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Hydro Nation Scholars Programme

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“developing the global water leaders of the future”



About this report

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The Hydro Nation Scholars Programme is supported by the Scottish Government and managed by the Hydro Nation International Centre.

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Overview

- The Hydro Nation Scholars Programme (HNSP) has provided a unique learning environment promoting research into contemporary water-related issues and has been a key component of delivering Scotland's Hydro Nation ambition. Through collaborative international research, the programme has cultivated a network of water expertise with a global reach, but with Scotland at its core.
- The programme has supported cutting edge research including delivering sustainable resource management, improving approaches to governance and the value of water, strengthening rural economies, supporting climate change resilience and risk, developing new low carbon technologies and innovation across the water sector.
- Approximately 60% of alumni remained in Scotland and over 80% are actively working within the water sector across policy, academia, industry, regulation.
- The HNSP is a partnership between government, academia and industry, that creates opportunities to promote direct links between those producing research and those using it, to maximise the likelihood that new knowledge will be used in ongoing policy and practice.
- The legacy and impact of the first 10 years of the programme is evidenced in its growing network of water expertise, with diverse knowledge transfer and exchange outputs delivered including research papers and posters, oral presentations, and other materials such as book chapters, blogs and policy briefs, and contemporary contributions to developing policy and practice.

Introduction

Water is central to Scotland's national identity and to its prosperity. Managing our water resources remains crucial and strategically important as we face new environmental and economic challenges. The Scottish Government is committed to having a leading role within the international community in tackling global water issues by making Scotland a "Hydro Nation". Scotland's Hydro Nation ambition was a bold new vision for sustainable water management and one where water resources are developed to bring the maximum benefit to the Scottish economy and its people.

This ambition was emboldened in the Water Resources (Scotland) Act 2013 ensuring that Scottish Ministers to "take such reasonable steps as they consider appropriate for the purpose of ensuring the development of the value of Scotland's water resources". Importantly both market and non-market value had to be considered. To deliver this ambition a shared vision and new way of working was developed across industry regulators, agencies, stakeholders, public and the research community. A trans-disciplinary approach to delivery was essential, ensuring scientific expertise and knowledge from Scotland flowed into and underpinned decision making and policy development.

The Hydro Nation Scholars Programme (HNSP) was established to support this innovative ambition for future water management, identifying and addressing critical path issues across the stakeholder community to underpin the longer-term delivery of the strategy. Scotland has a wealth of riches in many aspects of water research, but the novelty of the programme was in identifying where and how disciplinary expertise and interdisciplinary thinking could address specific challenges coming over the horizon.

In order to achieve this ambition, and further support on-going strategy development, the HNSP aimed to attract the best talent and problem solvers from across the globe to meet these critical science challenges. In return the programme provided a supportive network where individual scholars were given opportunity for liaison and working with key personnel across industry and policy, access to data and resources not normally part of a doctoral training programme was fast tracked, and the opportunity to study how the Hydro Nation approach supported the ongoing development of policy and delivery in Scotland. The programme aimed to develop these water leaders of the future, to become both leading experts and global ambassadors for the Hydro Nation vision both at home and abroad.

A key point of the Hydro Nation strategy which underpinned the HNSP was the realisation that to deliver, one needed to have both short-term institutional reform in the way water was managed hand in hand with a vision for the longer-term challenges the sector would face. Indeed, how to support that transition through the generation of new knowledge, particularly the development of low carbon approaches to water management, increased efficiencies and delivery, and ensuring a just transition addressing both the climate and biodiversity crises.

Specifically, the HNSP is uniquely positioned to contribute to the Hydro Nation ambitions by:

- Enabling the best global talent and expertise to deliver excellence and promote Scotland's academic reputation in water science and technology,
- Delivering Scotland's Hydro Nation ambition and impact through the co-construction of research projects with policy and industry
- Ensuring the fast-track integration of new knowledge into policy and industry, and
- Developing collaboration through knowledge and skills and international work to address our shared global challenges.

Enabling the best global talent and expertise in the water sector to promote Scotland's academic reputation in water science

Attracting Talent

The Hydro Nation Scholars Programme (HNSP) is a highly competitive international scholarship programme that supports Doctoral Training investigating leading-edge water challenges. In 2023, the HNSP marked its 10th anniversary and to date the programme has supported 52 scholars from 24 countries with studies affiliated to 12 Scottish Universities: Abertay University (1), Glasgow Caledonian University (1), Heriot-Watt University (2), Robert Gordon University (3), University of Aberdeen (7), University of Dundee (12), University of Edinburgh (7), University of Glasgow (1), University of Highlands and Islands (5), University of St. Andrews (1), University of Stirling (7), and University of Strathclyde (5), and three research institutes (James Hutton Institute, UK Centre for Ecology and Hydrology, British Geological Survey). Each scholar brings a unique set of knowledge, skills, experiences and perspectives to their studies, adding value and benefit to their project and to Scotland. By bringing together a broad international and interdisciplinary group of scholars, the HNSP has drawn on a wide range of expertise and provided a creative space to develop and nurture these talented and impact-driven individuals and support shared problem solving.

Meeting the Challenge

The scholars have furthered our understanding of the challenges of resource management and recovery, evaluating value and approaches to water governance, promoting health and wellbeing, understanding drivers of change and impacts, developing resilience and adaptation, supporting rural economies, evaluating the environmental, physical, ecological, and hydrological processes, and developing technical innovation across the water sector. Overall, these activities are clustered around four general themes: *Water & health; Sustainable water, Water smart society, and Global cooperation.*

Water and health

Research has supported the development of strategies for pollution detection and management including controls at source and pollutant removal prior to discharge and importantly understanding the direct and indirect impact of water quality on human health. Case studies include:

- Understanding emerging contaminants like microplastics¹ (Figure 1) and pharmaceuticals² on water quality

1 <https://link.springer.com/article/10.1007/s40362-017-0044-7>; <https://www.sciencedirect.com/science/article/pii/S0043135419306839?via%3Dihub>

2 <https://www.sciencedirect.com/science/article/pii/S0959652619311588?via%3Dihub>

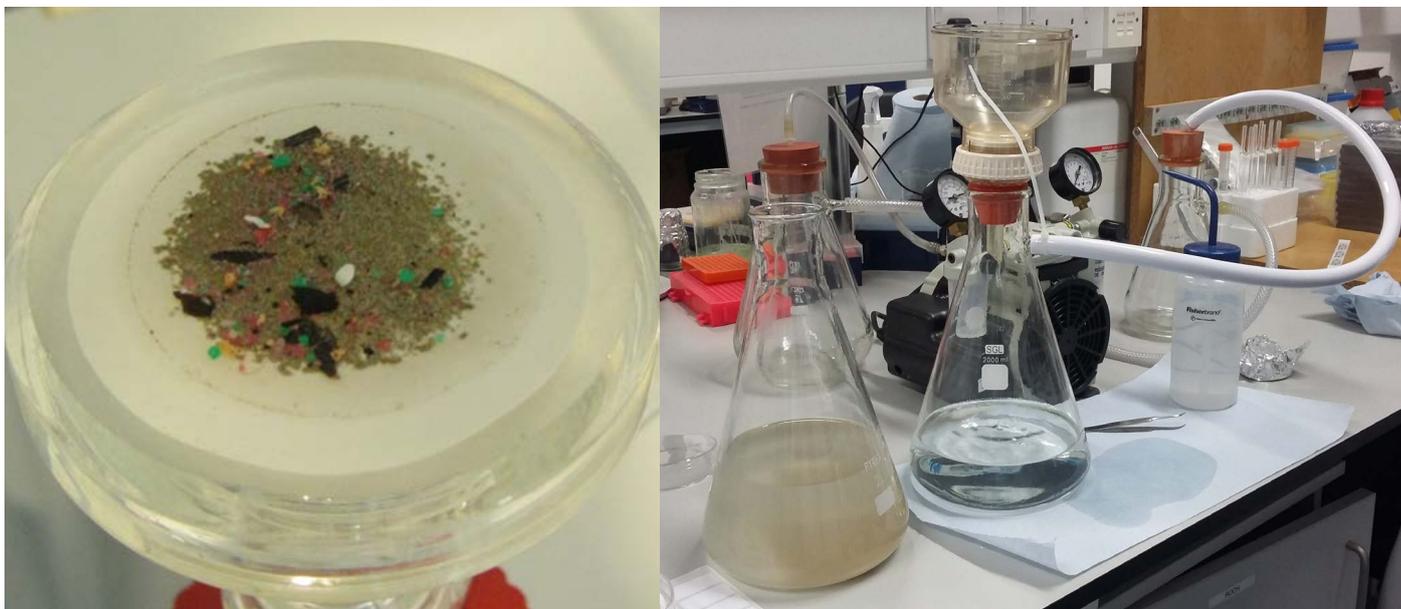


Figure 1 Extraction of microplastics from river sediment and wastewater (Photo: Maricela Blair)

- Biocidal development and low-cost water treatment³, and at source reduction
- Blue green prescribing

Sustainable Water

Research has focused on evaluating safe and resilient water supplies and services (Figure 2), the role of water in sustainable engineering including aspects such as water-smart cities, promoting resource recovery, improving climate resilience and alternative energy solutions. Case studies here feature:

- Production of valuable chemicals, energy and organic fertilizer from organic waste⁴
- Water supply network integrated energy recovery⁵
- Sustainable hydrogen production from wastewater⁶
- Place-based solutions and innovation for climate adaptation (Figure 3)



Figure 2 Wastewater treatment system (Photo: Maricela Blair)

3 <https://pubs.acs.org/doi/full/10.1021/acscatal.0c03325>

4 https://www.hydronationscholars.scot/sites/www.hydronationscholars.scot/files/scholar_outputs/processes-10-00156.pdf

5 <https://www.hydronationscholars.scot/scholars/jem-irving>

6 <https://www.hydronationscholars.scot/scholars/rhys-bourhill>



Figure 3 Live drawing of community workshop to generate ideas for place-based solutions to flood risk (Photo: Sarah Crowe)

Water Smart Society

Research has focused on evaluating the potential for digitalisation to revolutionise water sector delivery, as well as the intersection between research and water management through digital data derivation, evaluation, and solutions. Case studies feature work on:

- Citizen-derived digital data for water resources management⁷
- Digital data for water management and remote sensing, and *in situ* sensors⁸ (Figure 4)

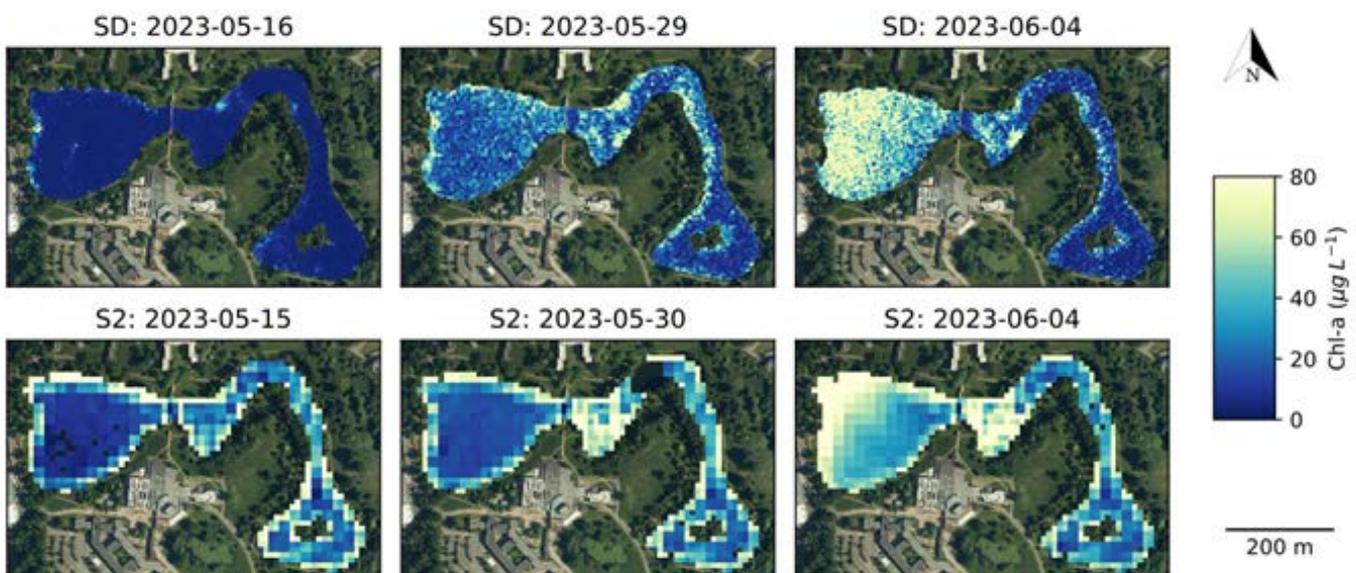


Figure 4 Satellite map of algae concentrations using remote sensing in Airthrey Loch (Photo: Daniel Atton Beckmann)

7 <https://www.hydrinationscholars.scot/scholars/donald-robertson>

8 <https://www.hydrinationscholars.scot/scholars/daniel-atton-beckmann>

Water and Global Cooperation

Research has promoted international co-operation with partners in the Global South and has promoted innovative approaches of knowledge transfer and exchange, blending perspectives from private, public, and academic sectors. It has also supported the expression and value of embedded indigenous knowledge in decision making as well as building Scotland's Hydro Nation profile as a trusted partner. Case studies here feature:

- Inclusive water governance and citizen science in Malawi⁹ (Figure 5)
- Building knowledge exchange between Scotland and India to tackle the water-food-energy challenge¹⁰
- Water governance in Brazil¹¹



Figure 5 Stakeholder engagement in Malawi (Photo: Donald Robertson)

A full list of past and current projects can be found in the Hydro Nation Scholars website: <https://www.hydronationscholars.scot/>

Nurturing Talent

In addition to the expertise developed through individual projects, the HNSP provides mentorship and exclusive opportunities via a bespoke training programme tailored to strengthen skills and competencies and to promote knowledge transfer with Scotland's wider water community. A key principle of HNSP is to facilitate engagement with industry stakeholders and those developing and implementing water policy in Scotland, so the HNSP supports training and professional development opportunities for scholars to meet water sector leaders, understand the Hydro Nation landscape and how information flows between science and policy, and help the Scholars to engage and establish meaningful connections early in their studies. These interactions and early engagements are crucial for building strong research foundations and informing policy as they provide scholars with direct insight into how their own work fits within the current and future water policy landscape, and emerging trends and priority areas to enable them to tailor their research projects to the needs of the sector and pursue opportunities for synergies and collaboration. The close association between scholars and representatives in the water sector brings added benefits to the projects through shared expertise, provision of data, and access and insights to career options.

Along with providing professional development, further training events are designed to promote interactions and foster communities of practice amongst the scholars, and between the scholars and the wider water research community. This supports the relevance, impact and legacy of the scholars' research, strengthens bonds within the Hydro Nation community, and empowers the scholars to be ambassadors of a "Hydro Nation" ambition raising Scotland's international profile and sharing its expertise. **Box 1** demonstrates two examples of outstanding talent from the programme.

9 <https://www.mdpi.com/2071-1050/11/6/1681>

10 <https://www.hydronationscholars.scot/scholars/bhawana-gupta>

11 <https://www.sciencedirect.com/science/article/pii/S0921800916314574>

BOX 1:

Christopher Schultz (2013 Cohort)

Building on his PhD research into values and water governance in Brazil, Christopher has been involved in major water policy-related research projects since graduating. First, he worked for the FutureDAMS consortium, based at the University of Cambridge (2018-2021), where he studied the history, legacy and impacts of the World Commission on Dams (1998-2000), a global science-policy interface. He also led the development of a global survey on valuing water as well as several other research and impact activities for the Government of the Netherlands' Valuing Water Initiative (2020-2023) with two of his former Hydro Nation PhD supervisors as collaborators. The conceptual framework for valuing water that Christopher developed during his research now features in the Global Water Partnership's IWRM toolbox. Christopher is a Lecturer in the School of Geography and Sustainable Development at the University of St Andrews (since 2022), and he continues to engage with water policymakers from the Netherlands and elsewhere on the topic of valuing water. He now also supervises three PhD students on water governance in rural Yunnan, Kenya, and Sri Lanka.

Julze Alejandro (2019 Cohort)

Julze has been recognised for his outstanding contribution to developing and proposing [policy recommendations](#) in the field of One Health and Planetary Health, specifically on upstream interventions to reduce pharmaceutical pollution. Julze worked on the development of Scotland's first Blue-Green Prescribing Programme for primary mental healthcare. Julze has a huge interest in knowledge mobilisation, translating evidence to policy and practice, and in integrating environmental sustainability in health promotion, health policy, and healthcare decision-making. He has contributed to health-related policy development in Scotland and the UK, such as the consultation on social prescribing by the Scottish Parliament's Health, Social Care and Sport Committee, and the development of policy options for environmentally sustainable prescribing. During his academic studies, Julze was awarded a policy fellowship by Scotland's Centre of Expertise for Waters (CREW); a parliamentary internship post at the House of Lords of the UK Parliament; a research grant for developing nature-based public health interventions in the UK from the British Council; and spent some time as a visiting researcher at Queensland University of Technology in Australia. Julze is currently a visiting research fellow at the Royal College of Surgeons in Ireland and recently joined the University of Edinburgh as a research fellow for Behavioural Research UK (BR-UK). Recently, Julze was also chosen for the inaugural cohort of the College of Medicine's Future Health Leaders Programme.

BOX 2:

Kerr Adams (2018 Cohort)

Kerr's research supported future policy through developing scenarios to explore future water pressures and trade-offs. Kerr took a participatory approach to engaging a range of different stakeholders associated with freshwaters in Scotland, to identify knowledge gaps on how Scotland can become a resilient Hydro Nation. In collaboration with SEPA and Scottish Water, he subsequently developed a decision-support tool to determine the impacts of future change on water resources and provided key evidence to inform regulatory and management actions to increase resilience. His research was instrumental to the development of Scotland's [One Planet Choices decision-making method](#) highlighting the need for partnership working and the ways it can be achieved in Scotland. Currently, Kerr is a Research Scientist at the James Hutton Institute evaluating future pressures and how best to manage water resources in both Scotland and Malawi.

Ensuring the fast-track integration of new knowledge into policy and industry

An important aspect of the HNSP is that it promotes a direct link between those producing research and those using it to maximise the likelihood that their findings will support policy and practice. In addition to delivering strategic research in support of policy and industry's future needs, the HNSP ensures that all contemporary new knowledge is available to stakeholders in real time (**Box 3**).

BOX 3:

Lydia Niemi (2016 Cohort)

Lydia has carried on her expertise from her research on pharma distribution and degradation in Scottish waters to co-coordinate the [One Health Breakthrough Partnership](#) (OHBP) - a cross-sector group addressing pharmaceutical pollution through knowledge exchange, research and innovation, and policy engagement. While still a scholar, a [video](#) on Lydia's PhD research was made by the Scottish Policy and Research Exchange (SPRE). Lydia met with representatives from the Scottish Parliament Information Centre (SPICe), and wrote a [blog](#) published by SPICe on pharmaceutical pollution in the environment and the significance to current policy in Scotland. Lydia's research was instrumental to the development of the OHBP and raising stakeholder and policymaker awareness of the issue of emerging contaminants in the water environment. Additionally, Lydia participated in the research team for the Centre of Expertise for Waters project to perform a baseline assessment of pharmaceuticals in the water environment in Scotland, and the follow-on development of the interactive data visualisation and mapping tool hosted by SEPA which overlays environmental monitoring data with NHS Scotland prescribing data at various spatial scales. Recently, she has applied her environmental expertise on pharmaceutical pollution, water quality, and One Health to sustainable healthcare research initiatives and policy development. She coordinated a UKRI funded project with cross-sector researchers and stakeholders investigating the development of an eco-directed framework that incorporates environmental data on pharmaceuticals into the prescribing process. And she contributed to the development of NHS Scotland's Climate Emergency and Sustainability Strategy which recognises the need to reduce the environmental impact from pharmaceuticals and is an active member of the "Sustainable Care" national priority workstream to deliver activity within the strategy.

Developing collaboration through knowledge and skills and international work to meet the global challenges

A unique feature of the HNSP is its international dimension. By bringing together talent from all around the globe, it enriches Scotland's water sector with diverse perspectives and expertise. The scholars conduct high-quality research addressing global water challenges, with 20% of projects located outside of Scotland, fostering knowledge exchange and global citizenship. Notably, specific international projects have been supported in Malawi, Brazil, India, Zambia, and Bangladesh. Furthermore, alumni continue to contribute to Scotland's Hydro Nation agenda, exemplified by the work supporting Scottish Governments international development agenda in Malawi (**Box 4**). In essence, the programme has cultivated a network of water expertise with a global reach, with Scotland at its core.

BOX 4:

Sydney Byrns (2019 Cohort)

Sydney is one of two current scholars conducting research in Malawi. Her PhD project involves detailed stakeholder mapping of the actors in the water governance system, as well as facilitating multilevel dialogue to overcome misalignments in policy and practice. The pilot resolutions stemming from her engagement with a broad range of stakeholders will contribute the much-needed evidence to help inform practical solutions that can be scaled or adapted for broader implementation and will help inform future Scotland-Malawi partnership activities through the Hydro Nation International Centre.

Donald Robertson (2021 Cohort)

Donald's transdisciplinary project focuses on the use of data, particularly from innovative sources like citizen science, to contribute valuable insights into water resources management in Malawi. Donald's work will continue to develop understanding of how decision makers interact with and utilise data and importantly, how this aligns with advancements in the scientific data collection to inform policy development and practice. By identifying the challenges to groundwater monitoring such as poor community engagement, guidance on monitoring operations, competing interests and political will, Donald, using his established connections at the Ministry of Water and Sanitation (Government of Malawi) will share recommendations from his work to directly influence change.

Through wider connections with the Hydro Nation International Centre and the Scotland-Malawi Partnership, Donald and Sydney have engaged with a diverse range of stakeholders across academia, government, NGOs, local communities and the private sector to foster international collaboration, build capacity in effective water management strategies that are a key part of Scottish Governments efforts towards Sustainable Development Goal SDG6 (Clean water and sanitation), SDG13 (Climate Action), SDG16 (Peace, Justice and Strong Institutions) and SDG17 (Partnerships for the Goals), as well as Malawi's Vision 2063.

Coordinating demand-driven research to steer change and make a positive legacy and impact on sustainable water management in a changing world

The legacy and impact of the HNSP is evidenced in its growing network of water expertise, the increasing production of various types of KTE outputs, and notable contributions to policy and practice. To date, the scholars have produced more than 40 peer-reviewed publications and over 250 KTE outputs including papers, book chapters, policy briefs, podcasts, digital media, and conference presentations, expanding the reach of the programme outside of academia. The quantity and variety of these outputs not only establish the HNSP and Scotland's expertise in water research but a leader in generating impact through collaborative policy making and facilitating change in industry through evidence-based research. Programmes and research based in Scotland have further developed the economic and environmental value of local water resources while the expansion and adaptation of programmes like One Health Breakthrough Partnership is internationally recognised for working together to reduce pharmaceutical pollution in the environment through sustainable One Health innovation and the research of our scholars have been fundamental in that movement, contributing to establishing the value of Scotland's water resources research around the world.

The scholars who have successfully completed their studies have continued to make a change in the water sector across Scotland and on the international stage in various fields of policy, academia, and industry. This highlights the impact of the HNSP in contributing to improving the educational and skill levels of the workforce in Scotland and abroad, as alumni contribute to domestic and global water sectors through sharing skills and experiences in their formal roles and through continued interactions with the Hydro Nation community.

Future Perspectives

In its first ten years, the HNSP has met its objectives by delivering relevant research in support of the Hydro Nation agenda and wider Scottish water community. It has achieved this through developing the best talent, establishing new ways research can be undertaken hand-in-hand with policy and industry, and ensuring that knowledge adds value through the production of timely, relevant outputs. The HNSP has provided a unique learning environment to carry out research into contemporary water-related issues. It has contributed to an international network of talented individuals who have achieved outstanding successes both internationally and domestically.

The legacy and impact of the HNSP is already evident through its global cooperation, policy engagement, open science, and interdisciplinary collaboration. In a rapidly evolving world, it is important that the HNSP remains adaptable and through creating new partnerships with the broader research community can play a vital role in addressing the future water challenges and opportunities.

Different knowledge exchange mechanisms can enhance the impact of research including academic publications, but increasingly now through, social media, and engagement with policy, industry and the public. Benefit to society, however expressed, needs to be recognised as an important element of the HNSP research legacy. A key focus for HNSP has been in recognising the diverse ways in which research can make a difference and this is central to our approach to research and project planning and how we interact with the Hydro Nation community.

In the coming years the programme will:

- Further strengthen its impact activities undertaking an evaluation of how HNSP research has delivered to the interests and needs of the Scottish Government Water Industry Team and Hydro Nation stakeholders and assess how the outcomes have been used at an organisation level to drive decisions and inform new policy.
- Focus on improving and leveraging the role of the HNSP within the Scottish Government's Hydro Nation policy landscape by delivering new evidence in support of the new Water Bill and supporting innovation into adaptation strategies (e.g. SNAP3). Further, the programme will continue to strengthen stakeholder engagement with national and international partners and sharpen the thematic scope to align with the ambitions and targets of the Scottish Government's Hydro Nation strategy and the ambitions of the wider water sector.