

# Blue Green Dream's Adaptation Support Tool (AST)

## for climate resilient urban design

**Planning for a climate resilient and sustainable urban environment is demanding. Key challenges include: Selecting adaptation measures appropriate for the local topography, climate and urban layout and Producing a design and implementation plan that is supported by all stakeholders. To tackle these challenges, Deltares, Alterra-WUR and Bosch Slabbers, in close cooperation with the other Blue Green Dream project partners, have developed an innovative, software-based planning methodology. This approach is centred on the intelligent use of ecosystem services, via the use of the specially developed, Adaptation Support Tool (AST). It has been extensively tested and developed in the Netherlands, the UK and also, outside of Europe.**

### Adaptation Measure Screening and Selection

There is a wide choice of adaption measures available, ranging from hard (grey - e.g., storm sewer pipes, retention tanks) to soft (blue green - e.g., rain gardens, porous pavements, bioswales, artificial wetlands). Moreover, their scale can vary from the level of an individual house to an entire district. This makes selecting the optimal interventions complex.

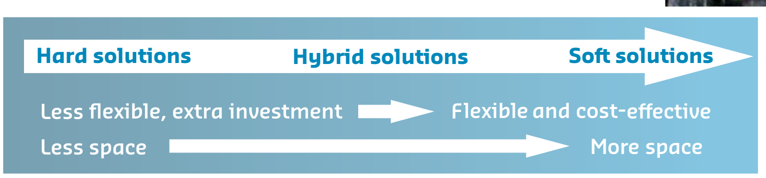


*Figure 1: The spectrum of Adaptation Measures*

*Foto: Madeleine d'Ersu*

Screening and selecting measures involves: 1) appraising all possible interventions; 2) ranking to find the most appropriate set of measures. In keeping with the Blue Green Dream (BGD)'s philosophy, these measures should be multi-functional, soft solutions - Blue Green measures. These harness the ecosystem services naturally provided by urban vegetation to

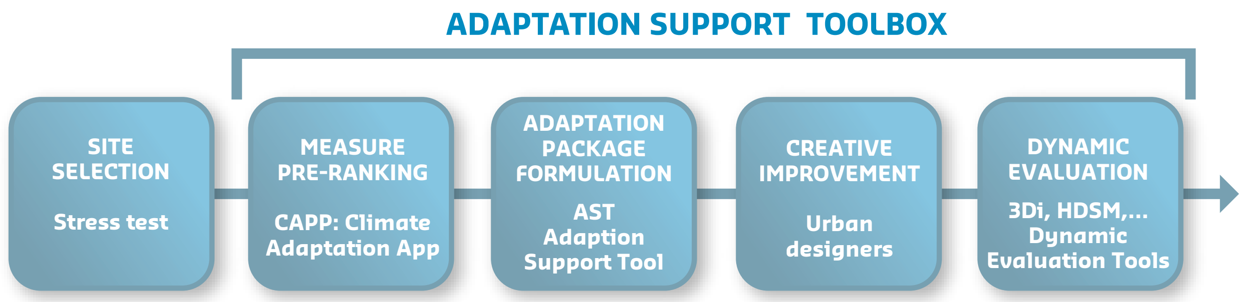


*Figure 3: The AST-enhanced planning process.*

deliver multiple benefits to our towns and cities. Not only do Blue Green measures improve our protection against flooding – pluvial, fluvial, coastal and groundwater - but also, they protect against heat stress and drought. Moreover, these interventions enhance the quality of our working and living environment, reduce our environmental footprint and promote biodiversity.

The goal of a healthy, sustainable and climate change resilient urban environment can therefore be achieved by the use of Blue Green Measures. The AST was created to help the client:

1. Select the best combination of adaptation measures
2. Produce an adaptation plan that is tailored to local stakeholder needs.

### Supporting Stakeholder Groups

Many stakeholders have vested interests in the project area; it is often hard to find an acceptable compromise across the entire stakeholder group. Moreover, some stakeholders may show a NIMBY reaction when confronted with plans that involve drastic changes to their environment. We overcome such barriers by actively involving stakeholder representatives in the plan's development.

*Figure 2: Application of AST to solve flooding problems in the Chota district of Beira, Mozambique*

The most pressing problems in designing an attractive and effective adaptation plan are: (a) the participants' lack of access to expert knowledge; b) absence of a clear overview of the locally applicable adaptation measures; (c) lack of insight into the effectiveness, costs and benefits of the measures.

The AST shows the impact of measures against multiple urban parameters such as created retention capacity, peak flow reduction, heat stress reduction and stormwater quality improvement. By providing to stakeholders key figures on performance, costs and co-benefits, the AST enables stakeholders to make informed decisions. Hence, stakeholders can deploy expert knowledge to achieve a mutually beneficial outcome. The tool operates on a touch-table, as shown in Figure 2. Stakeholders can therefore stand or sit around the table and discuss the problems, potential solutions and the best strategy to achieve climate change resilience.

## The toolbox

The planning process is typically non-linear and involves many steps. Complex interactions between designers, co-designers, planners and diverse stakeholders, coupled with the need to quantify performance, costs and benefits, lead to an iterative, spiral-like process, involving multiple feedback loops. Yet, the main steps in this process can be organized in a structured way. Our toolbox facilitates and optimises the procedure, so reducing the need for feedback loops and iterations.

The linearized, AST-enhanced planning process is represented in Figure 3. First, we delineate the project area. Then, we conduct a four step planning process to produce an adaptation plan ready for local/municipal decision making and implementation.

Throughout these four phases, the planners, stakeholders and engineers have to worth together in order to co-create a robust and viable plan. To achieve this multi-partner cooperation, the parties are brought together at the design table. Prior to the session all relevant data is collected and made accessible on the AST map touchtable (in essence, a giant iPad). Before, or at the start of the session, all data and information on the site is presented to the session participants.

### ***Phase 1***: Listing adaptation measures - Climate Adaptation App

The first step is to create a long-list of applicable measures. Potential adaptation measures are selected through consultation with stakeholders. In order to explore and rank the full range of adaptation measures we created the Climate Adaptation App, available at www.climateapp.org and in the Appstore and Playstore. The full list of over 120 measures is ranked on the basis of filters such as the adaptation targets, urban typology, soil properties and other key area characteristics. Initial information on applicability, impacts and benefits are reviewed by the session participants.

### ***Phase 2:*** Adaptation package formulation - Adaptation Support Tool (AST)

From the long-list of adaptation measures prepared in stage 1, we create 2 or 3 packages of adaptation measures that fulfil predefined adaptation targets. We use the Adaptation Support Tool to:

1. Find out which measures – grey, green, blue, blue green – are preferred, based on local land use conditions, adaptation targets and local preferences.
2. Provide an estimate of the effectiveness of these measures, their costs and their benefits: performance indicators for effectiveness can include effective additional storage provided, normative runoff return period, expected annual infiltration, cooling effect, construction costs, maintenance costs and water pollution reduction.
3. Identify the number, extent and location of sites to fit or retrofit the selected adaptation measures. Figure 4 shows an example of adaptation measure


*Figure 4: Application of AST for reduction of flooding problems in part of the Decoy Brook drainage area in London, UK*

scoping with the AST.

The AST supports the formulation process in the following way. AST's selection-assistant ranks potential grey and blue-green measures again, but now based on more detailed information on the project area. Session participants can select a measure (in the left pane) and apply it at a chosen location in the project area (central pane): multiple measures may be applied to the project area. Based on the figures provided by the AST's in-built database and the participants' input, the tool calculates the performance indicator values and shows these on a 'dashboard' (right pane). If available, in addition to the default Google Maps/Satellite view, other map layers can be displayed, such as a digital elevation map, special protection zones, or a map of critical objects and critical infrastructure. Each alternative plan can be saved separately, so that it is available for later use.

The AST results show:

1. Where to apply which measures, e.g. where to locate retention ponds, bioswales, porous pavements, green roofs, rain gardens etc.;
2. The water storage depth required for each measure and the size of the contributing paved surface.

The AST enables the co-creation of alternative plans. These plans can be compared on the basis of their individual performance indicator values. Moreover, options can be scoped in more detail before a specific plan configuration is selected.

### ***Phase 3:*** Creative improvement

The results of the AST are used by landscape architects and urban planners to create a more detailed design and to see how they can maximize the services provided by the proposed measures. Building on the co-created plan of phase 2, the proposed solutions are used to design visually appealing, cost-effective and benefit-maximizing adaptations. Designs are discussed with the stakeholders and further refined until a full endorsement is received from all key parties. During this phase, the final plan is selected and taken forward to stage 4.

### ***Phase 4***: Dynamic evaluation

However appealing the proposed plan might be, the proposed set of measures' performance under dynamic conditions – e.g. a heavy rainstorm or an extremely hot and dry spell - remains uncertain. Typical assumptions in the AST are that water flows from place A to place B, or that the supply of water was sufficient to sustain evapotranspiration even during a long dry spell. These assumptions can only be validated with hydrodynamic models, capable of simulating changes of flows over time and place. The nature of these models is complex;

numerous parameters must be calibrated to verify the performance of the plan under extreme weather conditions. For simulating flooding we can use the 3Di modelling software (www.3di.nu) or another 2D overland flow hydraulic model. For simulating the impact of the measures on drought stress the Drought Stress Model is employed to calculate the likely effect of sustained hot and dry weather on groundwater levels. Low groundwater levels affect land subsidence, wooden foundations and evapotranspiration, whilst evapotranspiration reduces urban heat stress. To estimate the measures' impact on urban heat stress, a Heat Stress Model is used to compare the new heat stress sensitivity map with the existing conditions.

## Applications

The toolbox supports an integrated approach to planning a more resilient urban environment. Creative design, engineering and stakeholder consultation – a complete knowledge sharing and application process – are synergised, producing a standardised, effective and efficient planning procedure. Although the procedure looks linear, it is iterative in practice.

The Adaptation Support Toolbox has been applied successfully both in Europe and overseas. As climatic conditions and key data values concerning costs, benefits and other evaluation criteria vary according to the region, the Adaptation Support Tool is recalibrated to each application area in order to meet the local conditions and client needs.

## Blue Green Dream

*The EU Blue Green Dream (BGD) project (www.bgd.org.uk) is funded by the European Institute of Innovation & Technology (EIT) through its Climate KIC programme. Its eco-innovative paradigm involves synergising urban water systems (blue assets) with urban vegetated areas (green infrastructure) to harnesses the full benefits provided by ecosystem services. The multi-functional Blue Green Solutions (BG Solutions) created can be applied to new developments and retrofitted to existing urban areas. Benefits include enhanced climate change resilience, opportunities for new economic activities, mitigation of noise, urban heat island effect and air pollution; enhancement of public health, biodiversity, quality of life, property values and building energy efficiency. The consortium, which is led by Imperial College London, features leading EU technical universities, knowledge institutes and consulting companies from each of the partner countries (France, Germany, UK, Netherlands).*

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