Chapter 9: A decision support tool for optimising blue space design and management for health

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Introduction

Some urban waterfronts work like a magnet for young and old people alike – for good reasons, as blue spaces can decisively impact our quality of life and have notable effects on physical and mental health (see Gascon et al. 2017; White et al. 2020 and Chapter 1). That is, as long as planners and operators take the right decisions. So, what are the factors that can make or break an urban blue space project?

We translated the reviews of scientific evidence, good practice, case study results and expert insights into a practical tool. The resulting “BlueHealth Decision Support Tool”, or BlueHealth DST for short, is a practical guidance and assessment tool for the optimised renovation or new construction of a blue space. In this chapter, we introduce the topic context and the development and piloting process for the tool and provide hands-on instruction for using it. The complete tool is freely available online at www.bluehealth2020-dst.eu.

Demand for guidance on good design and management of blue spaces

The BlueHealth project revealed that many cities still underutilise or jeopardise the potential of blue spaces simply by inexpedient design or management. Only a few of the mechanisms defining the success of a blue space are obvious at first glance. Therefore, decisions on how to design and manage urban water bodies can be complex, as case studies and expert interviews show. We commissioned a survey that revealed unmet demands for design and management guidance among many urban planners and landscape architects. They in turn requested up-to-date orientation and practical guidance in planning, reviewing and optimising urban blue spaces for positive health and environment outcomes. The World Health Organization’s (WHO) definition of health comes close to capturing both objectives, as “a state of complete physical, mental and social well-being” that explicitly covers environmental exposures (WHO & Secretariat for the Convention on Biological Diversity 2015). The health effect of blue spaces depends largely on ecosystem status (see e.g. Wood et al. 2018; Marcheggiani et al. 2019).

The outcomes of blue space interventions have been measured from economic, ecological and public health perspectives: with promising results, as shown in Chapter 1 of this book. Blue space interventions can transform neighbourhoods and critically improve social cohesion and both community and individual well-being (e.g. Collins et al. 2020; White et al. 2017). These improvements are of increasing concern, with already over half of the world’s population living in urban areas (United Nations 2018). However, securing such benefits from an urban planning project at hand cannot be based on blueprints. Priorities and challenges vary according to locational setting, existing infrastructure, intended activities and user groups. Blue spaces can host a wide variety of activities and benefits – ranging from access to an extensive ocean front to a small pond in an urban park. Thus, the motivations and interests of involved stakeholders are likely to differ, ranging between, for example, enhancing biodiversity and providing for

niche water sports. Good decision-making requires a common understanding of success factors to overcome possibly contradictory interests. A reliable overview of such factors should be derived from the growing body of scientific evidence and good practices (see examples in Part Three of this book). Particularly, as recent reviews and surveys (see Chapter 1) show, health benefits and risks are often insufficiently considered in existing blue space projects.

Evidence and practical guidance are scattered and neither covered by existing guidance tools nor in a comparable format. The idea of decision support for blue space design and management hence holds great potential. Blue spaces are typically public and open-air spaces; thus, anticipatory setup, design and management have to compensate for inherent limitations. These may include limited access control, funding or maintenance – and should not jeopardise the safety of users and thus of the intervention as a whole. Design and management guidance should therefore combine the enhancement of health and environment benefits with the prevention of water- and activity-associated risks.

Added value of the BlueHealth Decision Support Tool

The BlueHealth DST guides the user in on-site assessment and decision-making for optimal design and management. The tool is based on a combination of current scientific evidence, good practices from experienced practitioners and selected reviews of pilot projects. In a nutshell, the BlueHealth DST provides:

1. an overview of typical blue space health benefits and risks, including environmental considerations;
2. distilled background information on the relevance and mechanisms of the most critical health and environment considerations around blue spaces; and
3. a hands-on tool for desk- and field-based blue space assessment based on user choices as a basis for design and management decisions.

The BlueHealth DST guides stakeholders to 1) maximise health benefits, including environmental factors, and 2) reduce and manage associated risks. It is designed first of all to broaden stakeholders' understanding of all the key environmental and health topics around blue spaces before guiding, for example, a team of planners towards a systematic assessment and prioritised intervention. The tool presents the globally evaluated and organised evidence and experience around such benefits and risks. It is set up to help users to understand the health and well-being factors of blue space interventions along examples and effect estimates. The array of possible interventions and focus topics around blue-green infrastructure is enormous, but only a few may be suitable for a given setting and ideal for the local population. The user is thus guided to identify the planning and management factors most relevant for his or her blue space at hand.

The BlueHealth DST is particularly tailored to the needs of practitioners involved in blue space projects, ranging from urban planners or landscape architects to local decision-makers and their stakeholders. The target audiences thus also include professionals in civil engineering, water management, urban ecology, recreation management and related fields. It further caters to policy makers, public health specialists, researchers and other entities with a stake in urban blue spaces. As the practitioner-oriented assessment module can be used separately from the educative module, the BlueHealth DST may generally support:

1. the planning process for a new blue space,
2. the renovation of an existing blue space,
3. the review of an existing blue space and its management and maintenance schemes,
4. blue health policy making (as background information), and
5. research on blue spaces and public health (as topical orientation).

The tool is intended for projects on most kinds of public water bodies, except swimming pools, spas and other types which are typically covered by separate and highly specific regulations.

BlueHealth Decision Support Tool development

The BlueHealth DST is based on proven approaches for guiding decision-makers and practitioners on scientific evidence and good practices. The WHO's European Centre for Environment and Health led the development of the tool in close collaboration with two BlueHealth consortium partners – the Euro-Mediterranean Centre on Climate Change (*Centro Euro-Mediterraneo sui Cambiamenti Climatici*, CMCC) for the programming of the web-based tool and the Italian National Institute of Health (*Istituto Superiore di Sanità*, ISS) for pilot testing. This chapter presents key aspects of the development process:

- the concept and objective of the BlueHealth DST for policy and decision-makers
- an overview of BlueHealth DST components
- an introduction to comparable environmental decision support tools
- an overview of BlueHealth DSTs for urban green and blue space planners
- the knowledge and decision-making demand around blue spaces
- the common blue space types and circumstances in Europe
- a future outlook for blue spaces and trend impacts (politics, climate, etc.)
- the programming behind the BlueHealth DST
- piloting the BlueHealth DST

Background on decision support concepts

Loosely defined, a decision support tool is a way of coherently organising information to support decision-making. It is to inform decisions and ensure that they are robust, transparent, documented and reproducible (Liu et al. 2012). A DST is designed for situations in which problem formulation as well as solution generation and selection are difficult and partially or fully based on complex and possibly conflicting information (McIntosh et al. 2011). It is thus an ideal fit for the topic of environmental health at the complex interface of environmental and human systems.

For environmental-health related DSTs, the HENVINET (Health and Environment Network) project has developed the following definition:

Any tool based on environmental health knowledge that can be used in different decision-making contexts: from every day operation of health practitioners to strategic long term planning and implementation of policies for reducing the negative effects of environment on health.

(Liu et al. 2012, p. 2)

However, a review of environment and health-specific DSTs carried out by HENVINET indicated that many are limited to single sources, pollutants or health outcomes or to one specific area.

As instruments to support the translation of scientific evidence into decision-making, DSTs facilitate management based on complex and wide-ranging information (Bartonova 2012). The BlueHealth DST guides the screening of interventions on critical factors for health and well-being. Its guidance is based on the insights of a scientific consortium and extensive research reviews. Thus, we promote a concept that is not currently an explicit priority for decision-makers in this area, or at least has not been spelled out as a leading principle. Generally, the need for decision support in public policy is widely recognised, and a large number of DSTs have been developed, with varying degrees of success in their practical use.

Common decision support tool types and basic components

To base the BlueHealth DST on sound methodological principles, we review established concepts in the following section. DSTs aim to provide certain actors with tailored guidance for decision-making. The following elements are almost invariably present in DSTs:

1. The *decision problem*, typically presented as a finite set of alternatives from which a preferred option can be identified to meet the needs of a decision-maker. Those may in turn be representing (nominally or in reality) the preferences or interests of an institution, shareholders, society, etc.
2. The *decision-maker*, as the person, group or institution in charge of deciding on the way forward for the problem considered and thus the customer served by the DST. The decision-maker may choose to involve stakeholders (i.e. those with an interest or concern in the decision at hand).
3. The *decision support framework* is where the elements relevant for the decision and their predictable performance and/or consequences in various areas are organised coherently and systematically. It typically includes some representation of the aspects of importance to the decision-maker or to society. This framework would usually involve some type of user interface.
4. The *decision support outputs* generated by the tool: this may involve anything from a univocal representation of optimal performance of each alternative (e.g. a benefit/cost ratio or a ranking of alternatives) to something much 'fuzzier', such as guidance or identification of critical areas for consideration. Such outputs can include visualisations, quantitative data, text-based guidance or qualitative information and narratives.

For the design of the BlueHealth DST, each of the four elements was addressed and decided upon during a technical workshop and a consortium review. The BlueHealth consortium agreed on two goals for the BlueHealth DST: 1) the promotion and awareness raising of the relevance of planning and maintaining healthy urban blue spaces and 2) the identification of interventions/factors to establish, improve or protect existing blue spaces and to maximise their benefits for health and well-being.

Review of guidance tools for urban and blue space management

To understand the demand for a BlueHealth DST, the consortium carried out a scoping study of existing tools in the specific area. This review identified several tools available or under development for urban green and blue spaces (see also tools reviewed for the BlueHealth Environmental Assessment Tool [BEAT] in Chapter 5). Some tools targeted water-related management issues, but most focused on engineering and technical aspects or on very specific ones such as contamination. Finally, four tools were identified that cover blue spaces or urban water bodies to an extent relevant for planning and management purposes. They may be of added value for interventions with either a strong emphasis on ecosystem service investments, storm water management or urban environmental policy. The products were reviewed as part of the preparatory review for the BlueHealth DST development and are briefly described in the following.

Local Action Toolkit: ecosystem service investments and returns

The Local Action Toolkit provides a framework for the assessment of costs and benefits of catchment management programmes in urban landscapes. The toolkit guides the quantification of benefits of interventions designed to enhance ecosystem service provision. It does not cover direct access to and use of water bodies (e.g. water sports, etc.) or health risks associated with blue spaces. The framework is scalable and can be applied to a broad spectrum of urban situations and guide the measurement of potential benefits (whether directly monetisable or not). The list of interventions is based on green infrastructure components and sustainable drainage systems. It is categorised into 'existing assets' and 'interventions' based on the likelihood of future implementation.

The toolkit covers 12 benefits that influence quality of life. These consider to what extent a green or blue space intervention can help to 1) improve healthy environments, 2) reduce flooding risk and related economic damage, 3) improve habitat provision for biodiversity, 4) stabilise groundwater recharge and improve water quality, 5) support climate regulation and 6) provide social and cultural services and opportunities. The tool mainly aims at city-scale interventions to increase ecosystem services through nature elements and almost exclusively focuses on the provision of benefits (Defra Local Action Project 2017).

Water Sensitive Cities Toolkit: strategic storm water management

For blue spaces with a particular focus on storm water management, the Water Sensitive Cities Toolkit supports strategic planning of related green infrastructure initiatives in urban areas. Its final completion by the Australian Cooperative Research Centre for Water Sensitive Cities was planned for late 2020. The toolkit aims to enable evidence-based quantification of benefits rendered by context-specific planning, design and implementation of ecosystem-based storm water management. The toolkit comprises three functional components: 1) strategic planning and conceptual design, 2) future climate uncertainty and variability (in development) and 3) scenario assessment and multi-benefit evaluation.

The strategic planning and conceptual design component of the toolkit is called “UrbanBEATS”. A model combines urban planning information and geospatial data to generate storm-water management options based on a user-defined scenario. The component is based on a GIS and requires four basic input raster maps (elevation, land use, population and soil data), as well as non-spatial data in the form of rainfall and evapotranspiration data and urban design data (Cooperative Research Centre for Water Sensitive Cities 2020).

Green City Tool: sustainable urban environment policy

For urban planners with a broader aim of improving the city’s environmental sustainability, the European Commission (DG Environment) developed the Green City Tool. The tool is not explicitly linked to health outcomes but rather assesses overall environmental sustainability. It covers a wide range of urban sustainability topics and is based on a series of steps (assess conditions – view results – explore improvement options).

Guidance focuses on the policy level and helps users to review whether desirable approaches and instruments are in place. The tool reflects the criteria applied in the application process for the European Green Capital Award in 12 topics. Several topics are relevant for green and blue spaces. It does not (yet) provide information on the features of urban environments or how to manage risks and benefits of urban nature elements (European Commission 2019).

Principles for Water Wise Cities: eco-wise urban water policy

The Principles for Water Wise Cities established by the International Water Association (IWA) aim to guide policy makers in improving the urban water management in cities. Particular emphasis is put on eco-system services and the protection and efficient use of water bodies. The 17 principles are structured in five blocks addressing 1) vision, 2) governance, 3) knowledge and capacity, 4) planning tools and 5) implementation tools and feature four levels of actions, covering 1) regenerative water services, 2) water-sensitive urban design, 3) basin-connected cities and 4) water-wise communities. IWA provides implementation tools alongside a focus on financing and investment calculations (International Water Association 2016).

Review of urban landscape assessment tools

In order to understand the guidance needs and good practices for comparable tools, the consortium carried out a review of “tools for assessing places”. Seventeen tools fitted the selection criteria, of which most (13) focused on terrestrial assessments, and only 4 included water components (Blue Flag, Local Action Toolkit, Urban Waterfront

Regeneration, Urban Stream Condition). The reviewers pointed out that health and well-being was one of the least considered aspects, while the following categories were most common:

- Quality of landscape/environment (loosely defined);
- Maintenance issues;
- Accessibility to and within space (barriers for people);
- Safety: crime and security perception; and
- Others: transport, ecology, cultural heritage, economic values.

The tools' topical priorities indicate that blue spaces are – often – expected to provide rather general benefits. Thus, access, subjective perceptions of comfort and public safety, as well as maintenance, seem important to ensure active blue space use.

Based on this review, the BlueHealth Environment Assessment Tool presented in Chapter 5 (and in Mishra et al. 2020) was developed by researchers at the Estonian University of Life Sciences. It is limited to environmental dimensions and with a different target audience and output from the BlueHealth DST. It is designed for two groups of users: 1) experts, such as landscape architects, ecologists, recreation planners, urban planners or hydrologists, and 2) local community or citizen groups who have an interest in their local environment.

Needs assessment for blue space guidance in Europe

To assess practitioners' demands for decision-making guidance, the BlueHealth consortium, led by CMCC, carried out a survey among decision-makers and planners in Europe. The survey included questions on the current integration of health and well-being risks into the planning of blue spaces and comparable interventions. It also evaluated current levels of knowledge around public health in urban planning. The analysis served as a critical input for the setup of the BlueHealth DST.

The results showed that, at the time of the survey (2017), blue space projects:

- were planned with a strong consideration of the future implications for maintenance and related management needs;
- were rarely expected to generate improvements related to environmental exposures like noise or air pollution or to reduce disease occurrence; and
- seemed inadequately informed about local environmental conditions and risks, such as revealing a lack of awareness around vector-borne diseases.

Review of existing blue space projects

To identify typical and successful infrastructure and management elements for blue spaces, researchers at the Estonian University of Life Sciences conducted a review of 180 existing interventions (detailed results can be found in Chapter 10). The analysis included, amongst others, the following aspects:

- Potential to increase physical activity and to improve mental health;
- Equitable accessibility to and within the blue space site;
- Facilitation of visitor interaction with water (bodies);
- Day-to-day management and maintenance; and
- Safety and security measures.

Programming of the BlueHealth DST web application

The development of the web application was based on good practice and experiences by the BlueHealth consortium and the CMCC team. It is composed of two main parts: the front-end as the client application for the user's web browser and a back-end as the connection to the BlueHealth DST database.

The front-end component was developed using Ionic, an Angular-based framework. This framework allows the same application to run on both computer and mobile phone browsers. Figure 9.1 shows a diagram of the high-level BlueHealth DST architecture. It illustrates the relation between the user interface on the device (PC, tablet, mobile phone) and the web service on the server to provide the data presented to the user.

The communication between the client and the web service takes place through the HTTP protocol and a RESTful web service which provides data and contents stored in the database to the front-end. The client application connects to the web service and points in a transparent manner for the user. It requests the contents needed to populate the user interface. The data exchange format is JSON. An example of an endpoint is: `http://IP_SERVER/blue-health-backend/static/T4_1`.

The web service answers to this request by providing the textual content extracted from the database: `{"txt": "<h3>Injuries</h3>\r\n<p><strong>Summary</strong> </p>\r\n<p><em>Facilitating access to a blue space implies exposure to injury risk, including immediate fatality. Many of the. . ."}"`

All textual contents associated with the BlueHealth DST entities such as goals, targets and sub-targets are stored in a relational database. The entity-relationship (E-R) model is depicted in Figure 9.2. It describes the entities, their properties and their relations inside the database of the BlueHealth DST.

In order to obtain the implementation schema, the E-R model diagram was converted to a relational model, as shown in Figure 9.3. The model represents the tables and their properties and their relations as they are implemented in the database of the BlueHealth DST. The database instance has been implemented in the MySQL DBMS.

Figure 9.1

Application architecture of the BlueHealth DST: connection between user interface (hybrid app) and backend (database)

(Source: CMCC/Anna Wilczyńska)

Figure 9.2

A diagram representing the entity-relationship model within the database of the BlueHealth DST

(Source: CMCC/Anna Wilczyńska)

Figure 9.3

A diagram of the relational model within the database of the BlueHealth DST

(Source: CMCC)

Piloting of the BlueHealth Decision Support Tool¹

The development of the BlueHealth DST was supported by several test runs to ensure relevance and applicability in the field. This section provides an insight into the efforts made and shows how the test applications have helped to shape the final tool.

The first pilot version of the BlueHealth DST, produced by CMCC in 2018, was used by ISS for testing in the Appia Antica Park case study in Rome, Italy. A further developed version with improved functionality was then applied and tested at various BlueHealth case studies, led by ISS. The tool was also piloted by all partners during a field exercise at the consortium meeting in spring 2019 in Amersfoort, The Netherlands. The feedback on content and functionality of the tool contributed to the final BlueHealth DST version, which then was confirmed as fit for purpose during a final test application in Plymouth, United Kingdom, in late 2019.

Piloting in Appia Antica Park, Rome

A BlueHealth DST prototype was first piloted in Rome's Appia Antica Park (Figure 9.4a). This park, spanning an area of 4500 ha, contains several blue spaces, comprising both natural and artificial aquatic ecosystems.

The prototype of the web-based BlueHealth DST was applied to guide a project on wetland improvement through the development of a small pond, pathways and benches (see Figure 9.4b and c). The aim of this project was to improve the access and use for local residents who would like to improve their physical and mental well-being. The project team focused on 1) "promotion of human health" and 2) "improvement of ecosystem services", of which the following sub-targets were relevant: "nature experience", "socio-cultural interaction", "noise reduction", "shore activities", "local climate regulation" and "habitat restoration".

Figure 9.4a–d

a) Location and extent of the Appia Antica Park in Rome; b) the character of the park – the water body is relatively hidden among dense vegetation; c) one wetland to be improved by management; d) screenshot of one page of the DST application outcome following the testing

(Sources: a) OpenStreetMap CC-BY-SA; b) and c) ISS; d) BlueHealth DST)

For the selected sub-targets, the tool provided a text output listing a total of 49 factors (Figure 9.4d). For 1) the promotion of human health goal, upon analysis, three key benefits were identified for the project at hand: the reduction

Results

Linking environment, climate & health

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 666773

Pooled assessment for the following risk and benefits:

- Nature Experience
- Socialcultural interaction
- Shore activities
- Local climate regulation
- Habitat restoration

The below information provides you with important parameters to consider when planning, assessing, or managing and maintaining public blue spaces, or preparing for interventions and infrastructural measures within the blue space settings.

The pooled guidance document combines the information for the selected health risks and benefits into one document, and thereby provides a resource for structuring information collection and site assessments during field visits to the blue space. For such on-site visits, the pooled guidance lists the blue space features that need to be considered to reduce blue space-specific health risks, and/or to increase related benefits. However, it can also be applied for desktop audits and reviews. The pooled assessment includes a checklist where the need for follow-up action can be documented.

Information and guidance that is applicable for more than one risk or benefit can be identified by the respective label, indicating that the statement can be valid for

- two or more dimensions related to certain risk (▲) or benefit (●) categories
- a variety of different risks (labeled "Risks") or a variety of different benefits (labeled "Benefits"), or
- a variety of both risks and benefits (labeled "General").

Step 1: Review locational and water factors

- [Benefits] Are sensitive nature areas protected from human access to avoid environmental degradation (see habitat)?
- [Benefits] Does the local infrastructure enable for seating and playing in shaded areas (see UV) to reduce heat stress and provide breaks from recreational activities?
- [Climate regulation] Is the blue space surrounded by vegetation, particularly shrubs and trees, which can enhance the blue space climate regulation effect?
- [Climate regulation] Does the surrounding infrastructure enhance wind flow (e.g. through low-rise infrastructure or building gaps in wind direction to not block air exchange) to increase climate regulation capacity?
- [Climate regulation] Are there fountains or water falls that produce water mist with an additional cooling effect?

Figure 9.4a–d (continued)

of heat stress, which was to be realised by providing shaded areas for seating or shelter; the decrease of noise exposure, to be achieved by enhancing natural water sounds; and the promotion of social interaction through creating easily accessible open spaces. For 2) the improvement of ecosystems services goal, the most relevant factors revolved around the protection of native biota, for instance, by limiting visitor access seasonally or permanently to vulnerable areas and by identifying and managing alien invasive species. Furthermore, the BlueHealth DST-guided analysis revealed the importance of maintenance of the planned infrastructure. Overall, the pilot study confirmed the relevance and usability of the BlueHealth DST and, especially in this case, the benefit of drawing from a complete and exhaustive list of risk and benefit factors to be taken into account for project development, providing guidance on how the site could be managed to maximise its positive impact on public health. This confirmed that the proposed structure and content of the BlueHealth DST was functional and could serve as a baseline for further development and fine-tuning.

Piloting in Amersfoort

In the city of Amersfoort in the Netherlands, the BlueHealth DST was tested in spring 2019 at an urban canal (Figure 9.5).

To make the test run broad and effective, 10 scenarios were prepared, each representing a different type of user with different interests in the blue space and its features (see Table 9.1). For each scenario, four or five targets of the BlueHealth DST were selected for the on-site testing at the urban water canal, checking whether the guidance statements included in the respective risk and benefit targets were applicable and relevant. This setup ensured that each risk or benefit target of the BlueHealth DST was applied several times and tested by groups using the tool with a different perspective in mind.

The test application in Amersfoort provided insights and better understanding of the applicability of the guidance statements on many risks or benefits covered by the BlueHealth DST. The reviewers provided feedback after DST testing about 1) the description, applicability and relevance of risk and benefits; 2) the suitability of the guidance to support assessment of risk and benefits; and 3) its usefulness to provide information for future management of the

Figure 9.5a and b

Amersfoort and its typical canal system, showing some canal edges with barriers and some without, vertical walls rising out of the canal and other aspects which increases risks of, for example, drowning

(Source: ISS)

blue space. Most partners considered that the guidance helped to assess risks and benefits, and all of them agreed that the guidance provided useful information for future management of the blue space. As the piloting was done according to various scenarios, it allowed input on the applicability of the DST guidance statements from different perspectives and functional expectations. Based on the feedback of the piloting exercise, content and guidance statements were revised, and the internal consistency between aspects relating to more than one risk or benefit was improved.

Table 9.1 The ten different scenarios chosen for a BlueHealth DST test application in Amersfoort

<i>Scenario for DST application</i>	<i>Goal</i>	<i>Target</i>
<i>1 – Nature conservation/NGO</i> Blue space use: on shore only	Promote human health benefits Promote ecosystem benefits	Nature experience, shore activities Water regulation, habitat restoration
<i>2 – Climate change expert</i> Blue space use: on shore only	Protect human health and minimise risks Promote ecosystem benefits	Temperature, flooding, mosquitoes, snails Local climate regulation
<i>3 – Parents concerned about child safety</i> Blue space use: including swimming and water sports	Protect human health and minimise risks Promote ecosystem benefits	Drowning, injuries in water bodies, injuries around water bodies Water activities, shore activities
<i>4 – Elderly interest group representative</i> Blue space use: on shore only	Protect human health and minimise risks Promote human health benefits Promote ecosystem benefits	Inhalation/ <i>Legionella</i> Nature experience, sociocultural interaction, noise reduction Local climate regulation
<i>5 – Paediatrician promoting child health</i> Blue space use: including swimming and water sports	Protect human health and minimise risks Promote human health benefits	Drowning, UV Nature experience, water activities
<i>6 – Physical activity promotion network/green gym rep</i> Blue space use: incl. swimming and water sports	Protect human health and minimise risks Promote human health benefits	Injuries around water bodies, water ingestion and contact, UV Water activities, shore activities
<i>7 – Local health department</i> Blue space use: on shore only	Protect human health and minimise risks Promote human health benefits	Water ingestion and contact, inhalation/ <i>Legionella</i> , temperature, mosquitoes Shore activities
<i>8 – Water expert from local environment department</i> Blue space use: on shore only	Protect human health and minimise risks Promote ecosystem benefits	Water ingestion and contact Local climate regulation, water regulation, habitat restoration
<i>9 – Water sports club president</i> Blue space use: incl. swimming and water sports	Protect human health and minimise risks	Drowning, injuries in water bodies, water ingestion and contact, snails
<i>10 – Urban planner (trying to maximise benefits)</i> Blue space use: on shore only	Protect human health and minimise risks Promote human health benefits Promote ecosystem benefits	Flooding Sociocultural interaction, noise reduction Local climate regulation, water regulation

Piloting in Teats Hill, Plymouth

The further-developed BlueHealth DST was applied in Plymouth, United Kingdom, in November 2019 at Teats Hill, one of the BlueHealth case study sites located at a public section of the Plymouth marina (see Chapter 3). The application of the BlueHealth DST was carried out by members from the South West Coast Path, National Marine Aquarium, Plymouth City Council and local planners who worked on Plymouth's urban beach regeneration project at Teats Hill. The group identified the features and conditions that seemed most relevant for the Teats Hill redevelopment and then visited the site to assess the risks and benefits based on a set of guidance documents provided by the tool (Figure 9.6).

After the test application, the group discussed how they could use the DST in their specific areas of work. They also agreed that the tool's guidance and discussion prompts would be useful when justifying new planning bids.

The feedback showed that the changes implemented after the Amersfoort test run improved the tool significantly, and participants agreed that the BlueHealth DST will be valuable for practitioners when it came to redeveloping and optimising urban blue spaces. After the Plymouth test application, the BlueHealth DST was then edited and finalised in 2020. The final content and structure of the tool is presented in the next section.

The BlueHealth Decision Support Tool: optimisation of blue spaces for health

The growing scientific evidence on the health effects of blue and green spaces encourages the renovation or new development of urban water bodies. For the optimisation of such blue space projects, one needs to understand which factors are precarious versus beneficial for blue space design and management.

The DST is based on scientific evidence, good practice, case studies and expert insights on the mechanisms behind the possible health effects of blue spaces. It covers a total of 18 topics, divided into 10 health risks to be prevented (such as drowning or flooding) and 8 health or environmental benefits to be enhanced (such as nature experience or local climate regulation) (Figure 9.7). The BlueHealth DST presents each of these topics with a guidance document, including insights on typical scenarios and local relevance, and a practical assessment checklist. The checklist is built on the decisive factors identified for blue space success or failure.

Figure 9.6
Members of the group evaluate the redeveloped space at Teats Hill in Plymouth using the BlueHealth DST
(Source: Jo Garrett)

Figure 9.7
Critical topics to address in the optimisation of a blue space
(Source: Arnt Diener/Anna Wilczyńska)

The user or project team is guided through the topics to achieve two goals: first, to identify needs for precautionary measures to avoid health risks, and second, to define measures that optimise human health and environmental benefits. The 18 topics were bundled into seven targets (Figure 9.8) that will each be introduced in the following section. For detailed guidance, further references and the customisable assessment checklist, readers may refer to the online tool alongside the instructions provided in the penultimate section of this chapter. Beyond the BlueHealth DST, other tools, particularly the BEAT introduced earlier, can provide additional assessment guidance.

Step 1: Protection of human health and risk minimisation

For any blue space project, the prevention of serious injuries and illnesses should come first. We advise applying a risk-based and anticipatory approach, that is, the integration of infrastructural and managerial measures to prevent those health risks that are found to be most probable and serious in the given circumstances (WHO 2013, 2019).

Figure 9.9 lists the four targets to be reviewed for precautionary measures in blue spaces. In Table 9.2, examples of factors that determine the relevance of a mechanism for a blue space setting at hand are listed.

Figure 9.8
The array of assessment and intervention targets used in the BlueHealth DST
(Source: WHO)

Figure 9.9
Adverse health risk targets in blue spaces
(Source: WHO)

Table 9.2 Examples of factors for the protection of human health

Unintentional injuries	<ul style="list-style-type: none"> Water-body bottom conditions and depth in water entry zone can affect risk (e.g., underwater objects, steep or shallow relief, slippery surfaces)
Water-borne diseases	<ul style="list-style-type: none"> Contamination and nutrient inflows, including from sewage or agricultural runoff, and their seasonal dynamics (e.g. snowmelt or extreme rainfall) can increase health risk
Climate impacts	<ul style="list-style-type: none"> Surrounding relief, surface infiltration permeability and water flow patterns can increase flooding risk upon extreme rainfall
Vector-borne diseases	<ul style="list-style-type: none"> Corners and edges of the water body with water stagnation, particularly if shaded and shallow, or small water-bearing containers and flooded flower pots can be ideal breeding grounds for certain mosquito genera

Prevent unintentional injuries

Injury and mortality risk from drowning and unintentional injuries or accidents are associated with most uses and users of blue spaces (Table 9.3). The highest risks are commonly recorded among physically active uses and immersion in water (i.e. all water sports activities). Thus, a particular focus is to be put on drowning as the third deadliest injury in Europe (with five times as many casualties as firearm use). The respective guidance document provides a list of factors to be reviewed based on project documentation and on-site visits. The factors for this category are spread widely: while drowning risk may largely depend on water body features and user behaviour, falls have the highest mortality rates among older people and often occur along slippery or uneven walkways. The example of drowning illustrates the anticipatory design focus that blue spaces typically require in comparison, for example, with swimming pools that inherently allow more control of water depth, visibility, surveillance or access times (WHO 2014; Peden et al. 2018; Hamilton et al. 2018; Patel et al. 2017).

Prevent water-borne diseases

A considerable volume (of roughly 25 ml) of water is ingested during an average swim. Oral ingestion and inhalation, but also skin or mucosal contact, can result in acute and chronic health effects from contaminated water (Table 9.4). Notably, 85% of officially registered bathing-water sites in the European Union were rated at an “excellent” level of recreational water quality in 2019. However, water quality can be highly dynamic in time and space, with particular risk after heavy rain events for open water bodies or prolonged periods of stagnation in water fountains. The oral ingestion of contaminated water mainly risks diarrheal diseases caused by various pathogens. Less likely, contaminated water can also be inhaled and thereby allow certain pathogens,

like *Legionella*, to be transmitted through water spray or mist. In warm and nutrient-rich inland and coastal waters, adverse health effects can also be caused by the toxins released during algae or cyanobacteria blooms. Overall, the most susceptible population groups for water-borne illnesses are children, elderly or immune-suppressed persons. In children particularly, disease contraction may also occur through the ingestion of contaminated beach sand or coastal soil (European Environment Agency 2019; WHO Regional Office for Europe 2016; Huisman et al. 2018; Carlson et al. 2020; WHO 2017).

Table 9.3 Example factors to assess the risk of unintentional injuries

Drowning	<ul style="list-style-type: none"> Offshore winds (a risk for, e.g. flotation devices) and water currents (e.g. rip currents, river currents or tidal currents in maritime waters) can increase risk Provision of adequate equipment (e.g. lifejackets, lighting, first aid kit) on the shore/for water vessels can help to control risk
Injuries in water bodies	<ul style="list-style-type: none"> Water body bottom conditions and depth in water entry zone can affect risk (e.g., underwater objects, steep or shallow relief, slippery surfaces) Tourists and non-residents are likely to lack local knowledge of blue space risks and require particular attention and guidance (e.g. local currents, steep shores, local water contamination or hazardous aquatic animals)
Injuries around water bodies	<ul style="list-style-type: none"> Inadequate/deteriorated conditions of water-related infrastructure (e.g. jetty) and vegetation (e.g., slippery surfaces, risky diving or hangout spots) can increase risk Provision of medical supplies for injury treatment with provisions for the particular hazards of the area (e.g. removal kit for stingers) can help to control risk

Table 9.4 Example factors to assess the risk of water-borne illnesses

Ingestion	<ul style="list-style-type: none"> Contamination and nutrient inflows, including sewage, storm-water, solid waste, agricultural runoff or industrial site outflows, and their seasonal dynamics (snowmelt, low-gauge phases or flooding after extreme rainfall) can increase health risk Monitoring of water quality, particularly upon infrastructural changes within or upstream of the blue space and upon extreme weather events, can help to control risk
Inhalation	<ul style="list-style-type: none"> Prolonged periods with water temperatures between 25 and 45°C favour <i>Legionella</i> growth in water pipes/reservoirs Adequacy and maintenance of disinfectant concentration where relevant for artificial ornamental blue spaces such as fountains can help to control risk

Prevent atmospheric/climate impacts

Facilitating access and promoting the use of blue spaces can increase user exposure to extreme air and water temperatures, UV radiation and extreme weather events. Most of those climate-associated risk factors show apparent seasonal dynamics; in particular, water temperatures typically fluctuate more strongly over time and throughout the water body than expected in swimming pools, for example. Water contamination and injury risk in urban water bodies is adversely affected by extreme events such as flooding or drought. While the provision of UV-shading may be considered common good practice in many places, the monitoring and communication of critical, seasonal water quality dynamics is typically (still) limited to certain water body types. Guidance focuses on three distinct topics (Table 9.5):

1. UV exposure: Exposure to solar UV radiation can cause skin inflammation and adverse long-term health effects. Uses of blue spaces are often associated with prolonged times spent outdoors with reduced clothing and thus an increased exposure of skin surface. Even on cloudy days, up to 75% of UV radiation can still pass through an overcast sky. In blue spaces, exposure to solar UV can be aggravated by surface reflection, with water and sand

Table 9.5 Example factors to assess the risk of climate-related impacts

Solar UV	<ul style="list-style-type: none"> • Risk from UV radiation is higher in locations with a low latitude and high elevation above sea level and also increases with reflection from water, beach sand or snow • Infants under 12 months of age are particularly sensitive to UV radiation
Temperature extremes	<ul style="list-style-type: none"> • Cool zones or currents within the water body can unexpectedly increase cold water exposure for swimmers • Provision of cold showers near public swimming areas to prepare the body for cold water immersion can control risk
Extreme events/flooding	<ul style="list-style-type: none"> • Surrounding relief, surface infiltration permeability and water flow patterns may increase flash flooding risk during extreme rainfall • Preservation of local retention areas and reduction of sealed areas can help to mitigate flood risk

reflecting up to 15% and snow up to 80%. Over 20,000 deaths are attributed annually to excessive UV exposure in Europe, mainly caused by cancer (Greinert et al. 2015; Gilbertz et al. 2019).

2. Temperature extremes: Air and water temperature levels not only influence numbers of users of blue spaces but also their health risks. Water temperatures below 15°C can cool down the body around 25 times faster than can comparable air temperatures. The somatic effects can lead to so-called “cold shocks” and premature exhaustion which in turn increases the risk for drowning. Hot weather, on the other hand, is a risk factor, particularly for physically active and for older people. The heat wave in the summer of 2003, for example, caused an estimated 70,000 excess deaths in Europe. Urban water bodies are sought out for recreation and physical activity during hot days; preventative measures like ensuring access to drinking water or providing shading elements then become particularly relevant (Gunawardena et al. 2017; Tipton et al. 2017).
3. Extreme events: Flooding is the most common water-related extreme event. The influx of contaminated water and debris into blue spaces from feeder water bodies or surface water flows typically has adverse effects on water quality and site safety. Facilitating public access to the shores of flood-prone water bodies thus requires consideration for flooding situations, such as signposting, warning systems or physical barriers to prevent exposure. In the WHO European Region, floods affected 3.4 million people in the period from 2000 to 2011. Climate change is projected to increase the occurrence and frequency of flood events in large areas of Europe (Bell et al. 2018; WHO Regional Office for Europe 2013).

Prevent vector-borne diseases

Vector-borne diseases are caused by pathogens transmitted by host organisms such as mosquitoes, snails or ticks. Mosquito bites are common incidents around water bodies, which can act as breeding sites for them. Under certain conditions, those mosquitoes can also transmit illnesses. Similarly, snails can proliferate along the shorelines of freshwater bodies and carry an illness-causing parasite called *Trichobilharzia*. A review of the vector-borne disease risk can thus be relevant for both blue space users and the adjacent population (Table 9.6).

1. Mosquitoes: Mosquito-borne disease prevalence differs by geographic region, and the current risk for disease transmission in Europe is relatively low. West Nile fever is considered the most relevant disease and is typically associated with a concentrated presence of birds. In 2018, almost 1500 human infections of the West Nile virus and over 150 deaths were reported in the European Union (European Centre for Disease Prevention and Control 2020; Bruguera et al. 2020).

Table 9.6 Example factors to assess the risk of vector-borne diseases

Aquatic snails	<ul style="list-style-type: none"> Eutrophication, high influx of nutrients and presence of waterfowl can increase the risk of schistosome exposure Small children may be more vulnerable due to more extended stays in shallow water and near shorelines with potentially higher parasite concentrations
Mosquitoes	<ul style="list-style-type: none"> Maintenance of containers and blue space-adjacent areas without water drainage (e.g. by manual drainage or mosquito-proofing with lids) can control risk Corners and edges of water bodies with water stagnation, particularly if shaded and shallow, or small water-bearing containers and flooded flower pots can increase the risk of mosquito breeding

2. Snails: The most common snail-borne disease is the so-called swimmers' itch upon contact with *Trichobilharzia*-infested water. Outbreaks regularly lead to the closure of lakes for recreational water activities. In the future, global developments are expected to lead to an increase and further extension of vector-borne disease transmission in Europe (Selbach et al. 2016; Soldánová et al. 2013).

Step 2: Promotion of human and environment benefits

The second goal in optimising any blue space should be the improvement of potential benefits for users, neighbours and local ecosystems. We again encourage an anticipatory and tailored approach, that is, the integration of physical and managerial measures to leverage the benefits that are most prominent and relevant in the local circumstances. Introductions to each of the three targets can complement existing understanding of the topic. Each target consists of several topics that can be selected for reading and analysis for the specific site (Figure 9.10 and Table 9.7).

Improve mental and social well-being

Blue spaces can be ideal locations for both relaxation and social gatherings. The effects of nature experience and social interaction have shown significant influences on human well-being and a sense of belonging (Table 9.8).

Figure 9.10
Health benefit targets in blue spaces
(Source: WHO)

Table 9.7 Example factors for the improvement of health and local ecosystems

Mental and social well-being	<ul style="list-style-type: none"> Space and infrastructure provision for social and group activity without disturbance of user groups sensitive to noise
Physical activity	<ul style="list-style-type: none"> Provision and maintenance of opportunities for sport and play activity (e.g. footpaths, fitness and work-out equipment, playgrounds or ping-pong tables)
Ecosystem functions	<ul style="list-style-type: none"> (Seasonal) management of vegetation around blue space in balance with desired local climate effects (shading, evaporation) and various user group preferences (e.g. avoiding barren soil with low albedo during dry periods)

Table 9.8 Example factors to assess mental and social well-being

Nature experience	<ul style="list-style-type: none"> • Protection/promotion of biodiversity and visual attractiveness of flora and fauna enhances nature experience (e.g. through habitat restoration) • Space and infrastructure provision for social and group activity without disturbance of user groups sensitive for noise enhances mutual benefits
Social interaction	<ul style="list-style-type: none"> • Programmes encouraging social interaction ranging from neighbourhood groups for blue space maintenance to exercise groups and social events can enhance benefits • Provision of infrastructure promoting social exchange and participation targeting different groups (e.g. playground for children, soccer fields and BBQ areas for adults and families, or seating and boule lanes for older people) increase benefits
Noise	<ul style="list-style-type: none"> • Shielding from local noise sources through sound barriers consisting of natural compounds (e.g. trees and vegetation, rocks or landform) or artificial elements (e.g. noise walls) reduces noise exposure and can enhance the positive sound effect of water bodies • People with impaired hearing (higher vulnerability to noise) and persons with high stress levels may benefit the most from calm environments

1. Nature experience: Water elements are recognised as a key factor for mental restoration, particularly in built environments. Living in areas with greater availability of blue space has been associated with a range of mental well-being outcomes, including better mental health, lower odds of mood and anxiety disorders and better quality of life, though these relationships are not always consistent across countries and sub-populations (White et al. 2019; Finlay et al. 2015; Collins et al. 2020).
2. Social interaction: Social interaction in blue space settings may range from spontaneous gatherings of families, friends and acquaintances to organised common interest groups with associated infrastructure, such as running tracks. Participation in urban blue space activity can counteract today's hectic lifestyles, support the maintenance of social networks for older people and promote children's well-being and development. Research suggests that socially disadvantaged people are more likely to underline social interaction and well-being as the key benefit of blue space visits (de Bell et al. 2017; Frantzeskaki et al. 2017).
3. Noise reduction: Blue spaces and surrounding vegetation or green space can buffer noise pollution by pleasant water sounds or absorption. Good blue space design therefore considers the distance and shielding from noise sources like traffic or recreation. Noise is a major environmental health concern, particularly in urban areas, with adverse health effects. Environmental noise mainly include that emitted from traffic and leisure activities. Continuous noise exposure can have severe adverse effects on human health, both physically and mentally. It increases the risk of developing cardiovascular diseases, such as hypertension (high blood pressure) or myocardial infarction and can cause depression and sleep disturbance, reduce cognitive performance and lead to long-term annoyance. Even short-term exposure can increase stress levels and reduce the quality of life. Almost a quarter (23.3%) of the European population living in cities reported problems with traffic or neighbourhood noise in 2016 (Schäffer et al. 2020; WHO 2018; Lacasta et al. 2016).

Promote physical activity

Modern lifestyles and increased urbanisation have resulted in higher levels of physical inactivity due to greater use of motorised transport, sedentary work and lifestyle and inadequate provision of and access to activity-promoting public spaces. A lack of physical activity is a leading risk factor for health (contributing to about 10% of mortality in the WHO European Region), and surveys have shown that more than half of the European population is not active enough to meet health recommendations. Physical activity and recreation in blue spaces (swimming, surfing, etc.) and their surroundings (such as taking a walk by a coast/river or around a lake) can represent a major benefit for population health. Swimming is recognised as one of the most beneficial exercise forms. Research has shown that parks and aesthetically pleasing scenes are positively associated with physical activity, which access to water bodies can extend. Onshore, physical activity programmes like running meet-ups, boot camps and yoga classes attract young and old (Table 9.9) (Barnett et al. 2017; WHO Regional Office for Europe 2018).

Improve ecosystem functions

Urban blue-green infrastructure can have a regulatory effect on the microclimate through temperature, wind, humidity and precipitation. Furthermore, it can be utilised to provide resilience to flooding at times of water surplus and to drought at times of water shortage (Table 9.10).

1. Climate regulation: Water surfaces and vegetation evaporate water – which in turn creates a cooling effect. They also reflect more solar energy (higher albedo) than dark

Table 9.9 Example factors to assess physical activity

Water activities	<ul style="list-style-type: none"> • Separation of conflicting uses and functions of recreational water (e.g. separate zones for recreational swimming versus other [motorised] water sports) and shore areas (e.g. separate zones for sport activities versus relaxation at the waterfront) • Monitoring of ice thickness and likelihood of suitable ice cover during winter helps to manage risk
Shore activities	<ul style="list-style-type: none"> • Provision and maintenance of opportunities for sport and play activity (e.g. footpaths, fitness and work-out equipment, playground or ping-pong table)

Table 9.10 Example factors to assess ecosystem regulation and habitat services

Local climate regulation	<ul style="list-style-type: none"> • Surrounding infrastructure with opportunity for wind flow (e.g. low-rise infrastructure or building gaps in wind direction increase climate buffering effect) influences the buffering capacity • (Seasonal) management of vegetation around blue space in balance with desired local climate effects (shading, evaporation) and various user group preferences (e.g. avoid barren soil with low albedo during dry periods)
Water regulation	<ul style="list-style-type: none"> • Water infiltration rate (e.g. sealing of soil, density of vegetation) of surrounding area or green space enhances water regulation capacity • Clear rules on urban functions permitted or rejected in areas potentially required for water retention or regulation (e.g. recreational infrastructures, commercial functions, gastronomy, playgrounds, campsites, etc.)
Habitat restoration	<ul style="list-style-type: none"> • Presence of invasive (alien) species may cause risks to biodiversity • Seasonal or permanent limitation of access to certain sensitive water and shore zones to protect wildlife and eco-systems

surfaces like roads or buildings, which contributes to the mitigation of so-called “urban heat islands”. The local climate impact of urban water bodies can be remarkable: researchers found air temperature reductions of between 0.5 and 7°C through blue-green infrastructure and so-called “water cooling islands”. Findings recommend combining water bodies with complex vegetation, including shrubs and trees, and minimising the extent of impermeable surfaces like pavement (Vieira et al. 2018; Kuttler et al. 2002; Gunawardena et al. 2017).

2. **Water regulation:** In times of water excess, blue and green spaces can be used as retention areas. This may require (temporary) changes of function and periods without recreational access. Blue and green spaces can facilitate water storage, storm water harvesting and groundwater recharge to supplement urban water resources and provide fire-fighting water or buffer droughts (Voskamp and Van de Ven 2015; Abell et al. 2019).
3. **Habitat restoration:** The creation or renovation of water bodies can maintain or improve conditions for natural flora and fauna, biodiversity and habitat functionality, while human uses of such water bodies or surrounding green space may need to be restricted. Blue space planners can optimise the habitat and biodiversity value of an urban area in several ways, including by lowering nutrient levels in water or improving the environmental water quality, diversifying the current and depth patterns of the water body or stimulating surrounding natural vegetation growth with a diversity in habitat structure. A healthy aquatic ecosystem with a sound habitat and biodiversity status leads to improvements of related ecosystem services, ranging from water purification to food provision. Certain recreational activities can jeopardise ecological restoration efforts both on land and in the water, such as through the influx of sunscreen products and nutrients from human skin, water disturbance by motorboats or degradation and pollution of vegetation surrounding blue spaces. Investments in local ecosystems are supported by the biodiversity strategy of the European Commission that requires that “by 2020, ecosystems and their services are maintained and enhanced by establishing green infrastructure and restoring at least 15% of degraded ecosystems” (Oertli and Parris 2019; Sutton-Grier and Sandifer 2019).

Hands-on guidance for using the BlueHealth DST

The BlueHealth DST is essentially made up of four work processes: 1) assembly of a team and introduction to the concept of the BlueHealth DST, 2) a desk-based review of the topic summaries to understand key mechanisms in blue spaces and select relevant topics for your case, 3) an analysis of selected topics through on-site visits and information collection and 4) an assessment of identified priorities for interventions before their planning and implementation (Figure 9.11). The web application guides you through the process consecutively, and a demonstration

Figure 9.11
Step-wise guidance of the BlueHealth DST along optimisation steps
 (Source: Arnt Diener/Anna Wilczyńska)

Figure 9.12
Step 1 – Introduction
(Source: BlueHealth DST website)

video is also available on the BlueHealth website. The tool starts with an introductory page, which provides general information about the concept of “blue health” and the benefits of the BlueHealth DST (Figure 9.14). For the subsequent guidance, we recommend application of the tool by a blue space project team to bring different perspectives together.

1. Select your blue space type

Please select the blue space type that you are interested in. The type of blue space you select will determine the guidance and the priority risks and benefits that the tool will provide.

Coastal

Coastal settings refer to blue spaces on or near oceans, seas or similar water bodies (such as the Mediterranean, North Sea, Baltic Sea etc.), and are characterized by saltwater and a high level of movement (such as tides, waves and currents) that may trigger specific risks. The character of such coastal areas can vary widely according to local topography, sea defences and different kinds of development.

Key interventions relate to providing safe access to—and better recreational use of—marine coasts, and the reduction of potential risks related to swimming and water sports.

Figure 9.13
Step 2.A – Define your type of blue space
(Source: BlueHealth DST website)

2. Describe your blue space

Please provide the tool with information on the ways your blue space is used, and whether you wish to use the tool in connection to future interventions. This information will determine the guidance and the priority risks and benefits that the tool will provide.

Usage Type	Intervention type
<p>Please check the boxes below to indicate whether the blue space provides recreational opportunities on-shore only, or whether it also enables swimming, water sports or sailing/surfing, including winter sports that take place on ice.</p> <p>☒ On-shore User activities foreseen around the blue space</p> <p>☐ Bathing and water sports User activities foreseen in and on the water</p>	<p>Please check the boxes below to indicate whether you are using this tool to review health aspects of existing blue spaces (i.e. to evaluate and manage the site), or to support planning processes for (a) a major modification of an existing blue space, or (b) the establishment of a new blue space (i.e. prospective use for planning purposes).</p> <p>☒ Evaluation of an existing blue space to optimize health benefits through management and maintenance</p> <p>☐ Major modification or planning of a new blue space to support creation of a new blue space or significant alteration of an existing water body and/or its functions</p>

Figure 9.14

Step 2.B – Define your activity and intervention types

(Source: BlueHealth DST website)

Step 1: Assemble a team and introduce it to “blue health”

The first step in optimising or developing a blue space should include the definition of a team jointly to complete the BlueHealth DST. Whether your priority is well-being or environmental effects, you will benefit from a multi-disciplinary team. In the process, the team will need to steer the assessment and intervention selection, which will benefit from a clear mandate by decision-makers. One critical step of the assessment is the on-site visits, which will require at least the presence of a core team. Once the team has identified critical topics or even individual factors to focus on, it may make sense to involve additional stakeholders or temporary topic advisors. Experience has shown that the initial grasp of BlueHealth differs greatly between professionals of different disciplines. Thus, a joint introduction to BlueHealth is recommended to ensure a common understanding. Basic introductory information is provided in the first section of the BlueHealth DST, with a number of additional resources available on the BlueHealth project’s main webpage.

Step 2: Define your blue space

Following the introduction, you are asked to define the blue space at hand (type, activities, intervention) (Figures 9.13 and 9.14). Based on your selections, the tool highlights some of the 18 topics in subsequent steps as likely to be relevant. These highlights are recommendations only, and regardless of your self-categorisation, all subsequent parts of the tool remain accessible.

The tool only requires a very basic categorisation. Nevertheless, before continuing with the subsequent steps, it is recommended to gather and categorise any existing documentation on your blue space project. This may include maps and descriptions, stakeholder overviews, timelines or budgets.

Step 3: Review topics and choose relevant aspects for your blue space

In this section, your team is introduced to the blue-space specific health and environment topics. To guide selection of topics relevant for your blue space projects, they are grouped into three goals: 1) protect human health, 2) promote human health, 3) promote ecosystem function (see Figure 9.15). Within each goal, the topics are grouped into a total of seven targets. It is recommended to at least read up ("READ MORE") on each of the seven targets before deciding which targets and topics to include or exclude.

The respective guidance (example in Figure 9.16) provided by the BlueHealth DST presents information such as:

- an overview of the topic's health implications and their mechanisms;
- affected or vulnerable user groups;
- figures related to the health relevance and occurrence in Europe; and
- exemplary scenarios for blue spaces.

The team is expected to conclude this step by selecting topics you decide to assess later. A green tick appears above each tile selected. For selected topics, you may download PDFs of the guidance documents with additional sections on resources (as web links) in Step 4.

Step 4: Conduct assessment and prioritise interventions

This is the most important step of the BlueHealth DST. To prepare your assessment, you may now view or download the topical guidance sheets (with further resources as hyperlinks) (Figure 9.19). In addition, the checklist for your on-site and desk-based assessment is provided for download at the bottom of the page ("Pooled Assessment").

Figure 9.15

Step 3 – Gain topical understanding

(Source: BlueHealth DST website)

The pooled assessment can be printed as a PDF version for editing with a computer or mobile device and as a hard copy for handwritten notes. It combines the factors for each of the selected topics into one document, supplemented with fill-in tables for your notes. The pooled assessment is grouped into three perspectives on your blue space project:

- Review locational and water factors;
- Consider user group and behavioural factors; and
- Review, establish and maintain safe management and design factors;

The individual factors are marked as benefits and risks with icons, and the downloadable PDF version includes checkboxes to tick (Figure 9.18). You may use these checkboxes during a site visit to highlight the risk and benefits that

Figure 9.16
Example guidance sheet on the issue of drowning
 (Source: BlueHealth DST website)

4) Extract and print guidance sheets

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 666773

You have selected the following risk and benefits

The matrix below shows which risks and benefits you have selected for the extraction of guidance.

Please make sure that you have covered relevant risks (red) as well as benefits (green). Go back to step 3 if you want to add more risks / benefits to your selection.

You can read more on each risk or benefit or download the respective guidance document, providing you with an overview of health relevance and useful guidance for assessing and maintaining the blue space, or for planning future interventions.

At the bottom of the matrix, you will be able to access a pooled assessment document that merges all selected risk and benefits into one document. This pooled assessment is a useful document to guide local assessments and interventions on blue spaces. For existing blue spaces, it is recommended to use the pooled assessment for a site visit to review how existing risks can be reduced and prevented, and how potential benefits can be maximized. For this review, the pooled assessment provides a checklist to identify the need for follow up action. For planning purposes, the pooled assessment provides an overview of important risks and benefits to be considered during the planning process, and how they could be achieved.

Goal 1: Protect human health and minimize risks

Prevent injury

Drowning	READ GUIDANCE SHEET ONLINE	DOWNLOAD THE GUIDANCE SHEET
Injuries in waterbodies	READ GUIDANCE SHEET ONLINE	DOWNLOAD THE GUIDANCE SHEET

Prevent illness

Water ingestion and contact	READ GUIDANCE SHEET ONLINE	DOWNLOAD THE GUIDANCE SHEET
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Prevent extremes

UV	READ GUIDANCE SHEET ONLINE	DOWNLOAD THE GUIDANCE SHEET
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Goal 2: Promote human health benefits - Goal 3: Promote ecosystem benefits

Improve mental health

Socialcultural interaction	READ GUIDANCE SHEET ONLINE	DOWNLOAD THE GUIDANCE SHEET
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Improve physical health

Water activities	READ GUIDANCE SHEET ONLINE	DOWNLOAD THE GUIDANCE SHEET
Shore activities	READ GUIDANCE SHEET ONLINE	DOWNLOAD THE GUIDANCE SHEET

[POOLED ASSESSMENT](#)

Figure 9.17
List of selected risk/benefits and link to pooled assessment
 (Source: BlueHealth DST website)

Results

BlueHealth
Linking environment, climate & health

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 666773

Pooled assessment for the following risk and benefits:

- Drowning
- Injuries in waterbodies
- Water ingestion and contact
- UV
- Socialcultural interaction
- Water activities
- Shore activities

The below information provides you with important parameters to consider when planning, assessing, or managing and maintaining public blue spaces, or preparing for interventions and infrastructural measures within the blue space settings.

The pooled guidance document combines the information for the selected health risks and benefits into one document, and thereby provides a resource for structuring information collection and site assessments during field visits to the blue space. For such on-site visits, the pooled guidance lists the blue space features that need to be considered to reduce blue space-specific health risks, and/or to increase related benefits. However, it can also be applied for desktop audits and reviews. The pooled assessment includes a checklist where the need for follow-up action can be documented.

Information and guidance that is applicable for more than one risk or benefit can be identified by the respective label, indicating that the statement can be valid for

- two or more dimensions related to certain risk (▲) or benefit (●) categories
- a variety of different risks (labeled "Risks") or a variety of different benefits (labeled "Benefits"), or
- a variety of both risks and benefits (labeled "General").

Step 1: Review locational and water factors

- [Benefits] Does the local infrastructure enable for seating and playing in shaded areas (see UV) to reduce heat stress and provide breaks from recreational activities?
- [Benefits] Are sensitive nature areas protected from human access to avoid environmental degradation (see habitat)?
- [Shore activity] Does the surrounding of the blue space provide opportunities and infrastructure for active recreation, sport or play (playground, outdoor gym, sport equipment and play fields, boule lanes, jogging paths etc.)?
- [Shore activity] Are there facilities such as change rooms or showers?
- [Social] Is there accessible open space around the water body that enables social interaction or other forms of gatherings (e.g. group seating areas, children's playground, beach volleyball and BBQ areas for adults and families, or boule lanes for elderly)?

Figure 9.18

Part of the output of a pooled assessment: example of guidance statements on various benefits and risks
(Source: BlueHealth DST website)

need further discussion and action, using the follow-up list provided at the end of the document. That list of "action points", with an identification of the proposed action steps for the respective blue space, is your final output of the BlueHealth DST application. For guidance on good practices for design and management, you may then consult the further resources on the main BlueHealth webpage.

Application options

The BlueHealth DST purpose is to support and guide users in optimising their blue space for health and environment outcomes. The specific characteristics of the urban setting, the individual users and the water body itself make every blue space intervention unique. Whether the user is a policy maker, a planner or a member of on-site staff, the guidance is organised to facilitate flexible and prioritised or partial application. Most importantly, the user(s) of the

BlueHealth DST will represent different professions and roles – thus, we want to outline the possible application of the BlueHealth DST for three typical contexts:

1 Guidance for evaluation and revision

In many cities, blue spaces undergo changes of use and accessibility over the years. For such locations, the BlueHealth DST enables a retrospective application for stakeholders to review the health and well-being implications associated with the respective blue space. The tool can be used to assess existing blue spaces and whether and how the (re-)design of the blue space or its management and maintenance could be improved. Such an application of the BlueHealth DST is particularly beneficial in cases where health (and environment) had not been a critical planning factor before. This is often the case, according to our survey (see earlier section on existing tools).

2 Guidance for planners and practitioners

In situations where 1) an existing blue space setting is to be modified or further developed, or 2) a new blue space intervention is planned (adding new blue space dimensions to the local environment), the BlueHealth DST can provide valuable information on the health and well-being risks and benefits of the particular blue space type or intervention. The focus of this application option is to assure that planning, design, construction and maintenance mitigate the local risks and enhance the health and environment benefits. The guidance clearly includes both structural and management factors that guide an optimised management of the blue space.

3 Guidance for decision and policy makers

The tool's decision-making criteria and its structure are aligned to help maximise an urban blue space's positive effects on health and the environment. The information provided is arranged hierarchically. It thus also allows decision- and policy makers at higher levels or their advisors to gain an overview and selected insights on the impacts of their planning decisions on blue space-specific risk profiles and related health and well-being benefits. A critical reflection on the tool's guidance can assist in understanding the situation at a local or regional level, regarding 1) the interface of the respective sectoral circumstances, planning, and health and well-being outcomes; 2) critical challenges related to blue spaces; and 3) potentials to maximise health and well-being benefits through adequate planning and design.

Beyond its main purposes, the BlueHealth DST guidance documents can be used encyclopaedically by students or the interested public.

Conclusions

The BlueHealth DST is the first guidance tool for the optimisation of health and environment outcomes in blue spaces and their surroundings, with partial consideration of green spaces. The successful pilots and extensive consortium-wide reviews illustrate the suitability of the tool. The guidance incorporated within the tool reflects the current scientific understanding, including various recent findings of the consortium's primary and secondary research. The BlueHealth DST is essentially based on a translation of scientific evidence for practical use and thus relies on periodic reviews of this evidence as base for its continued currency. The evidence base is incomplete by nature and the tool's recommendations thus limited in scope and detail. Clearly, any decision and intervention based on the tool can only be as good and targeted as the degree to which the assessment of the blue space at hand was thorough and complete. The related goals of the BlueHealth DST are to widen the stakeholders' view and to ensure that the critical factors are considered for successful blue space projects. The scientific evidence around

the benefits of blue spaces keeps increasing – we hope that our tool can help planning teams also to realise those in practice.

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Note

- 1 The section on DST piloting was authored by Stefania Marcheggiani and Camilla Puccinelli.

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