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Review

Understanding Health Outcomes from Exposure to Blue Space Resources: Towards a Mixed Methods Framework for Analysis

Megan J. Grace [1], Jen Dickie [1], Phil Bartie [2], Caroline Brown [3] and David M. Oliver [1,*]

[1] Biological and Environmental Sciences, Faculty of Natural Sciences, University of Stirling, Stirling FK9 4LA, UK; m.j.grace@stir.ac.uk (M.J.G.); j.a.dickie@stir.ac.uk (J.D.)
[2] School of Mathematical and Computer Sciences, Heriot Watt University, Edinburgh EH14 4AS, UK; phil.bartie@hw.ac.uk
[3] The Urban Institute, School of Energy, Geoscience, Infrastructure and Society, Heriot Watt University, Edinburgh EH14 4AS, UK; c.j.brown@hw.ac.uk
* Correspondence: david.oliver@stir.ac.uk

Abstract: With healthcare systems facing growing pressure from ageing populations and associated complex care needs, attention is increasingly being focused on sustainable strategies to improve health outcomes across populations. Encouraging access to natural environments is one form of preventative public health strategy that has been shown to lead to improved physical and mental health outcomes at the population level. A significant body of research has documented the health benefits of accessing a wide range of natural environments, including green space and coastal areas. However, freshwater resources, or inland blue spaces, have received less attention in the field of human–environment interactions. This critical review highlights current research opportunities for developing rich and nuanced insight into inland blue space experiences. Future research must take steps to account for the dynamic and unique nature of inland blue spaces through the application of a wide range of flexible and sensitive research methodologies alongside the application of broader mixed methods research approaches. To effectively utilise inland blue spaces as public health resources, it is vital that research captures the influence of temporal changes on blue space interactions and considers the overarching impact of context-specific factors. Addressing current research gaps in combination with advancing research methodologies offers the potential to consolidate inland blue space findings and create a robust evidence base for the implementation of effective public health policies.

Keywords: blue health; blue–green space; public health; wellbeing; mixed methods research

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1. Introduction

Water environments constitute an important natural resource that supplies drinking water, supports biodiversity, enables food and energy production, and provides recreational opportunities [1–5]. Visiting blue spaces, such as lakes, rivers, and oceans, also has the potential to make a positive impact on population health and wellbeing. All visible surface waters, including both marine and freshwater environments, can be described as blue spaces [6]. Exposure to blue space, in the form of viewing waterbodies from indoor settings, submersion in the water, and close proximity to water-based environments, is associated with numerous health-related benefits. These positive health outcomes include higher levels of wellbeing [7–9], higher levels of self-reported health [10], and a better quality of life [11]. In recognition of the benefits of nature, interest in nature-based interventions, such as the promotion of blue space exposure, is increasingly growing, with governments and organisations beginning to introduce these interventions into policy and practice [12,13]. A significant advantage of nature-based interventions is that they act in a preventative manner, helping to mitigate the development of non-communicable diseases and consequently reducing pressure on healthcare systems [14,15]. However, despite the proven potential of exposure to nature for improving both mental and physical health outcomes, research

findings from blue space studies are only just beginning to be translated into policy. Blue spaces along with other natural environments are currently undervalued resources that remain significantly underutilised in public health policy [14,16,17].

Whilst the term blue space applies to a diverse range of environments, currently, not all of these environments have received equal attention in the field of blue space research. Most research on the benefits of blue space exposure has focused on coastal areas and the benefits associated with accessing marine environments; this can help inform the effective management of coastal areas but is not applicable for managing the health and wellbeing benefits of freshwater areas that differ substantially from coastal environments in terms of biodiversity, ecosystem services, and aesthetic values. An extensive range of freshwater types are categorised as part of inland blue space, including canals, waterfalls, rivers, lakes, and reservoirs. Compared to marine blue space, often, inland blue space incorporates a greater diversity of environments with vastly different aesthetic characteristics, contrasting spatial scales, and distinct differences in the flow of water and presence of nearby vegetation.

To further consolidate the blue space evidence base and help promote a range of blue spaces as public health assets, inland blue space exposure should be considered in more detail. Proximity to natural environments is a key factor that influences environmental usage, with individuals more likely to frequently visit nearby blue space environments [18]. Given that inland blue spaces typically have broad geographic coverage and national distribution, with correct management in place, freshwater areas therefore have the potential to regularly benefit a significant proportion of the population. A greater focus on inland blue space research is warranted to better understand the complex relationship between inland blue space exposure and health and wellbeing outcomes. Initial research has identified differences in the wellbeing outcomes associated with recreational activities at different blue space types, with coastal recreation often leading to higher wellbeing outcomes for visitors than activities at inland blue spaces [19–21]. Differences have also been identified in user groups between blue space types, with inland blue spaces shown to attract visits from individuals with higher socio-economic statuses compared to coastal areas [22]. To encourage equitable access to inland blue space and help promote positive health and wellbeing outcomes for all user groups, greater insight is required to gather definitive conclusions and effectively translate blue space research into policy.

A particular challenge when considering inland blue space exposure is to adequately account for the wide range of variables that impact on blue space experiences and consequently affect health-related exposure outcomes. This insight is vital for informing land management strategies, but due to the dynamic and subjective nature of personal experiences with nature, key information on the impact of environmental and socio-economic variables can be difficult to obtain. A variety of different but complementary research approaches are required to develop an intrinsic understanding of user experiences at blue spaces and determine definitive patterns in exposure outcomes [23–25]. The available evidence and future research directions for two broad categories of blue space exposure variables will be considered in this critical review: temporal and spatial factors. Within these broad categories, the effects of both environmental and personal determinants on blue space experiences and health outcomes will be discussed.

This critical review will focus on inland blue spaces and highlight the research limitations that need to be addressed to help facilitate efficient policy decision making. The three key objectives of this critical review are to: (i) evaluate, critically, the current gaps in our understanding of the impact of spatial and temporal factors on inland blue space usage and exposure outcomes; (ii) determine how our understanding of inland blue space exposure outcomes could benefit from the evidence base associated with human interactions with other environments, for example, green space; and (iii) identify the potential for an enhanced analytical framework focusing on qualitative and mixed methods approaches to provide novel insight into the importance of blue space environments through more nuanced and richer accounts of human experiences.

2. Sense of Place and Temporality

Globally, freshwater environments are utilised as community resources; therefore, at the individual and community levels, blue spaces are often associated with a strong 'sense of place'. Multiple definitions exist regarding sense of place; however, for the purposes of this review, the concept will focus on the significance and emotional value that individuals ascribe to specific locations [26,27]. A significant body of research, spanning several decades, has considered the importance of people–place relations [26–28]. Within blue space research, there have been increasing reports of a strong sense of place associated with different inland blue space environments [29,30]. Sense of place is a significant cultural factor, allowing for improved health and wellbeing outcomes at the individual level [31]. Local waterbodies can instil a sense of place for individuals and communities through personal experiences or day-to-day observations, helping form a community identity [6,32]. Since sense of place is a key factor influencing an individual's environmental attitude towards and preference for specific environmental types, it can, in turn, influence visit frequency of inland blue space types [33,34].

The process of 'place-making' and developing an attachment to an environment involves two separate entities, the people or users of the environment and the environment itself [35]. Therefore, changes in individuals' personal circumstances alongside alterations to the landscape itself can impact human–environment interactions and place-based relations [36]. Social context is an additional underlying influence that shapes the place-making process. This is because socio-economic factors can significantly affect how an individual perceives, uses, and experiences an environment [37]. Since place-making processes are socially constructed and rely on dynamic relationships between humans and the environment, it is recognised that sense of place can evolve significantly across different timescales depending on environmental change and socio-cultural practices [38–40]. A wide range of personal and socio-economic factors such as length of residence, age, and education have been associated with levels of place attachment [38,41,42]. Additionally, numerous environmental factors including urban change, wildlife interactions and environmental threats can also influence attachment to an environment [43–45].

To advance blue space research, there is a need to focus on how spatial and temporal changes can alter place-based relations and consequently affect the health outcomes associated with blue space exposure. Short-term temporal changes in blue spaces, such as fluctuations in water quality, have been extensively studied in relation to environmental health [46–48]. However, further research is required to reach a better understanding of the potential for larger-scale and longer-term temporal factors to influence place attachment and impact the relationship between blue spaces and health. Additionally, the potential interplay between contextual and temporal factors on inland blue space exposure outcomes should not be underestimated. This critical review will evaluate three broad categories of temporal changes that can affect sense of place and consequently influence blue space exposure outcomes: (i) environmental changes; (ii) broader societal changes affecting environmental perceptions; and (iii) changes in personal circumstances for blue space users (Figure 1). Alongside this, the overarching influence of two key contextual factors, relating to the rural–urban dichotomy and differing cultural practices, will also be considered.

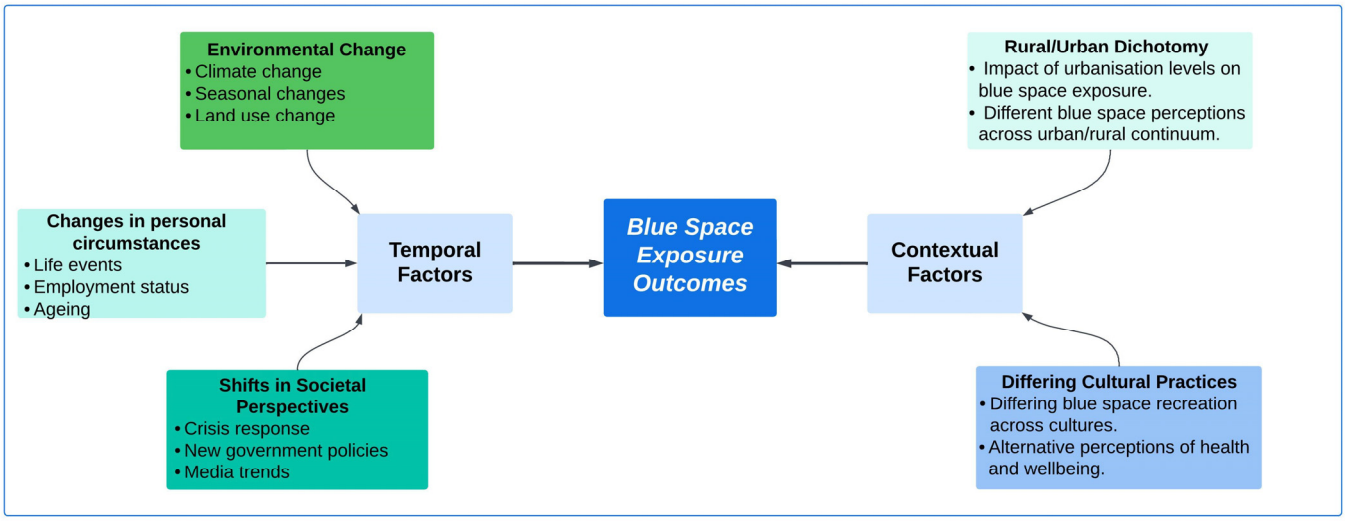

Figure 1. Examples of key temporal and contextual factors that can interrupt the relationship between blue space exposure and health outcomes.

2.1. Environmental Temporal Changes

The dynamic nature of water in both space and time means that blue space environments are continually changing. Changes in water characteristics can be observed across multiple timescales, from minutes (e.g., responses to rainfall runoff) to months (e.g., river base flow vs. spate) to years (e.g., drought year vs. flood year). The ambience of blue space environments can significantly alter as a function of time of day, wildlife presence, and shifts in visitor numbers [49]. This can, in turn, influence user groups, with research conducted at the river Rhine identifying that young adults were more likely to visit the river during evenings at the weekend whereas families and older adults used the riverside space more frequently during the daytime [50].

Over the course of a year, the nature of inland waterbodies will be significantly altered due to both changes in the surrounding scenery and vegetation as well as alterations to the flow of water. This may influence visitor behaviour at inland blue spaces and consequently influence exposure outcomes. Across the seasons, the frequency of visits to inland blue spaces can vary alongside the visit purpose and aesthetic preferences for blue spaces [51–53]; however, research findings remain inconclusive, indicating the significant complexity of seasonal effects on outdoor recreation and exposure outcomes. In line with seasonal changes, exposure outcomes can also vary because of weather conditions. Unfavourable conditions, such as high wind speeds and extended periods of drought, have been linked with blue space users avoiding these areas or reducing the length of time they spend near inland waters [32,54]. During calm conditions, exposure to a waterbody is likely to promote relaxation and stress relief [50] whereas in extreme weather conditions, such as excessive rainfall or prolonged periods of drought, blue space environments could cause severe anxiety and depression for nearby residents [55–57].

Over the next few decades, climate change has the potential to further alter inland blue spaces by detrimentally affecting hydrological regimes and negatively impacting biodiversity [58]. As noted by the United Nations, "Water is the primary medium through which we will feel the effects of climate change" [59]; therefore, blue space research should pay particular attention to this. The impact of climate change and associated environmental impact mitigation strategies can significantly affect communities by leading to the loss or alteration of areas deemed to be of cultural or historical significance [60]. For instance, the introduction of hard engineering strategies to prevent flooding can notably change the appearance of rivers. Due to a sense of place and attachment to local community sites, it is often the case that affected communities cannot be adequately compensated for their significant cultural loss resulting from environmental changes [61,62]. This is particularly

pertinent for indigenous communities who have a strong connection to their land [63]. The Australian concept of 'solastalgia' is often used to refer to this pain experienced by communities when environmental changes alter their homelands [64]. Vulnerable communities are also more likely to face inequalities with regards to accessing clean drinking water and safe blue space environments [65]. This issue will continue to be exacerbated because of climate change leading to increased water shortages in future [66]. Without the introduction of sustainable management strategies, the significant interaction between climate change, sense of place, and community identity has the potential to have a considerable negative impact over time on the potential for blue space environments to promote population health and wellbeing [67].

Land-use changes affecting blue spaces and their nearby surroundings can have a significant effect on residents and blue space visitors. In relation to the urban regeneration of blue space features, the associated land-use change can have a positive impact on residents by encouraging a sense of pride in their community and creating a therapeutic experience [17,68,69]. However, whilst regeneration projects may have an overall positive effect on a community, the relationship that individuals have with a location is subjective, and so, there will inherently be a degree of variation in how people react to land-use change. Longer-term residents who have memories attached to an area and a greater knowledge of its past may feel more strongly about environmental change [70,71].

An unintended consequence that can arise from land-use changes, particularly in the case of urban regeneration projects, is gentrification. The term 'green gentrification' has recently emerged to explain the process by which green and blue space development projects can improve a neighbourhood and lead to increased house prices and, consequently, the relocation of lower-income residents [72]. The process of green gentrification is intricate and dependent on several factors including location and existing infrastructure [73,74]. Therefore, not all regeneration projects will lead to gentrification. However, when the process does occur, it can have a long-term detrimental impact on the health status of residents, particularly among groups who are already marginalised, often leaving individuals feeling like they do not belong in the new regenerated community [71,75,76]. Additional research is needed to better understand how policies and practices can facilitate the community-led, sustainable regeneration of green and blue space facilities in deprived areas without leading to green gentrification and the further establishment of environmental inequalities.

Comparative research to understand how temporal changes in environmental conditions could alter the health outcomes associated with exposure to a range of different inland blue space typologies is now warranted. Several studies have assessed the impact of specific types of blue space environments on health and wellbeing outcomes [29,32,77,78]. In comparison, few studies have researched the potential for variation in exposure outcomes across different typologies of waterbodies. Initial research in this area has indicated that exposure to rivers and canals is associated with greater mental wellbeing than exposure to lakes [79]. However, this research only focused on three broad inland blue space types—lakes, rivers, and canals—and given the diversity of blue space environments, further opportunities exist to quantify the impact of a broader range of inland waterways, including wetlands, ponds, streams, and waterfalls [79]. In recognition of the overarching influence of environmental temporal changes on the appearance and ambience of blue space environments, research should also assess whether alterations to inland waterways and their waterside environments (both natural as well as management-related) can further magnify the variation in potential exposure outcomes from visiting different types of blue spaces.

Given the significant influence of environmental factors on blue space interactions, as well as the confounding effect of other variables including sense of place and cultural perceptions, it cannot be assumed that all inland blue space visits lead to positive exposure outcomes. Initial research has documented the more complex relationship between blue space and health, highlighting the potential for blue space to create a sense of isolation and cause frustration for user groups [80–82]. However, so far, this area of research has

focused on coastal blue space, and so, further insight is needed to capture a broader range of experiences at inland blue spaces. Additionally, most findings relating to negative blue space experiences are derived from specific case studies; therefore, larger samples are required to create generalisable results.

Environmental changes affecting inland blue spaces, such as seasonal variation in weather, land-use change, and climate change, are, to a certain extent, interlinked. It would therefore be worthwhile to assess the potential cumulative effect of these environmental changes on the relationship between blue spaces and health through the application of versatile mixed methods research approaches. Earlier research focusing on aesthetic preference for blue space environments largely relied on the use of cross-sectional photo-based preference studies conducted in laboratory settings [83,84]. Building on this, a mixed methods research approach using large-scale dataset analysis combined with a national survey and focus groups identified the significant range of factors that may influence aesthetic preferences for blue space users, including biodiversity levels, perceived busyness of an environment, and surrounding green-space quality [85]. However, the application of additional novel research approaches is required to consolidate these findings and account for subjective differences across populations. In situ methodologies may be particularly beneficial for capturing individuals' environmental perspectives of freshwater environments without the influence of recall bias.

2.2. Changing Perceptions at the Societal Level

Whilst several studies have considered the benefits of blue space exposure at the wider community and population level [24,86,87], considerably fewer have considered how populations collectively regard blue space areas and the nature by which these perceptions change over time. Public perception is a crucial factor that can alter people's willingness to adopt certain behaviours, and so, perceptions of inland blue spaces could have a major impact on environmental usage.

A pertinent example of how societal changes can impact the relationship between blue spaces and health is the range of lifestyle shifts brought about due to the onset of the COVID-19 pandemic. Research across twenty European countries discovered that at the beginning of the pandemic, there was a significant increase in the number of online searches for topics relating to nature and the environment, which suggests an increased awareness or appreciation of nature at the population level [88]. During the initial phases of the pandemic, blue spaces were associated with providing stress relief and mental wellbeing at the individual level [89,90]. However, for many, access to blue spaces was restricted during the pandemic due to public health interventions; this, in turn, affected overall wellbeing levels and altered the therapeutic nature of these environments for individuals [91,92]. As the impact of the SARS-CoV-2 virus, which causes COVID-19, continues to manifest, this will make a lasting change in society's perception of the importance of accessing natural environments and could consequently alter the health outcomes associated with blue space exposure. To enhance environmental and public health policies, the impact of the COVID-19 pandemic on the relationship between blue space and health across time provides a global exemplar for further investigation.

The introduction of new government policies can lead to a shift in how populations regard inland blue spaces and other natural environments as health-promoting resources. One noticeable blue space policy trend across Europe is the increasing establishment of designated marine and inland bathing areas [93,94]. Bathing waters are distinct from other water environments because the microbial quality of water in these areas is regularly monitored and action is taken to ensure that the quality is within pre-defined pollution limits [95]. As the environment of these blue space areas has been enhanced through the introduction of stringent policies on pollution, it is likely that bathing areas may positively impact the relationship between blue spaces and health. Furthermore, healthy and vibrant bathing waters provide social spaces, sources of wellbeing for recreational users, and key sources of jobs and revenue for local economies. A link has been determined between

improved water quality and an increased frequency of visits and improved attitudes towards a blue space area [96–98]. In coastal environments, sites with lower water quality have also been linked with lower ratings of perceived restorative potential [99]. However, in relation to bathing areas, a focus on water quality alone fails to account for the value attributed to bathing-water environments by the 'hidden majority' who rarely use the sea for immersive activities. For example, waterside environments promote social interactions and wider cultural ecosystem services [100,101].

Accounting for the wider value of coastal and inland bathing waters is critical to effectively managing and promoting, more generally, the role of bathing-water environments as important socio-economic resources. Considering the range of uses and the significant number of interlinked benefits associated with bathing areas, it would be valuable to conduct a range of comparative research studies to determine whether health outcomes and other cultural ecosystem services (CESs) provided by inland bathing sites vary significantly from the benefits provided by marine bathing sites. The CESs associated with environments are continually evolving and can be affected by environmental and societal changes; therefore, the potential for the perceived benefits of inland and coastal bathing sites to vary over time should also be considered [102]. This comparative and temporal insight will help underpin a robust evidence base for the creation of tailored environmental policies.

Social media offers the potential to track real-time changes in societal perceptions and can be used as an effective tool to aid in environmental planning processes. A growing body of research has assessed the CESs (such as aesthetic enjoyment and health and wellbeing outcomes) provided by a range of environments through the application of social media Big Data analytics [103–106]. The information gained from social-media-derived environmental research studies has proven to be highly valuable and can both aid in the evaluation of infrastructure and interventions as well as help inform land-use policy decision-making processes [107–109]. Currently, however, only a small number of CES studies have considered inland blue spaces in detail, and fewer still have used social media analytics to assess the CESs of inland blue spaces; therefore, there is scope to build on this. There are limitations to social media data. For instance, the datasets can include much noise due to fake or spam social media accounts, and establishing the generalisability of the findings can be challenging [110]. However, this form of data offers a host of opportunities for advancing the blue space research field in terms of enabling the opinions of the local community and blue space users to be quickly assessed and consequently helping to establish sustainable management strategies. If Big Data analytics were to be integrated with qualitative exploratory methods, this could provide rich, valuable insight into blue space perceptions and the factors influencing blue space usage at the societal level.

2.3. Changes in Personal Circumstances

Within a population, individuals will have faced significant and unique life events that can change how they view blue spaces at a personal level. This aligns with Conradson's concept of 'Therapeutic Landscape Experiences', whereby he suggests that the relationship between an environment and an individual is highly subjective and so different visitors of environments can experience vastly different health outcomes [111]. Furthermore, changes in personal circumstances can alter the way in which individuals value natural environments, and so, could significantly affect the health benefits obtained from blue space exposure [112]. Most research exploring the subjective relationship between the environment and health has focused broadly on natural environments, rather than exclusively on blue spaces, and so, more specific investigation of how different life events can alter perceptions of blue spaces is warranted. Combining in-depth personal information with broader population-level data trends could help inform more effective management of blue spaces and ensure that these health-promoting resources are accessible to all.

As people age, their relationship with blue spaces can alter, leading to different age groups attributing different benefits to visiting blue space areas [23]. Some studies have identified that for children and young adults, an association exists between coastal and

inland blue space exposure and mental health and wellbeing [113–116]. Research involving older generations has also highlighted the fundamental importance of being close to blue spaces for maintaining quality of life and wellbeing [7,8,80,117]. To advance blue space research, it would be worthwhile utilising cohort study designs to follow how the ageing process can directly impact the relationship between blue spaces and health. Cohort research studies are longitudinal and, typically, more resource-intensive and time-consuming than other research methods [118]. Despite these limitations, conducting longitudinal blue space research would be advantageous to effectively correlate available studies on blue space exposure and help create a stronger evidence base than can be achieved through the application of multiple cross-sectional studies. Having more information on the effect of nearby environments on different age-groups can help inform both environmental and public health policies to encourage healthy ageing across a population.

Coupled with ageing, an evolving employment status throughout an individual's life course could lead to changes in the health benefits gained from accessing blue space areas. The effect of the neighbourhood environment on health and wellbeing has been identified as having a greater effect on those who spend a larger proportion of their time at home or within their neighbourhood [119]. As a result of this, those who are retired or work from home may be more impacted by nearby inland blue space compared to those who work away from home. For those who are employed, a modifying factor is the type of commute taken by an individual; commutes that pass through natural environments are often positively regarded by individuals and linked with improved levels of mental health [120,121]. Those who are in higher income brackets typically have better access to high-quality blue space environments [122–125]; therefore, employment status is likely to add further complexity to the relationship between blue space exposure and health outcomes. Whilst specific research into the effects of employment on inland blue space access and exposure outcomes has not yet been conducted, the insights outlined from relevant research fields indicate that this is an important knowledge gap to address.

Research has identified the potential for sociodemographic factors to influence inland blue space usage. However, to date, most research has been cross-sectional, and so, the reasoning behind sociodemographic trends in blue space access cannot be established. Developing a greater understanding of sociodemographic influences is vital to effectively address existing environmental injustices relating to inland blue space access. Given the potential for lifestyle factors to change across time, the application of more innovative and longitudinal qualitative methods would help derive richer data and gain greater insight into temporal influences on blue space experiences. In line with this, diary keeping is one data collection method that could provide rich contextual knowledge relating to how changes in personal circumstances affect blue space experiences and exposure outcomes. Qualitative diaries can provide an effective means of unobtrusively assessing participants' emotions in real-life situations [126]. Research diaries are also useful for documenting short-lived events such as interactions with nature as these types of fleeting-events often do not have an overarching influence on people's lives and so could easily be forgotten [127].

Diary methods have previously proved effective in documenting the personal and wider-spread effects of experiencing flooding in the city of Hull [128]. This diary project had a national impact with findings subsequently used to inform water management policies. More recently, diaries have been utilised to assess the restorative outcomes associated with inland blue spaces for Scottish adults [129]. Conducting further diary-based research studies to track how personal and environmental changes affect blue space exposure outcomes clearly has potential to provide detailed personal insight into blue space exposure. The combination of diary methods with follow-up interviews has the potential to provide rich ethnographic-style insight into inland blue space experiences.

3. The Influence of Spatial and Contextual Factors

The relationship between blue space exposure and health is highly contextual, and so, alongside researching the temporal changes associated with environmental and socio-

economic factors, it is also important to consider the broad location trends that could have an overarching influence on exposure outcomes.

3.1. The Urban–Rural Dichotomy

The degree to which the area surrounding the blue space environment is urbanised could have an impact on blue space exposure outcomes. There has been continued debate as to whether the binary classification of 'rural' and 'urban' is still relevant and useful [130]. Industrialisation and globalisation are continually blurring the boundaries between rural and urban areas [131,132]; therefore, these two categories may no longer be distinct from one another. Additionally, there is no universal definition of what constitutes an urban or rural area, and so, this can lead to uncertainties and variations when comparing the health statuses of different populations. Despite the limitations of the urban–rural dichotomy, environmental exposure outcomes are heavily context-dependent, with research continuing to identify that individuals from rural and urban settlements have significantly different place-based narratives [133–135]. As such, it remains worthwhile to consider whether different levels of urbanisation can impact blue space exposure outcomes. There is also scope for investigating whether temporal factors affect individuals from contrasting backgrounds, such as rural and urban residents, in different ways [112].

Limited research has contrasted the impact of rural and urban blue space exposure [23,29,113]. Findings from such studies have been inconsistent with further in-depth research required to provide a greater understanding of the magnitude of the urban–rural effect and the reasoning behind any variations in health outcomes arising from blue space exposure. The current inconsistencies in findings may relate to the different blue space classifications included in the research, varying ages of the sample groups, and the context-specific nature of blue space exposure outcomes. This variability suggests that longer and larger coordinated studies across a greater urban–rural spectrum may yield stronger evidence to underpin our understanding of how urbanisation can influence any variations in health outcomes from blue space exposure.

Currently, most blue space research has focused on better understanding exposure outcomes for urban blue space [7,136–138]. Further research into rural blue space is required to ensure that freshwater management policies can be tailored towards the needs of both urban and rural residents. This research strategy would align with the policy of 'rural proofing' that has been adopted across the European Union to ensure that policies and resources are appropriately adapted to meet the varied needs of rural communities [139].

A greater focus on more dynamic research approaches in relation to the urban–rural continuum is required. Future research should appreciate mobility patterns, with individuals travelling from urban to rural areas and vice versa, irrespective of administrative boundaries, to access blue space and natural environments [140,141]. It is possible that quantitative research studies that consider health outcomes strictly in relation to residential proximity to natural environments may underestimate people's willingness to travel on trips and outings in order to connect with nature [140]. Therefore, a range of nuanced and complementary research approaches is required to understand motivations for accessing blue space environments across the urban–rural continuum. In addition, future research should carefully consider the way in which urban and rural areas are categorised. Relying solely upon administrative boundaries to define urban areas can lead to a significant overestimation of green- and blue space accessibility levels since administrative boundaries often include rural areas that are on the outskirts of urban settlements [142]. Considering this, sensitive methods are required to better define land-use areas and inform resource management strategies; the application of urban footprints to more accurately quantify the extents of cities could be an alternative approach.

Creating a versatile evidence base for policy decision making across the urban–rural continuum will ensure that diverse needs of communities can be accounted for. Thus, multidisciplinary research detailing blue space community case studies in rural and urban areas coupled with more broad-scale comparisons of rural and urban exposure outcomes

would be advantageous for achieving this (Figure 2). Participatory photovoice methods that involve communities and individuals taking photographs to represent issues of importance in their everyday lives constitute one such technique that has previously proven effective in providing detailed insight into specific communities' blue space management concerns [143]. However, whilst participatory research can provide a greater understanding of issues relating to social and environmental justice, this type of research is typically limited in terms of scale. Therefore, the combination of contextualised participatory research findings with large-scale population-based studies of high statistical power would be an effective means of developing a robust blue space evidence base to inform the implementation of freshwater management strategies. An alternative option could be to utilise in-depth case-study data in combination with Big Data analytics to help verify rural and urban blue space trends.

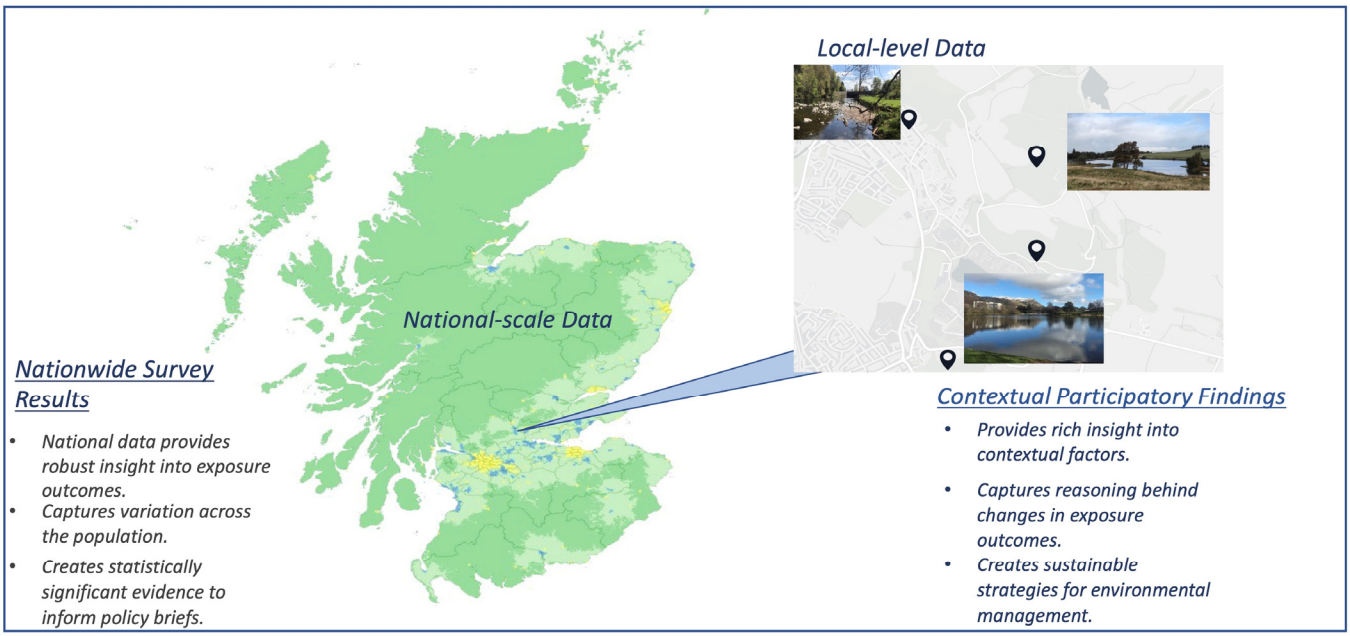

Figure 2. Exemplar of the potential for a mixed methods research approach at different spatial scales to provide detailed insight into a blue space research topic [144,145]. The colour gradients on the map represent rural and urban areas of Scotland.

3.2. Differing Cultural Practices and Blue Space Perceptions

Blue space research is increasingly challenging the presence of dominant Western perspectives on wellbeing outcomes [146–148]. Furthermore, there is an increased awareness that due to differing leisure practices and perceptions of water across cultures, the generalisability of research findings should be carefully considered [147]. Participating in surfing or canoeing, for example, can have significantly different meaning for Maori populations as opposed to non-indigenous groups who may not have the same traditional narratives or spiritual connection to the water [149,150]. However, despite this growing recognition regarding the importance of context in determining leisure practices and health and wellbeing values, to date, the majority of blue space research studies have been conducted in the Global North [151]. There is, therefore, a need to conduct research across a range of different cultural contexts. Furthermore, to gain insight into lived experiences across cultures, it is important that blue space research approaches continue to incorporate participatory and co-designed research methods that are sensitive to differing perspectives of health and recreation.

Health, happiness, and wellbeing are all subjective concepts that can vary between individuals and communities depending on social context [152,153]. Given this subjectivity, the perceived wellbeing and health benefits gained from blue space exposure could vary

significantly across different countries and populations. This further justifies the benefits of conducting cross-cultural blue space research. Due to the complex nature of health-related concepts, it would also be worthwhile to adopt a multidimensional approach to measuring health and wellbeing outcomes. Currently, most health-related research on blue spaces has adopted a (semi)quantitative stance by focusing on health and wellbeing outcomes through the application of questionnaires and health-related datasets. This has provided a good overview of the potential of blue space environments to aid health outcomes. However, the current evidence base could be significantly strengthened through the application of alternative methods such as novel mixed methods research approaches. Mixed methods approaches are increasingly popular in health-based research due to their potential to provide multiple perspectives on complex problems [154,155]. In terms of blue space research, combining quantitative and qualitative methods, such as the application of robust nationally representative health-based datasets with detailed qualitative interviews, would significantly advance the research field by providing an enhanced understanding of the variables affecting freshwater experiences and health-related exposure outcomes at the individual and national levels.

4. An Enhanced Blue Space Analytical Framework

This review has highlighted the broad variety of spatial and temporal factors that influence inland blue space user experiences and identified several research priorities (Figure 3). Alongside the need to address existing research gaps within the blue space evidence base, to effectively advance the translation of blue space research into public health policy and practice, an enhanced blue space analytical framework is required. Future research methods must be flexible and responsive to capture the dynamic nature of human–environment interactions. Mixed methods research approaches offer the potential to record the spatial and temporal dynamics of blue space interactions across multiple timescales, allowing for rich insight into user experiences (Figure 4).

Figure 3. Three of the key research priorities identified in the narrative review, presented alongside potential research methods for addressing the priorities and a feasibility assessment.

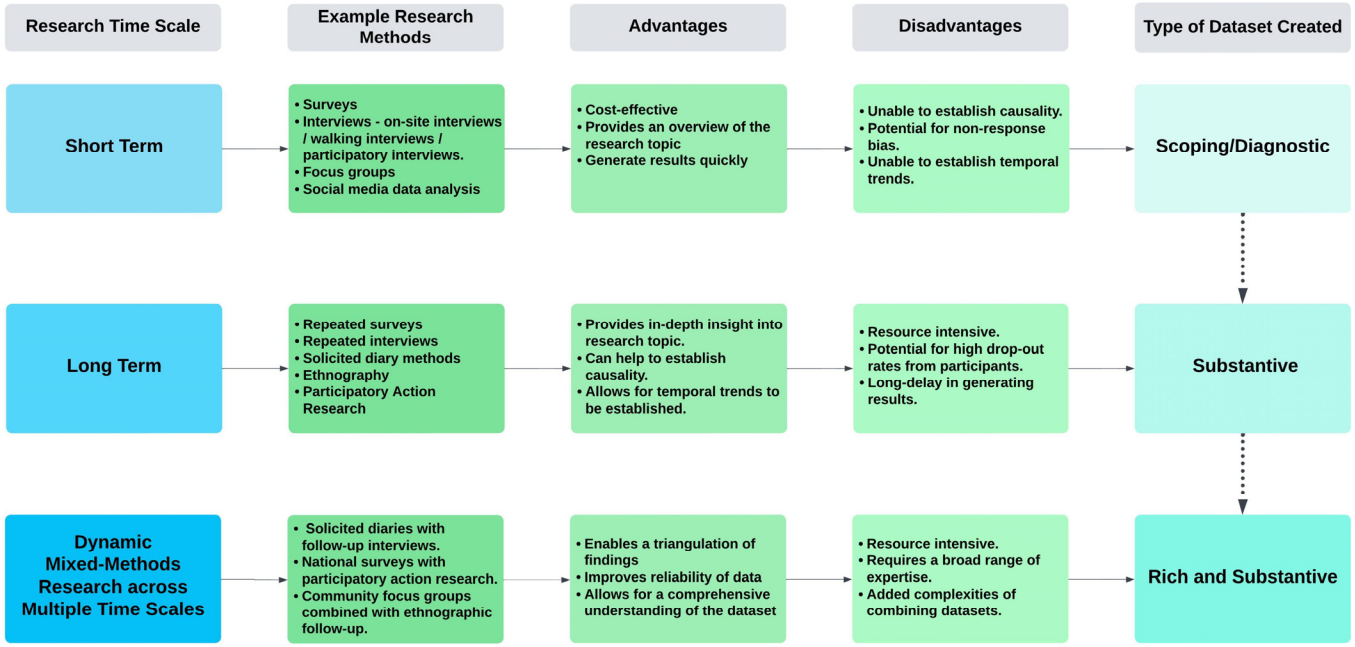

Figure 4. An outline of the advantages and disadvantages associated with conducting research across different timescales. The arrows link the factors associated with different research time scales whilst the dotted arrows highlight the increasing richness of the associated dataset.

A significant number of green-space studies have comprehensively assessed human–environment interactions using mixed methods research designs [156–159]. The mixed methods approaches adopted by these studies had clear benefits, facilitating a comprehensive exploration of the factors that can predetermine green- or public-space usage and providing a detailed understanding of environmental experiences [158,159]. Further mixed methods research in the blue space research field will help consolidate our current understanding of the complex, overarching impact that environmental factors can have on exposure outcomes. The application of a range of different methods enables multiple perspectives and insights into a topic area to be recorded, creating powerful insights into environmental interactions. For instance, the combination of qualitative walking interviews with geospatial data can help create contextualised knowledge and provide a better understanding of how individuals relate to different environments [160]. In the field of blue space research, this merging of methods may, in turn, provide a greater understanding of the wide range of factors that influence blue space exposure outcomes. A mixed methods approach can also help achieve the 'complementarity' of research findings, whereby the findings gained from one method can be used to further understand or enhance the evidence gained from another method [161]. This overlapping of research findings can create a more nuanced understanding of blue space exposure.

Alongside the application of mixed methods research projects, conducting further collaborative and cross-disciplinary research could help facilitate the development of evidence-based policies. Typically, cross-disciplinary research involves engagement from a range of stakeholders. This engagement is beneficial to the research process as it helps to ensure that the research outcomes remain relevant and applicable for aiding the target audience and facilitating a wider dissemination of research findings [162,163]. The BlueHealth project is an example of how a multidisciplinary research approach can help build a better understanding of the value, impact, and public-health potential of blue spaces across different populations [96,164,165]. The focus of the BlueHealth project was, however, largely on oceans and coastal environments, so the opportunity remains to advance inland blue space research through the application of innovative multidisciplinary research approaches. Inland blue space research aligns closely with public health, sociology, human geography, and environmental science research fields. This alignment with other disciplines offers a

host of opportunities for close research collaborations to provide more powerful analytical methods, both helping strengthen research findings as well as increasing public awareness.

It would be particularly beneficial if future blue space research approaches utilised longitudinal data collection strategies. Whilst cross-sectional research projects are quicker and cheaper to conduct, these short-term data collection methods can only provide a relative snapshot into environmental interactions and often rely on participants reflecting on and considering their blue space experiences from memory. Longitudinal blue space research would provide a better understanding of whether, and to what extent, temporal changes can subsequently impact blue space exposure outcomes for individuals whilst minimising the risk of recall bias. A range of different methods could be used to carry out longitudinal research, including the application of wearable research technology over a prolonged period of time, ethnographic observation, qualitative and quantitative research diaries, and videography. Incorporating longitudinal research alongside short-term research methods such as interviews and surveys could provide novel insight into blue space exposure outcomes. The creation of geospatial longitudinal datasets, through the application of mixed methods research approaches, would help develop an increased understanding of the dynamic spatial and temporal processes that impact human–environment interactions [166]. This would allow for a triangulation of research methods to capture multiple perspectives on blue space temporal dynamics and help create a more comprehensive understanding of the research topic [167].

Future research should also seek to include creative practice into mixed methods research designs. Blue spaces, particularly rivers, have commonly been used as inspirations for creative practice research in the fields of education and psychology [168]. Community-led projects have also focused on blue space environments to encourage engagement from residents. The 'Our Living Rivers and Glens' project is one such example of this, whereby professional musicians were informed by the words, sounds, videos, and images collected from local residents to create music representing environmental experiences during the COVID-19 pandemic [169]. Whilst some blue space studies have used novel arts-based methods to gain in-depth insight into community perspectives, the application of creative practice remains underutilised [170,171]. In light of the success of previous projects, there is scope to develop creative methods further within the blue space academic research field to create a rich understanding of environmental exposure outcomes.

5. Conclusions

Blue space research is increasingly helping uncover the wide range of complex and interlinked factors that can affect blue space exposure outcomes. Whilst an increasing number of research studies demonstrate the importance of blue spaces for population health and wellbeing, further research is required to ascertain the overall influence and impact of different temporal and spatial variables on blue space exposure outcomes in order to better inform environmental policy. Arguably one of the most effective means of facilitating the translation of blue space research into policy and practice is to continue to develop transdisciplinary research projects and interventions. This would involve the collaboration of different stakeholders, including policy makers, blue space users, and healthcare practitioners, as well as involvement from scientific researchers. Alongside this collaborative research, further focused research is necessary to address the key gaps in the blue space evidence base, which could prevent the development of evidence-based policies. One such gap is a lack of longitudinal research. This type of long-term prospective research is necessary to help establish causality and draw definitive links between blue space exposure and health and wellbeing outcomes. Future studies should also move beyond traditional research approaches and seek to capture embodied knowledge through a combination of sensitive quantitative and qualitative methodologies such as solicited diaries, wearable technology, and videography. The application of a range of methodologies alongside the effective integration of research findings will help increase the breadth of blue space research and enable a wider range of blue space exposure variables to be considered.

Whilst an increasing portfolio of research findings indicates the potential of blue space environments to be utilised as public health resources, further investigation is needed to fully understand the range of factors that can affect blue space experiences and modify the potential of these natural environments to improve population health and wellbeing.

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