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The health potential of urban water: Future scenarios on local risks and opportunities

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ABSTRACT

Although cities can be characterised as sources of economic, environmental and social challenges, they can also be part of the solution for healthy and sustainable societies. While most cities are situated close to water, whether inland waterways, lakes, or the sea, these blue spaces are not integrated into urban planning to their full potential and their public health impacts are not always recognised by planning authorities. Furthermore, cities face future challenges regarding climate change, socio-economic developments like tourism, urbanization, and rising social inequalities. The development of healthy blue spaces can support cities in their pursuit of ways to confront these challenges. Interdisciplinary and transdisciplinary analyses of the local impacts of these trends and promising interventions have been scarce to date. This study explores the use of such methodology by presenting experiences related to five European cities: Amsterdam, Barcelona, Plymouth, Tallinn and Thessaloniki, using an interactive and participative approach with local experts and stakeholders. Future scenarios have been developed based on the question: How can blue spaces contribute to a healthier city population, given the long term trends? The results highlight the importance of addressing the local context when seeking sustainable solutions for cities. The future scenarios deliver information that could serve as useful input for local planning processes.

1. Introduction

Local policy makers have to anticipate on the challenges set by diverse categories of trends, such as climate change, economic development (e.g. tourism, inequalities) and demographic changes (e.g. ageing population, migration). Moreover, these trends may reinforce each other, depending on the local context. On the other hand, cities strive to create healthy outdoor environments (blue and green spaces) for their citizens that support a healthy lifestyle and well-being. These urban blue and green spaces may also be used for climate adaptation strategies as spaces for cooling or collection of excess water during heavy rainfall events. This means that urban planning more and more requires interdisciplinary and transdisciplinary approaches to improve the understanding of the combined impact of trends and develop balanced strategies. Scenario studies could support such approaches (Ramirez et al., 2015). This article presents the experiences in Europe

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with an interactive participative approach to explore on the question how healthy blue spaces could play a contributory role in enhancing the impact of long term trends and create co-benefits for public health.

While most cities are situated close to water, like inland waterways, lakes, or seas, these blue spaces (Grellier et al., 2017) have not been integrated into urban planning to their full potential and their health impacts have not always been recognised by planning authorities (Nieuwenhuijsen et al., 2014).

1.1. Health potential of urban water

Cities face multiple challenges regarding urban water (Bolson et al., 2018; Brown et al., 2009; Koop & Van Leeuwen, 2017). For instance, the impact of flooding and drought due to climate change (EEA, 2017), issues related to the availability of good quality drinking water resources, increasing drinking water demand and declining sanitation infrastructure (UN-Habitat, 2016) and the ecological ambitions set out in the European Water Framework Directive (2000/60/EC) (Grizzetti et al., 2017). Compared to these challenges, the health potential of urban blue spaces could be considered a topic of minor relevance. However, a better understanding of the drivers of healthy blue spaces, may be helpful in realising other goals for urban water quality, such as the UN Sustainable Development Goals (UN, 2015), notably SDG3 (good health and well-being), SDG6 (clean water and sanitation) and SDG 11 (sustainable cities) (Wuijts et al., 2020).

Research has provided evidence that water environments, like other natural spaces, deliver societal benefits for health and well-being in terms of mitigating heat stress, supporting physical activity, encouraging social interaction, and facilitating relaxation (White et al., 2020; WHO, 2016). On the other hand, water environments can also pose specific health risks such as illness caused by water contamination, drowning, or stress related to (the threat of) sea-level rise or flooding (Smith Korfmacher et al., 2015). While literature on creating healthier and more sustainable cities through green environments is growing (Kruize et al., 2019), comparable knowledge regarding water environments is scarcer (Gascon et al., 2017).

Various aspects of the urban water environment are relevant to health. Like green spaces, the health potential of blue spaces depends on people being aware of their existence (Kruize et al., 2019) and the extent to which they are accessible, so that people can actually use them. For instance, the opening up and regeneration of waterfronts has resulted in greater use of the water environment (e.g. Jensen et al., 2015). Also climate adaptation measures intended to reduce heat stress and mitigate the effects of extreme rainfall can provide new opportunities for the development of accessible blue spaces in cities that contribute to health and well-being. Water playgrounds exemplify this: they serve to cool urban areas, act as water buffers, and at the same time offer opportunities for children to play in. But probably more pronounced than for green spaces, the health potential of blue spaces also depends on conditions related to safety (risk of drowning) and water quality.

Also other global trends affect the health potential of urban water that can be realised, since urban space is scarce and subjected to multiple uses and complex interactions. Demographical changes, like ageing populations lead to different demands regarding the access to blue spaces and the possible risks associated with blue spaces. Economic regeneration of blue spaces, changes in property prices and the privatisation of areas prone to blue spaces, may lead to gentrification and potentially increasing inequalities in access to blue spaces (Cole et al., 2019). Technological developments create opportunities to inform the urban population more precisely on water quality and its suitability for bathing, but also can improve water quality by advances in waste water collection and reduction of overflows (Jensen et al., 2015). Nature degradation can result in fewer usable blue spaces and less biodiversity in the city.

Besides these direct impacts, global trends may also interact and may have a joint impact. For example, the urban 'heat island' effect, combined with an ageing population and increasing social inequality, can exacerbate the risk of heat stress for vulnerable groups in deprived neighbourhoods (Filho et al. 2017). Another example is that, in many parts of Europe, climate change is not only resulting in increasing temperatures and the number of warm days, but also in sea level rise, a higher frequency of extreme weather events such as storms and heavy rainfall, and an increase in perceived temperature (a combination of temperature and humidity) (Field et al., 2012; Scoccimarro et al., 2017). All of these developments have implications for the quality of life in urban settings and how blue spaces may contribute to urban ambitions in this field. Intersectoral assessment of health aspects of water environments gives insight into dilemmas and interventions that may serve several objectives. To date, urban water challenges are often addressed from a sectoral perspective (Bolson et al., 2018; Koop & Van Leeuwen, 2017), although some scholars explore joint solutions for the urban food-energy-water nexus (Yuan et al., 2021). Interlinkages with the public health domain have been limited to the exploration of green spaces (Gascon et al., 2017). This article addresses this knowledge gap by presenting the results of a study into the future health potential of urban water in five European cities: Amsterdam, Barcelona, Plymouth, Tallinn, and Thessaloniki. It provides a systematic analysis of the various opportunities and challenges these cities may face in the coming decades in their pursuit towards healthy and sustainable cities (EC, 2016) while anticipating impacts of climate change and other trends.

1.2. Future scenarios for local opportunities

In future scenarios, the potentially relevant trends are analysed regarding how they might interact and influence each other, and affect cities (e.g. IPCC, 2014). Applying a scenario approach results in coherent, internally consistent, systematic and plausible description of a possible future states (http://www.ipcc-data.org/guidelines/pages/definitions.html). Such an approach is not an attempt to predict the future, but merely to explore possible outcomes and to anticipate combinations of future trends (Van Der Heijden, 1996). Addressing relevant uncertainties regarding future trends is an important element in scenario approaches. These uncertainties are not only reflected in limitations of our knowledge, the cognitive uncertainties, but also the distinction of normative uncertainties, representing differences in what is considered as a desirable future, is important in scenario development for policy planning (Andreescu et al., 2013; Schoemaker et al., 2020). This requires input from local stakeholders and experts. A participatory approach, engaging diverse and relevant stakeholders is then essential (Mallarach & Verschuuren, 2019; Tompkins et al., 2008).

The importance of local knowledge and values to plan for inclusive and sustainable (urban) spaces is widely recognised within science and practice of urban and regional planning (Bolson et al., 2018; Forester, 1999; Healey, 1997; Healey, 2010). By giving local stakeholders a key role in ranking local opportunities and challenges, they provide data into the futures desired by particular groups, which may inform urban strategies.

Future scenarios to support policy planning have been used since the previous century by various entities, including governments, businesses and academia (Van Notten, 2006). Scenario-based approaches have been used to explore a variety of issues such as water management in England and Wales (Henriques et al., 2015), health impacts of temperature-related mortality (Huynen & Martens, 2015; Sanchez Martinez et al., 2018), and the health and economic-related effects of combinations of urban design (Mueller et al., 2019), yet multidisciplinary scenario approaches focusing on local impacts seem to be limited.

In this paper we explore the complex interactions of multidisciplinary trends at local level and different scenarios for the development of healthy blue spaces, that could feed into urban planning processes. We aim to provide insights into how the local context plays a role in developing healthy blue spaces that take into account future

developments. Five European cities have been used as case studies to address this question.

This study forms part of the EU Horizon 2020 funded BlueHealth project (Grellier et al., 2017).

2. Methodology

We used a combination of methods for scenario-building and stakeholder engagement processes to facilitate an understanding of the uncertainties of (global) future trends, their local impacts on urban blue spaces and the related risks and benefits for human health.

2.1. Case study selection

All the cities studied are situated in Europe and have to meet the European ambitions on healthy sustainable cities (EC, 2016).The cities were selected as case studies for their diversity of climate zones, availability and type of urban blue spaces, socio-economic conditions, and governance regimes (see supplementary material). It was envisaged that this would provide a variety of results that would facilitate a discussion of the added-value of contextual information for policy planning of healthy blue spaces (Yin, 2009).

The selection was also influenced by one of the aims of the overarching EU H2020 BlueHealth project to use the scenarios to reflect on experiences with local interventions at blue spaces and their use in other settings. These interventions vary from access to blue spaces by urban design (e.g. construction of a jetty or recreational facilities) or policy (e.g. governance of urban bathing sites) to studies that aim to promote a healthy lifestyle (e.g. more exercise) and thus support physical health and well-being (https://bluehealth2020.eu/research/).

2.2. Conceptual framework and research design

The scenario approach used for this study addresses both cognitive and normative uncertainties (Van Notten, 2006). In order to understand these uncertainties and how they relate to the future of blue spaces in European cities and their impacts on human health, we developed a conceptual framework that identifies possible relevant future trends, then analyses their impact taking into account the current local situation and possible relevant developments and illustrates how policies can play a role in shaping the future.

The conceptual framework for the scenario development (Figure 1), builds on the closely-related frameworks DPSIR (Drivers, Pressure, State, Impact, Response) (EEA, 1999), DPSEEA (Driving Force, Pressure, State, Exposure, Effect, Action) (Corvalán et al., 1996), and eDPSEEA (Reis et al., 2013).

2.2.1. Relevant global trends

As a first step, possible relevant trends were reviewed in three rounds by an interdisciplinary group of researchers with knowledge in the domains of health, water, or environmental planning in Europe. These trends differ in terms of temporal and spatial scope, and their dependency on other trends.

The DESTEP method used for trend identification in this study, builds on the PEST analysis, a tool for strategy planning, in which PEST is an acronym for Political, Economical, Societal and Technological macro-environmental factors that may be relevant to the entity of study (a firm, a city, a country) (Narayanan & Fahey, 1994), and was extended with demographic and ecological factors (Schoemaker et al., 2020), supporting the focal point of our study, the interlinkages between water and (public) health in the development of blue spaces that offer benefits to (public) health and minimize the risks.

After the review, all identified trends were assessed in terms of how they interacted with each other and how this affected their impacts on water and public health at the local level (Wuijts et al., 2019). The result was a broad identification of trends that drive changes in the fields of water and health and well-being (referred to as 'health' in the remainder of this article). This set of trends functioned as a starting point for the discussions with local stakeholders on their relevancy at local level and the scenario development.

2.2.2. Current city-level situation and developments

The second step held the collection of a wide array of local information using input from both (grey) literature and local stakeholder

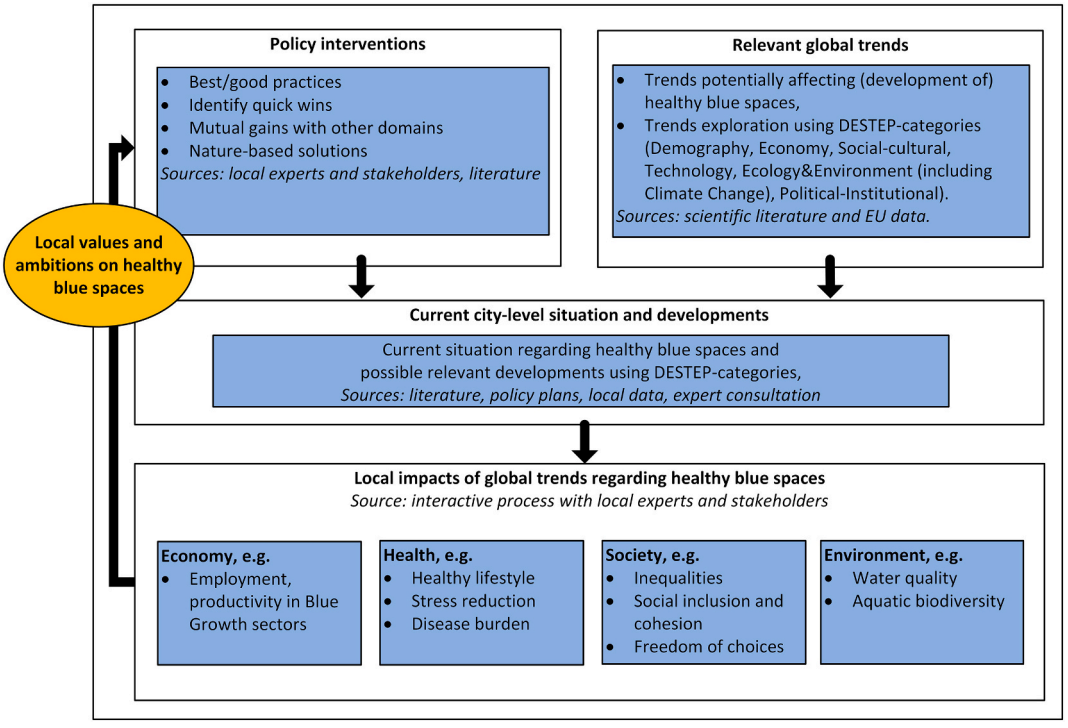

Fig. 1. Conceptual Framework used for this study.

knowledge on the current situation and already planned developments. This information was necessary to identify local impacts and was used as input for the stakeholder workshops and the consequent scenario building (see also Wuijts, De Vries, et al., 2020).

2.2.3. Local impacts of global trends

The relevance and impact of global trends at local level were then, as a third step, discussed in workshops with local stakeholders and experts. Based on local knowledge and normative views, locally-relevant trends could be identified, as well as the impacts that these trends might have on water and health-related issues in the local context.

2.2.4. Normative views or ambitions

Since policymaking is intrinsically linked to normative views on desirable futures, identifying local ambitions formed an important aspect of our scenario building process. These normative views were also collected during the local workshops.

2.2.5. Policy interventions

Possible policy interventions to mitigate the impacts of trends that contribute to local stakeholders' normative views on water and health were first identified as the last step of the local workshops.

These interventions were then complemented with information from (grey) literature in drafting the scenarios.

2.3. Data collection and scenario development

Data on trends and possible impacts has been collected from scientific literature (Wuijts et al., 2019). Data on local developments was collected from both grey and scientific literature and inputs from local experts. Inputs from stakeholders during the workshops have been quantified into scores of what was valued most relevant and most uncertain, supported by qualitative explanations.

For each city, a trend scenario and two normative scenarios were developed based on the elements of the conceptual framework (Wuijts, De Vries, et al., 2020). All draft scenarios were reported back to the participants for feedback and their content to be agreed upon.

2.4. Selection of local experts and stakeholders

To identify the relevance of global trends at local level, a thorough understanding of the local characteristics, e.g. climate zone, urban design, water system characteristics, demographic and economic conditions and governance structure, is indispensable. For this reason, input from local stakeholders was used throughout the process, from the stakeholder workshops to the development of scenarios.

Local knowledge, representation of different fields of expertise related to one or more of the identified categories of trends, different roles and responsibilities (but all related to blue spaces and public health), were therefore used as criteria to invite a variety of stakeholders to local workshops that were organised for each of the cities. A protocol was set up for the organization of these workshops (see supplementary material).

3. Results

This section describes the debates and outcomes of the workshops which formed the basis for the scenarios. A full description of all scenarios can be found in Wuijts, De Vries, et al. (2020).

3.1. A resilient and healthy Amsterdam for all

Amsterdam, the capital city of the Netherlands, is a densely-populated urban area (854,000 citizens in 2018, density 5042 inhabitants/km^2) including a port complex and adjacent industrial zones. The city was built around the rivers Rhine and Amstel in the twelfth century and is situated below sea level. Because of climate change, the risk of flooding is increasing, especially as a result of heavy rainfall in the city itself. The risk of sea level rise is expected to be less of a concern because of the high level of protection afforded by dykes. The population of Amsterdam is projected to age progressively in the coming decades (Municipality of Amsterdam, 2018) and ethnic diversity will increase further (currently 70% of the population has a mixed ethnic background). The continuing development of social inequalities is a major challenge for the city.

During the stakeholder workshop, climate resilience and promoting social equality were identified by participants as the most commonly-shared ambitions for healthy blue spaces (see Table 1 and Municipality of Amsterdam, 2016, 2018).

3.1.1. Climate change and social inequality as interlinked challenges and opportunities for the city

Changing institutional and governance structures (including a shift in decision-making from government to multi-stakeholder governance), rising income inequalities, climate change, and the increasing individualisation of citizens were observed by the workshop participants as the most relevant trends for the city of Amsterdam (Table 1). As income inequalities can confer disparities in health (Beenackers et al., 2012; Marmot, 2018), their prospective increase was viewed as relevant for the ambition regarding social equality. The increased risk of flooding caused by heavy rainfall and expected water quality issues, were among

Table 1
Most important values and trends identified during local stakeholder workshops related to healthy blue spaces.

Cities (*workshop date*)	Values for healthy blue spaces	Top 5 of trends, perceived most relevant for healthy blue spaces
Amsterdam (*May 11th, 2017*)	• Climate resilience • Promoting social equality	1. Changing institutional and governance structures 2. Income inequality 3. Decision-making is moving from government to multi-stakeholder governance 4. Water availability 5. Social cohesion/ individualisation
Barcelona (*March 13th, 2019*)	• Climate resilience • Promoting social equality	1. Income inequality 2. Climate change 3. Water availability and fluctuations 4. Increasing life expectancy 5. Increased investments in smart urban water management
Plymouth (*December 12th, 2018*)	• Access to blue spaces • Improving identity and pride: realising we're an ocean city	1. Increasing life expectancy 2. Further loss of biodiversity and other ecological impacts 3. Income inequality 4. More recreational use of blue spaces 5. More waterfront development for urban regeneration
Tallinn (*April 16th, 2019*)	• Access for all to blue spaces • Preserving biodiversity	1. Further loss of biodiversity and other ecological impacts 2. Climate change 3. More waterfront development for urban regeneration 4. Changing population composition 5. Digitalisation of society
Thessaloniki (*September 19th, 2019*)	• Sustainable urban design • Health for all	1. Climate change 2. Migration 3. Technology for more healthy urban living 4. More recreational use of blue spaces 5. More healthy urban living in EU policies and strategies

the motivations for selecting climate change as one of the most relevant trends.

Extreme weather events will occur more frequently in the coming decades in the Amsterdam region (Scoccimarro & Gualdi, 2020). Extreme rainfall results in excess water on the streets and overflows of sewage water into canals and other surface waters in the city, causing pollution. Polluted water on the streets could present an infectious disease risk. A proportion of the areas prone to flooding are situated in more deprived neighbourhoods (see http://www.rainproof.nl/ and PBL, 2015). Many citizens of Amsterdam are unaware of the risks associated with the use of urban blue spaces for bathing. The vast ethnic diversity of the city makes it challenging to reach out to all the different groups in terms of communication and specific needs regarding the use of blue spaces.

However, climate change adaptation measures could also be seen as opportunities to improve outdoor spaces. Open water bathing sites situated outdoors may be cheaper and more accessible compared to swimming pools, for example. Swimming lessons in natural water could be used to build confidence, thereby eventually reducing risks of drowning and increasing awareness of other risks, like contamination.

3.1.2. *Cross-sectoral spatial planning and citizen's engagement as promising strategies*

In order to achieve health benefits from blue spaces, both health and climate resilience need to be accounted for in spatial planning processes. This requires advances in cross-sectoral spatial planning to be made by including the public health sector, e.g. when introducing waterfront protection zones to secure access for all and create safe bathing sites. The ambitions set for healthy environments in the upcoming national Environment and Planning Act (in force by 2022) could support this opening up of the planning process. Using such a joint approach, climate action programmes could also contribute to improving the livability of deprived neighbourhoods.

Furthermore, the stakeholders viewed the engagement of local groups and citizens as an important aspect of blue space redevelopment. To support this engagement, the usage and satisfaction regarding blue spaces should be monitored and brought into the municipal policy cycle. Currently, this type of information is missing. An integrated set of tools have been developed to this end as part of the BlueHealth project (Grellier et al., 2020).

3.2. *Barcelona, a sustainable and healthy city for all*

Barcelona, the second most populous city in Spain, is situated in the north east and is the capital of the autonomous region of Catalonia. The city is one the largest urban conurbations situated on the Mediterranean Sea, has a very high population density (16,000 per km^2), is characterised by its rich cultural heritage, and is a major tourist destination (>30 M tourist visitors per year in 2017). Barcelona has a Mediterranean climate with mild winters and warm-hot summers, and has beaches within its city borders. Rainfall is infrequent and there can be long periods without rain. Droughts are a re-occurring concern. However, rainfall can be intense and the largely impermeable surface contributes to the risk of flooding (City of Barcelona, 2013). Income inequality in Barcelona is large and there is a strong spatial concentration of poverty in a number of neighbourhoods (City of Barcelona, 2017). By 2030, almost a third of Barcelona's residents will be 60 years old or older (City of Barcelona, 2018). Access to affordable housing is likely to decrease with rents in the city continuously rising, and reduced availability of suitable housing for residents because of tourism (City of Barcelona, 2017).

During the stakeholder workshop in Barcelona, two values were identified as dominant for the city: climate resilience and promoting social equality (see Table 1 and City of Barcelona, 2013).

3.2.1. *Climate resilience and social equality: balancing socio-cultural inequalities*

The most important trends identified during the workshop were income inequalities, climate change and water availability, changing institutional and governance structures, technological developments towards smart urban water systems and increasing life expectancy (Table 1). These trends are expected to put pressure on the livability of Barcelona and related adverse health effects will occur if no adaptation measures are implemented (City of Barcelona, 2013, 2017). Climate change will have effects on availability of drinking water, bathing water quality, related waterborne and vector-borne infectious diseases, heat stress and related health effects (Filho et al. 2017).

Inequalities are likely to increase because of climate change, as vulnerable groups (e.g. people with low incomes, older populations), often live in poorer circumstances and have fewer resources to adapt to the effects of climate change. Access to blue and green space in Barcelona is not evenly distributed across the city and is better for high income groups.

The challenges related to climate change potentially open up opportunities for the citizens of Barcelona as interventions in other policy domains, e.g. related to work, income, housing, transport, can contribute to climate resilience and health benefits directly or indirectly. This holds especially true in urban environments with a high density of activities and complex social interactions. For instance, the realisation of blue and green spaces, like water squares, parks, or green playgrounds offers cooling spaces and opportunities for water storage. Health benefits are created by these options for physical exercise, relaxation and social interaction. Although investments in good quality blue and green spaces contribute to resilience and public health, they could also result in more gentrification and widen the social inequalities if these issues are not explicitly taken into account in the urban planning process. Furthermore, political discussions in the region regarding the status of Catalunya as an independent state may have an impact on decisions made within the domains of water and health in the city, as it might make institutional responsibilities unclear.

3.2.2. *Adapting the built environment in collaboration with citizens for a sustainable and equal Barcelona*

Stakeholders underlined the importance of a healthy, socially fair and safe city, where active living is promoted, where you can breathe clean air and enjoy quality public spaces, and people's health and well-being is guaranteed. Implementation of the so-called Superblocks, where greening and traffic-calming measures in a cluster of several blocks are applied, could be a promising strategy to improve health and livability if implemented on a city-wide scale (Mueller et al., 2019). A healthy and socially fair and safe city could be created through the implementation of more green and blue public spaces, especially in deprived neighbourhoods. For example, an urban riverside regeneration project for the Besòs river in a deprived neighbourhood facilitated access to the riverbank for pedestrians and cyclists, and improved physical activity and perceived health and well-being (Vert et al., 2019). The diversity of Barcelona's citizens needs to be considered when developing interventions to ensure these can be beneficial to all citizens. Protecting water as a basic vital resource could be accomplished by adapting the built environment to mitigate the effects of climate change, but also by informing and raising awareness among Barcelona's citizens of the need to use water more efficiently. Stakeholders saw the importance of including perceptions, needs and ideas of different stakeholders, especially local residents, in plans for creating more equitable blue and green spaces within the city, for example, through the digital platform'Decidim' (https://www.decidim.barcelona/).

3.3. *Valuing Plymouth's natural and cultural heritage for all*

As a maritime community with international recognition in trade, emigration, exploration, and ocean science, Plymouth is located on the

coast of the south-west of England with 33% of its coastal infrastructure classed as 'artificial' (i.e. sea walls and rock armour revetment) (Knights et al., 2016). Plymouth is a medium-sized city, 264,000 inhabitants (2016), somewhat densely populated (3300 per km^2), with many pockets of socio-economic deprivation; a reality in contrast to the extensive recreational redevelopment of many of the city's waterfront areas to attract tourists and second-home owners. The Plymouth population is growing and ageing (https://www.plymouth.gov.uk/annualreport201718), and life expectancy in some neighbourhoods is among the lowest in the United Kingdom.

The stakeholder workshop in Plymouth focused on the city's coasts and oceans as a primary blue space of interest, with ambitions for valuing Plymouth's natural and cultural heritage, and creating accessible blue spaces for all (see Table 1 and Plymouth City Council, 2019).

3.3.1. Redeveloping accessible waterfronts as an opportunity and a challenge

The trends identified as most important for healthy blue spaces at city-level were increasing life expectancy, further loss of biodiversity and other ecological impacts, rising income inequality, more recreational use of blue spaces and more waterfront development for urban regeneration (Table 1).

Stakeholders identified more waterfront redevelopment as being an impactful global trend in Plymouth but with mixed perspective on what that impact could be. Some saw the benefits of redevelopment, recognising it as an indicator of economic investment which may lead to increases in people employed in the service industry. Others saw such redevelopment as a risk in terms of the gentrification of the city, potentially 'pricing out' its poorer residents from home ownership, which threatens its identity, a value identified as particularly important to Plymouth by this group of stakeholders. Potential increase in recreational activities at blue spaces was another important trend, seen as having a more positive impact. Most stakeholders saw increases in recreation as a way of both improving the health of the population through physical activity, and a means of improving social cohesion through a stronger identity of the city. Stakeholders identified demographic changes as having implications for creating equal access to more natural waterfront areas. Loss of biodiversity caused by this increasing recreation at waterfronts was also seen as an important trend, but stakeholders also noted that the designation of Plymouth Sound as the UK's first National Marine Park may go some way towards protecting marine ecosystems.

3.3.2. Promising strategies for inclusive waterfront heritage

Stakeholders noted that public participation in creating safer, more attractive, and more accessible blue spaces would be vital in ensuring a space meets the health needs of the local population. One challenge identified was trying to achieve this in the face of greater vested interests from other waterfront redevelopments. There is a tension between developments with the highest probable economic return, and the need to make those places more inclusive for Plymouth's changing population. Nonetheless, stakeholders identified opportunities too. For example, they saw the Mayflower 2020 celebrations (year-long commemorations of the sailing of the Mayflower) as a platform for potentially pushing for more inclusive design of waterfront areas. Stakeholders also recognised the need to involve the public very early on in spatial planning processes if they are to be receptive to the ideas and feel ownership of the plans.

The second key ambition for this group of stakeholders was valuing (and preserving) Plymouth's natural and cultural heritage. To achieve this ambition, stakeholders saw redevelopment of the city's waterfront as an opportunity to preserve cultural heritage. For example, it may lead to people increasing their frequency of recreational interaction with those spaces, thereby fostering an increased appreciation of the cultural value of the city's coastline.

3.4. Blue spaces with preserved biodiversity for all in Tallinn

Tallinn, the capital city of Estonia, is located in the northern edge of the country, on the shore of the Gulf of Finland of the Baltic Sea. In 2019, it had a population of 434,500 inhabitants (32% of Estonia's population), with a density of 2730 person per km^2 and is a major financial, industrial, cultural, educational and research centre of Estonia (https://andmed.stat.ee/en/stat). Tallinn is the birthplace of many international high-technology companies and platforms and listed among the top ten digital cities in the world (The Age, 2012).

During the stakeholder workshop in Tallinn, 'Access for all to blue spaces' (City of Tallinn, 2011) and 'Preserving biodiversity' were identified as the key values for healthy blue spaces (Table 1).

3.4.1. Loss of biodiversity, climate change and urban regeneration as an intricate challenge

The most important trends identified during the workshop that impact healthy blue spaces were further loss of biodiversity and other ecological impacts, climate change, more waterfront development for urban regeneration, changing population composition and the digitalisation of society (Table 1). The loss of biodiversity, pollution and depletion of natural resources have a negative effect on water-related ecosystems, as is the case for the water bodies of Tallinn. The impacts of climate change identified were mostly related to moderate flooding and heat stress risks for health and well-being. The increasing income inequality and waterfront regeneration perspectives might affect water-related health and well-being qualities. Tallinn has several beaches as public bathing areas as well as several business-owned closed areas where public access to the sea is prevented. Due to significant increases in building activity near the coast, there is a risk that areas that have been in public use until now will be built over and lose their function as a public space.

The inhabitants of Tallinn city are relatively young, stemming from rural-urban migration whereby the young move into the city and older people retire and move to the suburbs and countryside. This demographical development brings different challenges, such as the demands set for accessibility to the waterfront for different age groups. Other effects might be the changing frequency of age-related diseases and the changing private/work/care balance of the working population resulting in different needs regarding urban water use, both in terms of availability and water quality.

3.4.2. Waterfront access to tie up spatial planning, demographics, economy and IT

In its Environmental Strategy 2030 (City of Tallinn, 2011) the city recognises the importance to preserve and restore the water bodies (including the sea) in the internal structure of the city and aims to increase the link between green and blue spaces, and their use, by creating public points of access to these spaces. This also improves the coherence between the blue-green network and residential areas in the city and enables this use of public space for restoring natural areas and protecting biodiversity.

Tallinn aims to use its advanced technological/digital infrastructure services towards more efficient domestic water management and smarter urban water systems. The precise direction of further technological progress is unknown, however, it will unmistakably have an impact on the daily life of Tallinn's inhabitants. The city of Tallinn together with other sectors involved, should facilitate the development of user-friendly interfaces for data and information related to urban biodiversity and a healthy environment, especially regarding water-related health risks and benefits.

3.5. Sustainable urban design for all in Thessaloniki

Thessaloniki (Greece) is located, at the north-eastern corner of the Aegean Sea, bordered on the west by the Axios river. Thessaloniki city

has a population of 325,000 inhabitants, a population density of 7100 per km^2 (https://population.un.org/wup/). The city has an extensive sea front, with a total coastline of about 5.5 km and hosts the second largest container port in Greece. Three point three kms of the waterfront was renovated in 2014 and a total area of 238,800 m^2 was totally redeveloped with the addition of trees, plants, green spaces, bike roads and playgrounds.

The city climate is directly affected by the sea and lies in a transitional climatic zone (humid subtropical climate) (Beck et al., 2018). The summer in the city is hot and quite dry with about 32 days per year with a temperature of over 32 °C.

During the stakeholder workshop, participants identified 'sustainable urban planning' and 'health for all' as important values for healthy blue spaces for Thessaloniki (Table 1).

3.5.1. Balancing challenges set by climate change and social cohesion

The most important trends identified during the workshop were climate change, migration, technology for more healthy urban living, increasing recreational use of blue spaces and more healthy urban living in EU policies and strategies (Table 1). Sea level rise because of climate change, may lead to an increased risk of flooding of waterfronts. The increase in rainfall during parts of the year (Scoccimarro & Gualdi, 2020) could have a positive impact by reviving the Gallikos river and downstream deltas. Both the Aliakmon and Axios delta host thousands of ducks, mainly during winter months. Thirdly, the increase of heat waves could impact vulnerable groups in particular, as they often live under suboptimal circumstances (old buildings without heating or cooling facilities) and have fewer recourses to adapt to the effects of climate change. Gentrification caused by increasing social inequalities related to income and ethnic diversity was identified as a potential risk for urban cohesion in different parts of the city. Currently, 6.2% of the population in Thessaloniki has a foreign nationality, the majority being located in the Western districts. Moreover, because of the vast number of immigrants who arrived in 2018–2019, socio-economic information on newly arrived immigrants is missing, and thus, it is more difficult to integrate them in the local society.

The trends towards new technology for more healthy urban living may stimulate the development of smart urban water management and climate resilience.

3.5.2. Climate change as a catalyst for developing more healthy blue spaces

With the increase of heat waves, the workshop participants put forward that it could be important for the city to create more places with public access to high-quality tap water for all its citizens. Moreover, the use of cool sea wind as a ventilation system in the streets, and the shadow of the trees as a cooling system could be upscaled to larger parts of the city. A heat map alert (e.g. at bus stops) could be created to inform citizens on risks from heat waves. Big data may have a major role in the development of a blue space-friendly environment for tourists and the residents of the city, concerning the management of urban transportation, water and energy resources, wastes and weather information.

Finally, water activities, such as swimming, could also provide cooling on warmer days, although more swimming may increase the risk of drowning. Swimming lessons in schools and lifeguards at local beaches are important to secure the safety of bathing children. Information on the risks of bathing could also be important to other groups, e.g. immigrants, refugees and tourists.

Workshop participants argued that the long waterfront offers great potential for developing healthy blue and green spaces and attract more tourists. Engaging residents in the development of plans, was seen as important to tailor the design to their needs and increase acceptance.

4. Discussion

This study aimed to identify how urban ambitions regarding healthy blue spaces could be achieved, accounting for multiple, interacting global trends at the local level, using a participative, future scenario approach for five European cities. Research so far on the health potential of urban blue spaces has been limited, especially with regard to how observed associations between blue space and health in highly urbanised areas might play out in the future (Gascon et al., 2017).

4.1. The role of contextual factors in developing healthy blue spaces

Although there are multiple commonalities between cities in Europe, the local context appears to be important in identifying local ambitions, the relevancy of multiple trends, their interaction and combined impacts and the development of appropriate interventions to enhance the development of healthy blue spaces. Research so far often focused on specific trends and impact categories (e.g. Huynen & Martens, 2015; Sanchez Martinez et al., 2018). For instance, the risks and impacts of flooding were different for the different cities because of their geographical situation and climate, but also because of differences in urban design, such as the percentage of paved areas and the presence of retention facilities. This affected possible health risks and benefits. As a result, appropriate interventions are different from city to city. Another example can be given for tourism. Increasing tourism came forward as an important trend in all cities, but their impact on water and health was valued differently, from creating less access for locals to blue spaces and, in some situations, creating more unsafe places (Amsterdam and Barcelona) to a way of boosting the local economy and waterfront renovation (Plymouth and Thessaloniki). Urban planners have to deal with these complexities regarding the multiple use of space, amplified impacts of trends (e.g. urban heat island effect) and their interactions (e.g. consequences for an ageing population) in their ambitions for a resilient and healthy city.

Development geared towards designing healthy urban spaces can be observed in various European cities (e.g. Paris-Plages, Copenhagen Harbour, Amsterdam, Rotterdam) and local authorities face challenges in balancing the multiple uses of space and aspects of water quality and physical safety therein (Wuijts, Friederichs, et al., 2020). A pro-active exploration of future trends and current challenges as presented in this study, could support the development of resilient policies that benefit health.

4.2. Reflections on the methodology used

4.2.1. Strengths

The interdisciplinary approach used opened up discussions between the domains of urban water, urban planning and public health, who all have different roles and perspectives. It is a good approach for identifying joint ambitions and the possible interventions to achieve these and meet the targets set by the SDGs and European Union. The use of a uniform approach for these discussions enables the exchange of experiences and outcomes between cities, for instance within the framework of the EU Urban Agenda. This may facilitate learning and the identification of contextual factors which are relevant for the application of local interventions in other cities. Participants of the workshops shared that they now feel better prepared to recommend strategies and solutions to local authorities and decision makers, to ensure they take action to preserve blue environments and keep their communities healthy and safe. The use of normative views in this process of scenario-building adds to the understanding of relevant impacts and possible interventions and thus to their applicability in planning processes, compared to 'value free' scenario-studies that primarily study the impacts of trends for instance on health, environment or economy only (e.g. (Henriques et al., 2015, Sanchez Martinez et al., 2018).

4.2.2. Limitations

In scenario studies, both cognitive and normative uncertainties can be distinguished. In this approach, normative uncertainties were addressed in the workshops by discussing the different values and

ambitions held by the participants. Workshop outcomes can, therefore, be biased if the relevant stakeholders are missing. When used as one of the stepping stones in a policy process for future planning, this bias could be overcome by holding follow-up discussions and reflections in other settings.

The workshops organised for the five cities offered a variety of relevant values, trends and possible interventions. But it was difficult to achieve a representation of all related fields of expertise, e.g. because of issues related to planning (conflicting events), perceived relevance to the invitees, 'workshop fatigue', or the absence of networks in specific fields of expertise.

In both the *Amsterdam* workshop and the *Barcelona* workshop stakeholders with a more economic perspective were lacking. This could explain the limited focus on economic trends, even though this can be an important driver for developing climate resilience programmes. In the *Barcelona* workshop for instance, tourism came forward as an important trend for the city but was predominantly discussed in terms of social equality and less in terms of the economic impacts.

For *Plymouth* the diversity of stakeholders was such that trends and ambitions surrounding recreational use and coastal redevelopment were more likely to emerge as salient as opposed to technological or political trends, or indeed trends and ambitions related to climate change. In both the *Tallinn* and the *Thessaloniki* workshop, the participants seemed to focus more on the topics brought to the table rather than the topics missed.

Opening up the planning process and including the health domain, enabled a broader identification of relevant trends, interactions and potential impacts, for instance regarding the health impact of climate change in deprived areas, but also made it more complex to identify effective interventions because they needed to serve multiple objectives.

Follow-up discussions should therefore focus on specific impacts and interventions rather than broad discussion as illustrated by Gao et al. (2018). The discussions on healthy blue spaces and scenarios drafted could be regarded as the first steps in this iterative process towards urban planning of healthy blue spaces (Ramirez et al., 2015).

5. Conclusions

Urban authorities throughout Europe are facing multi-faceted challenges to create and preserve a healthy and resilient outdoor environment due to different trends like climate change, rising inequalities and the development of tourism. Urban blue spaces could be a valuable part of such an environment and promote health and well-being, but to date health benefits of blue spaces as a co-benefit of for climate adaptation for instance, have not been included in urban policy development. Achieving these co-benefits requires an interdisciplinary approach with a range of local experts and stakeholders to ensure that policies can be best adapted to meet the needs of the residents, for example, when mitigating the effects of urban heat islands while also creating spaces that promote physical activity and well-being and protect ecosystems. The approach used for this case study research can be used to identify these local risks and opportunities. Continuing to advance our knowledge of how health and wellbeing are connected to blue environments and how they may be impacted by future trends will make us better placed to transfer this knowledge from one city to another, to make them healthier and more resilient places in the future.

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Declaration of competing interest

None.

Appendix A. Supplementary data

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