose and there is no one quick-win solution to developing the perfect business case to adequately represent the multiple benefits of GBI. The only real chance lies in a genuine desire to change the Treasury Green Book - a task to which iCASP are well placed to assist and advise on should a collaborative approach be called for that will truly help business case developers and appraisers access GBI evidence and unlock future business case development with benefits for biodiversity.

Our response to Challenge 3: Invasive Species is also relevant here.

4. Environmental targets can generate action and provide a strong signal of intent. Could additional statutory targets contribute to improving the water environment? If so, what types of targets should be considered?

We need to develop, upskill and invest in communities of practice, advisory services and joint initiatives.

Most targets can only be met if there is sufficient data gathering in place to monitor change or progress and if there is sufficient funds and genuine ambition in place to deliver improvements. However, lack of standardisation, available digital data and issue around sharing data prevent a more strategic approach. .

There has been a steady reduction in routine WFD and other water quality / ecology monitoring spatially and temporally over the years. Yet there is a growing appetite amongst professional partners, including the catchment partnerships (many organisations of which are iCASP partners too) for more data to enable more informed targeted delivery of projects to mitigate known issues in the wider water environment.

iCASP assisted the Environment Agency in the Strategic Monitoring Review (SMR) for surface water quality. This resulted in the Derwent Data Finder project aimed to develop a collaborative monitoring plan for the River Derwent, Yorkshire that would help address evidence gaps in catchment management challenges and provide information on current monitoring approaches. A key aspect of this was the production of a metadata map for anyone to access freely.

Although the project sought to achieve the aims above, several challenges, related to data gathering, hindered progress of the project including lack of standardisation of data, availability of digital data and the capacity of partner organisations to collect, analyse and store data effectively. Link to the report can be accessed here. <https://icasp.org.uk/resources/derwent-data-finder/>

A meta database was generally agreed by partners as being beneficial but the above barriers remain a challenge and there needs to be adequate long-term funding for hosting such a resource.

There must also be consideration of providing adequate resources to interpret the data too. One of the lessons from the SMR process was that with a focus more on 'agile' monitoring and presumed

reliance upon third party data there is a requirement for informed analysis and interpretation of those data. Environment Agency (EA) staff are very skilled at both collecting and analysing data but must be given adequate resources, staffing levels and time to do so. At the moment EA data are widely used and indeed fundamental to investment decisions being made by all catchment partners (the EA included) but it must be adequately resourced and that includes consideration of post project appraisal.

As referred to in our response to the water story, monitoring and data collection across the water 'story' must be representative of all components of that story from ground water to surface water and coastal waters. There are too few monitoring points or monitored elements in coastal waters to provide a meaningful assessment of the state of estuarine or coastal waters around the UK (and therefore the impact that fluvial systems have upon them). The fish classification tool for instance in coastal waters is unable to provide an adequate fish classification: Given that WFD data unpins the Marine Strategy Framework Directive this disparity needs to be corrected as a matter of urgency. The UK's coastal waters are home to some of Europe's most important seabird, fish, invertebrate and marine mammal populations as well as habitats and species of international importance and scarcity. Our work on the Derwent Data finder and Strategic Monitoring Review informally highlighted how closer collaboration in both fluvial and coastal waters and an adequately funded multi-partnership approach to, data analysis and indeed subsequent regulation and enforcement is long overdue.

Challenge 1: Changes to water levels and flows

5. What can be done to address the challenge of changing water levels and flows?

An integrated catchment management approach can help address the issue of water quality and quantity in rivers (it is good to see Groundwater now being included as part of the narrative for the integrated 'story'). One landscape element in particular to consider are peatland ecosystems that, if healthy and in good conditions, participate to purify the water, which means lower costs of water treatment.

Through the Optimum Peatland Restoration (OPR) project iCASP and partners developed a User Guide for Valuing the Benefits of Peatland Restoration (<https://icasp.org.uk/resources/peat-resources/>). The guide illustrates a number of examples. In Cambridgeshire - Wicken Fen National Nature Reserve the flood protection benefit to the farmers and homeowners from restoring the wetland - equivalent to avoided damage to crops and property - is estimated at £17,750/year or £37/ha/year. This is based on the fact that the restored wetland has the capacity to protect 2000ha of farmland and 10 homes by acting as a flood storage area. The value is calculated based on the costs to farmers using crop values, the cost to homeowners using the EA's estimates of damage cost of a flooded home and insurance claims associated with past flood events, and a risk of flooding of the area of once every 20 years.

The OPR User Guide also gives the example from Calderdale and Upper Calder Valley - West Yorkshire - where the estimated value of flooding mitigation through peatland restoration is £47 million, which represents the losses generated by the flooding event of Boxing Day 2015 to the local

economy – a calculation based on the damages/costs to 1600 small and medium sized businesses. It assumes an average loss per firm of £47,000 and that for every £1 reported in direct losses another £0.6 on average was lost indirectly throughout the regional economy (Sakai, P., Holdsworth, A., Curry, S., 2016. Economic Impact Assessment of the Boxing Day Floods (2015) on SMEs in the Borough of Calderdale. Final report available upon request.)

Drought and water availability remains important and frequently overlooked aspect of water management, with flooding grabbing all the headlines and many partners unaware of the EAs role in drought and abstraction management. Perhaps the narrative and terminology used by the EA and partners needs to change.

iCASP have also worked to demonstrate the important role that Natural Flood Management (NFM) can play in addressing changing water levels and flow, and flattening the curve during flood events. NFM needs to be considered on a larger scale and includes best practice soil management, peat and wetland restoration as well as the more widely publicised woody debris dams. The Government's 25 Year Environment Plan highlights an important role for natural flood management in flood alleviation. DEFRA NFM Community Fund Pilot schemes in Yorkshire are the focus of an iCASP project to develop best practice and demonstrate how working with natural processes can deliver a range of benefits.

Academic experts in modelling and monitoring are advising practitioners and communities methods to evaluate and quantify the effectiveness of NFM interventions. The project team will share insights from these pilot schemes with larger-scale flood alleviation schemes such as in Leeds, York, Sheffield, and Calderdale. The integration of NFM processes with hard engineered structures could give more cost effective and higher levels of protection to homes, businesses and transport links in the region making NFM a win-win option.

We need to rethink completely our environmental flows agenda. Much more research is required into the ecological, geomorphological and water quality impacts of regulated flows. We need more monitoring and data. We need think more carefully about managing flows for the environment.

6. The abstraction plan, referenced in the changes to water levels and flows narrative, explains our current and future approach for managing water abstraction. What else do we need to do to meet the challenges of climate change and growth while balancing the needs of abstractors and the environment?

University of Leeds studies suggest that climate change might have less of an additional effect than most abstractions already have on river ecosystems. This means that the responsibility lies with the regulator to withdraw unsustainable licenses as soon as possible to be able to incorporate climate change (uncertainty) into abstraction planning. This is also important for maintaining trust between abstractors and regulators.

Summer is the major season where competition for water is already high and damage to ecosystems occur. With climate change we can expect additional demand on our water resources and resultant pressures on the environment to grow. The reasons for high abstractions during summer and

demand growth during this period should be closer assessed so that potential solutions to alleviate pressure might be developed from there.

Solutions to consider may include altering the timing and amount of water available perhaps giving consideration to ways of storing water when it is plentiful for times when it isn't. The new ELMS could have an important role to play with this (as does NFM) and indeed the way in which the land is used may also need to change (e.g. crops/ agriculture or manufacturing).

Seasonality will also need to be a meaningful part of abstraction licensing that includes a spatial component (e.g. if more rain falls in the North). We also think that hot spots in rivers where high temperature and/or low water quality coincide with low flows should be clearly identified and mapped.

Literature clearly states that environmental flows cannot be protected sufficiently if the focus lies on low-flow protection alone so it is important that the whole flow duration curve is put into focus to enable us to better protect and manage water resources.

Driving water efficiency and investing in radically reducing leakage would be an equally essential component of meeting future demands and addressing the challenges of climate change. The 'greening' of our cities through Green Blue Infrastructure projects and a review of planning guidelines (promoting more permeable surfaces) would also help with surface water storage and ground water recharge.

7 . What kind of a water flow environment do we want? Should we maintain statutory minimum water flow and level standards universally across England as we do now, or go further in some places based on environmental risk?

We need to consider the environmental needs across the whole of England, and go much further.

We should strive to maintain a water environment that protects designated sites and protected species (irrespective of whether they occur in a protected site or not) alongside important water resources is important for the environment, society, sustainable economies and health and wellbeing of the nation.

Common Standards Monitoring of designated sites adopted by the country nature conservation bodies and subsequent guidance on setting and assessing conservation objectives are welcome. However, updating of individual documents is still required.

Compliance with flow targets is currently mandatory where data is available to make a judgement. Widespread collection and analysis of data as referred to elsewhere in our response is therefore important.

Traditional WFD assessment and objectives are not always compatible with Common Standard Monitoring but a broader classification system that recognises wider ecological components and one that incorporates a risk assessment would be welcome.

Challenge 2: Chemicals in the water environment

8. What can be done to address the challenge of chemicals in the water environment?

New techniques and new integrated approaches are required.

We need to take an integrated approach that considers whole systems from what goes onto farms, urban pollution and what goes down the sink and then is not captured at WWTWs. We need a complete sea-change in capturing resources / chemicals at WWTWs and finding markets for reuse. There is so much more we can do here.

9. Do you support the Environment Agency's proposed strategic approach to managing chemicals as referenced in the Chemicals in the Water Environment challenge document? If not, what changes would you make?

The climate emergency and current extinction event require prompt action now. The Chemicals in the Water Environment Challenge document refers to the progressive reduction of Priority and Hazardous substances. Many of these substances require immediate bans. This must be accompanied by education and awareness with users and the general public. Production of educational material and school/public engagement is something that the EA used to do so well but has ceased to produce in recent years.

10. What balance do you think is needed between current chemical use, investing in end-of-pipe wastewater treatment options and modifying consumer use and behaviour?

Modifying consumer use and behaviour has a far greater role to play in reducing impact of harmful chemicals through reduced usage. Less usage equals less end of pipe treatment and less pollution.

Education has an important role to play in bringing about behaviour change and reduced usage of chemicals. Every organisation has a role to play in this, and government organisations such as the EA have a far greater role to play with outreach and production of materials here - it can't be left to charities and lobby groups to bring about those behaviour changes. However, it is not always possible to stop using harmful chemicals, and some of those will have a cumulative impact and still require treatment. Education still has a role to play here in raising awareness and reducing unnecessary usage.

Many of the inland waterways in the European Union and UK are under threat due to the introduction of Watch List chemicals that are not currently regulated under the European Water Framework Directive. These chemicals include the so-called "gender changers" such as estradiol and the contraceptive pill, and other pharmaceutical drugs such as triclosan and diclofenac, which have

been shown to be harmful to wildlife. These chemicals are introduced to our waterways as a result of our day-to-day activities and through industry. Regardless of the source, they accumulate in the sediments in our rivers and canals.

Water regulators and managing authorities (including the EA) do not always know the levels, the locations or the impacts of these pollutants. Nor do they have the tools to assess sediments confidently and make decisions with regard to managing them. An interdisciplinary partnership of scientific experts, regulators and water managers led by the University of Hull and including partners from University of Leeds, Yorkshire Water, the EA and others has been developing and testing new tools to better assess, treat and prevent contamination from these chemicals. This project was carried out at nine sites, all of which have a history of sediment problems, in the North Sea Region's Elbe, Humber and Scheldt river catchments.

The aim of the 'Sullied Sediments' project was to enable regulators and water managers to make better decisions with regard to sediment management, removal and disposal, thereby reducing economic costs and the impact of these pollutants on the environment.

The partnership also endeavours to reduce the amount of chemicals entering the water system by raising awareness about what we, as consumers, are releasing into the environment through the use of common drugs and household products. Part of this includes the involvement of volunteers in a sediment sampling initiative across the region, which will inform and empower these citizens as water stewards and champions. The project is in its final stages and final reports should be due soon.

Challenge 3: Invasive non-native species

11. What can be done to address invasive non-native species?

In 2019, iCASP gave both an oral and written response to the Environmental Audit Committee's inquiry on Invasive Species. That response highlighted that the main driver of the introduction to the UK and secondary spread (of invasive non-native species, INNS, from one region to another within the UK) is human activities including trade, agriculture, transport, and recreation. Climate change may affect the likelihood that a species that is introduced establishes a population, but is not the main reason for arrival of INNS in the UK. Prevention is the first line of defence against the impact of INNS, so it is important that we prioritise slowing the introduction and spread of INNS as a result of human activity. The UK needs greater focus on prevention, including biosecurity, to slow the introduction and spread of INNS. The UK is not a leading country in biosecurity, and lags decades behind New Zealand and Australia. The UK needs greater investment on controlling the risks of further invasion and spread of INNS.

Biosecurity must be a priority as it is the most effective and cost-effective option. Treatment of established INNS is costly, requires years, and often can only control rather than eradicate. The recent Environmental Audit Committee report that iCASP contributed to establishing that 'it is hundreds to thousands of times cheaper to prevent invasive species from establishing, rather than tackling them once they are established. Biosecurity and closing pathways are critical first lines of defence to prevent the introduction of INNS'

We need to better understand the redistribution of INNS during flood events by sampling flood deposits. Wastelands could become INNS hotspots.

Strong biosecurity practises such as 'Check, Clean, Dry', is also key to reducing wider spread and associated costs of new and established INNS.

It is imperative that the UK ensure biosecurity legislation is resourced and enforced for invasive species as well as for plant and animal health. [Invasive species do not comply with borders and therefore the UK must ensure that it adopts the EU Regulation into domestic legislation post EU Exit and continues to cooperate with the European Union.](#)

Interviews conducted with local authorities identified a number of issues facing local authorities and preventing effective eradication and biosecurity.

Information about surveying and treatment of INNS is often shared between organisations, but it can be in an ad-hoc manner and different techniques in surveying can mean it is not possible to easily compare what organisations are doing. We are as yet unclear whether organisation are working from and sharing the same datasets which might improve coordination between organisations coordinated response to the treatment and prevention of INNs is essential to realise cost effective treatment and prevention in the region.

All organisations recognise the importance of surveying and treating a watercourse from the headwaters downstream however we have found it is unclear how extensively information is shared between organisations as to where surveys and treatment have been undertaken. It appears that this information is shared in an informal manner with different stakeholders aware which 'patch' themselves and others are working on. Organisations use a variety of software packages to record the presence and treatment of INNS (INNS mapper and irecord) but it is unclear to what extent organisations are sharing and working from the same datasets.

Differences in the way organisations survey along watercourses means comparing the costs of treatment are not easy. There are differences in the means by which organisations assess and survey the presence/treatment of INNS. A common metric used is linear meters along a watercourse, this does not take into consideration the volume of the invasive at a given location therefore the cost associated with treatment may vary from site to site. This limits the ability to make accurate cost evaluations and comparisons.

Not all aspects of the impacts of INNS are currently considered meaning their negative effects are being undercosted at this time. Valuing knock-on effects would strengthen the case for investment in biosecurity and treatment.

There is little consideration given to the knock on cost of INNS. Impacts such as reduced access to recreational areas are not currently considered. Evaluation of these impacts could strengthen the case for more investment and allocated resource for treatment and prevention.

The below text is taken from the iCASP INNS project literature review (unpublished):

The total cost of INNS to the British economy, provided by the government, is £2 billion yr-1,; The costs of controlling aquatic INNS is estimated as £26.5 million yr-1, however, costs of control could total £43.5 million yr-1 if management was undertaken in all infested areas. The total cost of INNS to recreational activities such as angling is £4.9 million and recreational boating is £30 million.

Our response to question 13 is also relevant here.

12. How would you promote Check, Clean, Dry to all recreational users of water, including those who are not in clubs or attend events?

13. Are there any barriers stopping you adopting good biosecurity when you are in or near water?

iCASP's INNS project is using research evidence and expertise on biosecurity, GIS modelling, stakeholder engagement, policy development and behavioural change to inform Local Authority strategies and produce resources to support the development of good biosecurity practice tailored to their needs. The long-term outcome will be new strategies embedded across Yorkshire that can also be applied to catchments elsewhere, to reduce the spread of INNS and cost of treatment of infestations.

Interviews conducted with local authorities identified a number of issues facing local authorities and preventing effective eradication and biosecurity. Information about surveying and treatment of INNS is often shared between organisations, but it can be in an ad-hoc manner and different techniques in surveying can mean it is not possible to easily compare what organisations are doing. We are as yet unclear whether organisations are working from and sharing the same datasets which might improve coordination between organisations coordinated response to the treatment and prevention of INNS is essential to realise cost effective treatment and prevention in the region. Organisations use a variety of software packages to record the presence and treatment of INNS (INNS mapper and iRecord) but it is unclear to what extent organisations are sharing and working from the same datasets.

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Tackling INNS is largely reactive, responding to when a problem arises rather than proactive to prevent its occurrence – in the long term a reactive approach may be more costly than a proactive approach through deploying biosecurity measures. A barrier to adopting good biosecurity practices may be the way impacts of infestations and their knock-on effects, such as restricted access to recreational areas or human health impacts, are not being considered. Factoring in the cost of these

impacts as well as treatment will strengthen the case for improved biosecurity measures. This would also make it easier to promote awareness and champion the treatment/prevention of INNs to influence senior management to allocate resource to developing better biosecurity policies and procedures.

Challenge 4: Physical modifications

14. What can be done to address the physical modification of our rivers and coasts?

Promotion of NFM approaches as these provide wider benefits in terms of river geomorphological condition. Interdisciplinary research into compound flooding effects (sea-level rise and riverine flooding) and how to tackle these issues is required. We have the world-leading expertise at the University of Leeds – these experts require funding to enable major advances. If we can slow the flow elsewhere and use our existing infrastructure such as reservoirs to manage flood events more effectively then we can look to reduce river channel modification and invest more confidently in river restoration.

Education and awareness remains a key priority. In particular, misinformed attitudes around dredging continually resurface each time there is a flood and persist in flood and water management organisations at a high level. Media responses to flood management also do not help.

iCASP are now looking to work with partners to produce an impartial summary briefing about dredging as a reference for all risk management authorities.

15. Giving more space for rivers and coasts to move and adjust naturally will regenerate habitat, improve wildlife and help us adapt to climate change. What can you and others do to support these changes?

We absolutely agree. As academics we can provide evidence and briefing documents to help support such a view. Also some historic perspective can be useful. For example, large parts of eastern England were once wetlands, but have been 'reclaimed' by human interventions. Getting this understanding enhanced may help with people thinking about adjustment to accelerated sea level rise and resilience measures required.

Natural flood management (NFM) has potential to deliver a significant role in achieving multiple benefits and outcomes if carried out in a carefully planned manner and on a large enough scale. The NFM pilot schemes in Yorkshire are currently the focus of an iCASP project to develop best practice for modelling and monitoring. Defra's 25 year Environment Plan highlights the important role that natural flood management techniques can play in flood risk management. The Yorkshire work will therefore contribute valuable learning for the rest of the UK (that will now be incorporated into the CIRIA NFM guidelines currently being drafted by iCASP and partners). The iCASP NFM pilot project

will help to develop best practice and show how natural flood management can deliver a range of benefits in addition to flood protection.

During the project, iCASP are helping to road-test the guidance on setting up natural flood management schemes that was released in the Environment Agency's Evidence Base on Working With Natural Processes. iCASP is creating guidance to aid practitioners in measuring the range of co-benefits delivered by NFM interventions.

The aim is to demonstrate a greater return on the investment so that the business case for future funding of natural flood management will be easier to make. Similar schemes elsewhere in the UK claim not just to deliver flood reduction benefits but also to improve water colour and quality, provide more varied habitat for wildlife and enhance the feeling of well-being for visitors.

iCASP will ensure that evidence of effectiveness and other insights about design and maintenance are passed on to larger flood alleviation schemes such as in Calderdale, Leeds, York and Sheffield. Risk Management Authorities are now keen to integrate natural flood management processes with hard engineered structures at even greater catchment scale to give greater protection to homes, businesses and transport links in the region.

The Community of Practice (CoP) Group was set up by iCASP as a component part of the NFM project to bring together people working on different natural flood management projects across Yorkshire. The meetings provide a forum for networking, learning and disseminating best practice: they are designed to build regional capacity amongst NFM practitioners through sharing knowledge and discussing challenges and opportunities. The meetings enable participants to undertake informal continuing professional development (CPD). Many of the meetings take place on sites where NFM interventions have been installed to allow a tour guided by those who have designed and installed the NFM measures.

The CoP has now gathered national interest and there is a desire to secure the longer term hosting of this valuable group - the benefits of which are obvious in terms in upskilling, knowledge share and cost saving.

Challenge 5: Plastics pollution

16. What can be done to address plastics pollution in the water environment?

Microplastics often get the headlines but most microplastics start out as macro plastics to which little attention has been drawn until relatively recently. iCASP have carried out a short review of the current literature to identify existing methods for capturing macroplastics to contribute to a proposed future project to reduce the macroplastic waste in the River Aire. Macroplastics, such as bottles, traffic cones and plastic bags are not only unsightly and detract from the social and economic value of the local environment, but they can also trap and harm wildlife and as they degrade over time will eventually become micro-plastics small enough to be ingested by invertebrates and so enter the food chain. This mini-project has helped to provide some background knowledge for a proposed partnership project that the University of Leeds Sustainability Team, Canal and Rivers Trust, Yorkshire Water and Aire Rivers Trust are developing. Better understanding of

existing methods of plastic capture will allow an assessment of whether existing science can meet the challenge and if so how it can be scaled up and applied more widely. There are some innovative methods that can remove plastics without affecting ecology e.g., bubble barriers (air from plastic tubes on the base of a river that cause submerged plastic to float so it can be collected).

Public engagement is key, and a range of organisations have used information packs, activity packs and notice boards. Innovative events such as ‘plastic fishing’ have also been set up, whereby participants float along rivers in boats, paddleboards or canoes, collecting litter

17. What actions should the Environment Agency take to reduce plastic pollution?

Whether its microplastics or plastic bottles and traffic cones in rivers, it is still pollution.

Monitoring the scale of this problem (micro and macro in rivers, estuaries AND the coast) and including this as an additional environmental health check would be a start. There would then need to be internal EA provision for allowing access to funds for EA teams and partners to help address the issue through clean up project work. A concerted multi partnership approach that includes the EA would be more effective. Enabling the catchment partnerships, through funding, to access resources to help address this problem would be a good place to start.

Within fluvial systems, plastics can be both floating and submerged; the submerged portion of plastic should not be underestimated as it can represent a large portion of plastic reaching the ocean. There is also large amounts deposited on floodplains after flood events. It is more cost effective to remove plastics from rivers than oceans. We need to understand the flux of pollutants – the transport rate from source-to-sink. This requires understand the baseline conditions by sampling rivers, river banks, and floodplains.

Challenge 6: Pollution from abandoned mines

18. What can be done to address pollution from abandoned mines?

Pollution from abandoned mines is rarely given as a reason for failure or not achieving good ecological status in watercourses. However, there are very many abandoned mines in Yorkshire that are still discharging harmful chemicals into local watercourses but are not being picked up by route WFD monitoring. This is largely due to the infrequency of routine monitoring both spatially and temporally - monitoring points are frequently too far downstream to register an impact.

Work by the University of Hull and the Environment Agency on Sill Howe mine on the North York Moors has demonstrated how moorland restoration techniques (as promoted by iCASP's Optimal Peatland Restoration Guide and our Yorkshire Peat Partnership partners) can be used effectively to address the impact of harmful chemicals entering the local watercourse, improving local ecology as well as water quality. However, obtaining funding for such projects is problematic especially when

WFD evidence does not support the need to intervene despite evidence to the contrary. A more agile approach to monitoring and interpretation of data and evidence is required.

Challenge 7: Pollution from agriculture and rural areas

19. What can be done to address pollution from agriculture and rural areas?

Much can be done but we need to underpin recommendations with evidence and with demonstration sites in different types of soil, climate, and farming contexts.

iCASP are currently involved with several agricultural projects that include a Payment for Outcomes trial, an EU Horizon2020 Community of Practice group looking into improvements to payments for environmental services as well as a project on 'Integrated Nitrogen Management and Soil Health'.

Our work on integrated nitrogen management reveals that there is a lack of 'joined-up' agricultural policy and practice to tackle excessive nitrogen pollution from fertiliser use and animal waste affecting climate and water, air, soil, biodiversity and ecosystem quality. Under emerging government policy, related to the 25 Year Environment Plan and the new Agriculture Bill, there is an opportunity for the 'polluter pays principle' to be balanced with payments for 'public goods' related to environment and human health benefits. If farmers are to meet targets that reduce air and water pollution and increase soil health and biodiversity, they need to know the best approaches for achieving them whilst simultaneously maintaining or increasing farm profitability.

iCASP held a workshop in April 2019 with 40 stakeholders from farming, policy and academia and the recommendations led to the development of a new project that is due to start imminently. This project will synthesise good practice from scientific knowledge, innovative farming, and previous policy lessons to identify benefits, trade-offs and pitfalls to inform more integrated and efficient nitrogen use in mixed arable and livestock farming. The results will be co-produced in close co-operation with key stakeholders, especially with Yorkshire farmers, farming networks, and their advisors. The project will produce a user-friendly guidance document for integrated nitrogen management (INM) on mixed arable and livestock farms (which matches Defra policy with farm management practices), along with briefing papers of key outcomes of the work for different stakeholder groups such as Defra, Natural England, Environment Agency, Regional Advisers, Local Farmer Networks etc.

iCASP have also been assisting The National Trust (NT) and Yorkshire Dales National Park Authority (YDNPA) with running a 'Payment for Outcomes' trial (PFO) with a group of NT tenant farmers in the Yorkshire Dales (Malham, Wharfedale, Wensleydale and Swaledale). The trial is testing the feasibility of a scheme which would see farmers implement positive measures for biodiversity, addressing pollution from agriculture and natural capital on their farms in return for payments above and beyond that which they may be receiving through agri-environment grants. This generally means targeting actions on areas of land that are outside the scope of current Countryside Stewardship or existing Environmental Stewardship payments. The novelty of the approach is that farmers receive a payment on the basis of achieving certain 'outcomes' rather than for implementing certain

measures. This gives farmers some flexibility in determining how they achieve the desired outcomes. Farmers will also be involved in monitoring the outcomes.

At present the PfO trial is focused on pollinators and soil health but there is interest in exploring whether Natural Flood Management (NFM) could also be delivered through this approach. This iCASP project is improving lesson sharing across payment by results/for outcomes trials, enabling coherent messaging to inform the national Scheme. Outcomes from the project will be published on the iCASP Resource Page in due course.

In 2018 an iCASP project reviewed the evidence on agricultural interventions for improving soil health to inform future land-use policy in Yorkshire and the UK. Both the full review and summary are very relevant to this response and can be downloaded [from our website](#).

This resultant report presents the key findings of a rapid systematic review of the academic evidence base concerning the impact of ten land management activities on eight soil health indicators that are related to key soil functions that deliver public goods, including reduction in pollution and sedimentation. In the report we have highlighted, from a stakeholder-derived shortlist list of ten, which land management interventions lead to an improvement in some key indicators of soil health and the delivery of other public goods, such as climate change mitigation, improved water quality and flood alleviation.

The gaps in evidence that the report highlights can provide a focus for future/current research, including Defra-funded trials/tests, use of transition period funding, and UKRI/NERC programmes. It is critical that this current/future research is done with a range of stakeholders, including farmers, land managers and academics, to enable immediate use in informing the new ELMS.

There is a need for critical assessment of the ability of different interventions to deliver multiple public goods such a clean water. This information is currently lacking in the literature and urgently needed. The same mitigation option will not result in the same impact everywhere due to variations in soil type, climate, crop rotation, fertilizer application and land management practices. Sometimes, although we may see an improvement in one targeted public good, the same intervention may result in the deterioration of another public good.

Recent claims from the United Nations, our partner universities and the media about soil fertility in the UK disappearing within 30 to 60 years may be debatable in terms of timescales but the consequences of ignoring these warnings for all of us are not.

Our response to question 23 is also relevant here.

20. How can we support the farming sector to excel at innovative solutions which benefit both productivity and the environment? What should these solutions look like?

We recommend investing large amounts of funding into water innovation programmes that stimulate economic growth through research and innovation partnerships across the water and farming sector.

The relationship between the state and the farming sector needs to change for the benefit of environment, rural economies, society and the long term sustainability of the farming sector. iCASP is a partner in the EU funded Horizon 2020 project called CONSOLE (CONSOLE (CONtract Solutions for Effective and lasting delivery of agri-environmental-climate public goods by EU agriculture and forestry). This project is a collaboration with 20 EU partner countries and multiple organisations focusing on promoting the delivery of Agri-Environmental Climate Public Goods (AECPGs) by agriculture and forestry through the development of improving contractual solutions (that is, the relationships between the public administration (at different scales) and the farmers). The project team has recognised the challenges that often result in trade-offs between environmental performance and farm profitability, the time lag between action and impact, and the potential mismatch between scales of actions and effects. The project is funded until 2022. However, some of the first outputs will very soon be publically available.

One of iCASP's contributions to CONSOLE is to present case studies from the Yorkshire projects within the Countryside Stewardship Facilitation Fund (CSFF) programme. We have produced a number of higher level and in depth factsheets that will soon be made available on the iCASP and CONSOLE websites. The latter will contain factsheets and lessons learnt from across other EU countries. We established a CSFF Community of Practice and it was immediately apparent all the lead advisors were looking for such an opportunity as one did not exist - many had not even met before. Being given the opportunity to share experience, network and upskill was welcomed. One way of supporting the farming sector therefore is to support the network of advisors (such as the CSFF advisors) who help deliver or co-ordinate many of the payment schemes available!

Challenge 8: Pollution from towns, cities and transport

21. What can be done to address pollution from towns, cities and transport?

Parks, open spaces, playing fields, woodlands, street trees, allotments, Sustainable Urban Drainage systems and gardens, as well as rivers, canals and ponds are all examples of GBI. Their presence can not only improve property values and local economies but offer flood protection, habitat improvements, wildlife corridors, air quality and overall health and well-being benefits. The iCASP GBI project is currently looking at how to improve the Business Case Development for GBI.

Improving the link between health and the environment could also allow for more informed planning and investment decisions in towns and cities that can be used to address pollution issues. Following the declaration of a climate emergency at Leeds City Council (LCC), all departments have come together to form clean air and climate emergency action groups, acknowledging the need to effectively coordinate a response. These groups have identified the importance of evidence-based collaborative decision making across sectors. Increasingly, these sectors are realising common goals/outcome measures, e.g. flood risk management, water and air pollution, public health, education, transport and infrastructure planning and development. Currently there is no tool to assist stakeholders in their efforts to make collaborative evidence-based decisions to develop the city in a sustainable way whilst increasing resilience to the impacts of climate change. A new iCASP project called SHAPE (Strategic Health Asset Planning & Evaluation) will use an existing web GIS tool to serve

as a focal point for pooling and visualising integrated health, environmental, infrastructure and socio-economic data. The use of the tool will be scaled up to other cities in the UK through the growing number of SHAPE subscribers (currently 8,000 across England), enabling more decision makers to collaborate and increase the resilience and sustainability across their jurisdictions.

22. How can sustainable drainage systems and green infrastructure be most effectively used to tackle pollution from urban areas? What challenges are there to using them?

As referred to elsewhere in our response there are multiple barriers to the effective valuation of green blue infrastructure (GBI) and therefore its implementation.

Parks, open spaces, playing fields, woodlands, street trees, allotments and gardens, as well as rivers, canals and ponds are all examples of GBI. We know that their presence can enhance property values, flood protection, air quality and overall health and well-being, but planners and developers struggle to make a persuasive business case for investment in them.

The many available tools for planners, developers and local authorities are not suitable for assessing GBI and do not readily lend themselves to delivering a clear practical and rigorous approach to GBI cost benefit analysis.

The iCASP GBI project has conducted a critique of the current tools but what is needed is a re-write of the Treasury Green Book rules to unlock GBI funding. We are hoping to work with HM Treasury on our project so that we can develop or at least facilitate the development of an approach to GBI cost benefit analysis that will help business case developers and appraisers access GBI evidence and enable future development of GBI projects

Challenge 9: Pollution from water industry wastewater

23. What can be done to address pollution from water industry wastewater?

We recommend that more is invested in full resource recovery solutions and innovation. Investment is needed to look at markets for resources recovered from waste and work is required to remove unnecessary barriers to that market.

It is better to tackle the pollution problem at source than to clean it up, but this is not yet widespread practice amongst the water industry. An integrated catchment approach to water management can reduce the burden on water companies, treatment and the quality of the final effluent. A few water companies are now starting to invest in catchment management initiatives but more needs to be done.

Sediment is a significant issue for the majority of Yorkshire rivers and is associated with high levels of certain pollutants such as phosphate, nitrates and metaldehyde amongst others. However, sediment is not a direct measure of water quality or of WFD river body status despite the obvious impacts on

ecology and water quality. iCASP's project work on the Rivers Derwent and Skell has also highlighted that no organisation directly and currently measures sediment in water bodies. Furthermore, there is little or no information about what constitutes natural 'background' levels of sediment in rivers. It can be almost impossible on many rivers (particularly lowland rivers) to accurately assess the impact of both polluting activities identified from site walkovers and how effective chosen interventions are if no one knows how much sediment should be in that water course or where it comes from.

There are emerging new technologies that, with sufficient research, development and investment, could provide a solution to improved clean up and removal of chemicals. The Sullied Sediments project referred to elsewhere in this consultation (<https://northsearegion.eu/sullied-sediments/>) has been trialing new technologies involving use of pollen spores to clean up certain EU WFD Watch List Chemicals.

As referred to elsewhere in this consultation response, more widespread monitoring, reporting and analysis of water quality is fundamental to understanding the water 'story'. Nowhere is this more important than in coastal waters where lack suitable monitoring (spatially, temporally and by chemical element) by regulators and water companies means that the ecological and chemical condition of coastal and estuarine waters is not fully understood.

24. What opportunities exist for water companies to collaborate with other sectors and organisations on measures to improve the water environment?

We need to remove the 5 year AMP barriers that are currently in place. Water companies should be encouraged (not hindered, as they currently are) from investing in research that looks at catchment-based solutions.

Water companies should be investing more in working with landowners to improve soil conservation, keeping the soil on the land and reducing costs to the water industry and consumer from having to remove both sediment and harmful chemicals. Recent initiatives by our partners at Yorkshire Water to invest in land management initiatives on their land are very welcome and a step in the right direction. However, an integrated approach working with the catchment partnerships and advised by both Natural England and the Environment Agency across entire catchments, irrespective of land ownership would be welcome.

As referred to elsewhere in our response it is important for water companies to work closely with the Environment Agency, catchment partnerships and others to educate water users and the public. Water pollution is caused by humans and long-term improvements can only be brought about by behaviour change. Education is the catalyst by which long-term behaviour change occurs - it can't be solved through economics or regulation alone. Working with the EA and partners to educate and advise users, including the public to about impacts of chemicals regardless of sector (be it agricultural, industrial or domestic) and their usage upon the environment is vitally important for the water industry and for the consumer - there is also a very clear monetary incentive for doing so.

Bold ideas also exist for collaboration between water companies, the EA, catchment partners and industry but to date have relied upon individual effort or third party (for example Lottery) funding to initiate. With appropriate Government intervention and incentives this could change. One of iCASP's project partners, the Yorkshire Derwent Partnership, has identified the opportunity to divert a

harmful coastal discharge to inland water. In doing so this could recreate (and in some locations protect) a large and important wetland and lowland peat habitat that would benefit local wildlife, improve water quality (including bathing water) and provide important recreational and health benefits. However, lack of incentive (and local politics) prevents this being achieved. A regulatory incentive would help. This is just one example. However, the concept of water companies working with partners to create and provide important wetland habitat close to known discharge points as means of improving water quality of final effluent is one that has multiple socio, environmental and economic benefits.

Our response to Challenge 8 is also relevant here. Green Blue Infrastructure also has a role to play in helping to reduce both the treatment costs and environmental impact.

Catchment partnership working

25. How can local partnerships become more inclusive and representative of all of the stakeholders within their catchments?

iCASP's work to help with the Environment Agency's Strategic Monitoring Review (via the Derwent Data Finder project) highlighted the importance of resourcing data collection and interpretation for Catchment Partnerships. To date, catchment partnerships are under resourced both in terms of finance, expertise and time to collect and process data needed to allow them to make fully informed decisions. Post 'project' monitoring and appraisal is similarly important.

The Derwent Data finder found that often multiple organisations are working on the same topic area, gathering similar data in isolation – in most cases any data collection by partner organisations is bespoke and to fill gaps from the EA data used. There is also no resource available to collate, analyse and sort this data – important information / baselines are being lost.

Community of Practice groups have an important role to play with social learning, knowledge exchange and inclusion. iCASP have developed two Community of Practice Groups as referred to elsewhere in this consultation (CSFF and NFM). The iCASP NFM community of practice for instance has a wide uptake and has proven very useful to partnership working – it has enabled the time and space for practitioners to meet and share knowledge and experience. .

Our aim of generating £50million+ of benefits to Yorkshire's economy from influencing investments, identifying cost savings, and creating new products and jobs can only be achieved through inclusive partnership working. We aim to create a network of catchment management experts, inform policies and strategies and produce materials that help environmental science to be used by practitioners. That partnership between academia and practitioners has facilitated the growth of a strong and sustainable regional network to pioneer a more integrated approach to catchment management and develop knowledge and share expertise nationally and internationally.

26. How can local partnerships achieve a better balance of public and private funding to support and sustain their environmental work?

Co-ordination and alignment of different aims and objectives of different partners and the close collaboration of partners is key to achieving a balance of public and private funding, however, it is recognised that this is challenging. Academia can provide the robust scientific evidence required to influence funding decisions often in a way that other organisations (including the government) cannot. Closer collaborations between catchment partnerships and academia through models such as iCASP would be an effective way of helping to influence public and private funding.

Who pays?

27. How should the step change in protecting and improving the water environment be funded and who should pay? Are there any barriers to doing this?

Government need to invest. The rewards will be great and will payback in terms of a resilient and clean environment. The private sector can invest through changing practice and innovation, but it needs to be driven by government investment in research and innovation, and a clear mandate for delivering radical change to catchment management and the water environment.

As we have identified through our GBI project, and repeatedly referred to elsewhere in this response, behaviour change and education are required to bring about a re-evaluation of society values to place the environment - together with the tools required to fund it - at the very top of the political and social agenda.