Integration of multiple methodologies to evaluate effects of Nature Based Solutions on urban climate mitigation and adaptation
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1. Introduction. Drivers.

**Urban growth**
66% of global population expected to be living in cities by 2050*

**Climate change**
Projections on climate change show increasing frequency and severity of extreme weather events, such as heatwaves**

**** Advancing earth and space science, 2015. What will temperatures be like in 2100?
1. Introduction

Actions.

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Adaptation and mitigation are complementary strategies for reducing and managing the risks of climate change. The trend driven by the Covenant of Mayors for Climate and Energy is to include both climate and mitigation aspects.

At least 20% of the budget should contribute to climate change objectives, helping to ensure substantial support for adaptation and mitigation action in the Member States.

The EU Research and Innovation policy agenda on Nature-Based Solutions and Re-Naturing Cities aims to position the EU as leader in ‘Innovating with nature’ for more sustainable and resilient societies.
1. Introduction. Objective.

How the existing methods and tools allow assessing NBS effectiveness to mitigate and/or adapt the urban environments to climate change.

Nature Based Solutions for re-naturing cities: knowledge diffusion and decision support platform through new collaborative models*

*Nature Based Solutions for Cities (N4CITIES) is a project funded by the European Union’s Horizon 2020 research and innovation programme under grant agreement No 730468. Topic: SCC-03-2016
2. Procedure followed

**Step 1: Climate resilience methodology**
Definition of all the features that a climate resilient methodology must cover.

**Step 2: Methods selection and characterization**
Identification of all the methods and tools that can cover at least one part of the previously defined features.

**Step 3: Methods classification**
Classification of the methods according to the relevant steps of climate resilience and NBS effectiveness that they cover.

**Step 4: Case study**
Analyze in a practical case study a combination of various of those methods.
3. Results (1-8)

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Features of interest that allow assessing from climate trends to NBS effectiveness

- Climate trends
  - Air Temperature
  - Rainfall
  - Air quality
  - Colder winters, warmer summers
  - Urban heat island effect
  - Runoff

- Threats/Hazards
  - Air pollution
  - Water quality
  - Wind field

- Strategies
  - Mitigation
    - Building cooling and/or heating energy demand reduction
    - Global warming potential reduction
    - Primary energy demand reduction
  - Adaptation
    - Runoff reduction
    - Carbon sequestration
    - External air temperature reduction

- Indicators
  - Parks and gardens
  - Structures associated to urban networks
  - Structures characterized by food and resources production
  - Natural and semi-natural water bodies and hydrographic networks

- NBS
  - Constructed wetlands and built structures for water management
  - Green roofs
  - Urban planning strategies
  - Works on soil
  - Vertical structures (green walls and façades)
  - Direct human interventions
3. Results (2-8)

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## Methods identification and characterization (1-2)

<table>
<thead>
<tr>
<th>Climate resilient feature</th>
<th>Climate resilient (sub)feature</th>
<th>Number of methods</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strategy</strong></td>
<td></td>
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<tr>
<td>Mitigation</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Adaptation</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Mitigation &amp; Adaptation</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td><strong>Climate trends</strong></td>
<td></td>
<td></td>
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<tr>
<td>Air temperature</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Rainfall / precipitation</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Air quality</td>
<td>9</td>
<td></td>
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<tr>
<td><strong>Climate threats/impacts</strong></td>
<td></td>
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<tr>
<td>Colder winters, warmer summers</td>
<td>12</td>
<td></td>
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<tr>
<td>Urban Heat Island</td>
<td>12</td>
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<tr>
<td>Runoff</td>
<td>12</td>
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<tr>
<td>Air pollution</td>
<td>13</td>
<td></td>
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<tr>
<td>Water quality</td>
<td>8</td>
<td></td>
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<tr>
<td>Wind field</td>
<td>10</td>
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<tr>
<td><strong>Indicators</strong></td>
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<tr>
<td>Building cooling and heating energy demand reduction</td>
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<tr>
<td>Global warming potential reduction</td>
<td>6</td>
<td></td>
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<tr>
<td>Primary energy demand reduction</td>
<td>7</td>
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<tr>
<td>Runoff reduction</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Carbon sequestration</td>
<td>5</td>
<td></td>
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<tr>
<td>External air temperature reduction</td>
<td>10</td>
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</tr>
</tbody>
</table>
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#### 3. Results (3-8)

Methods
identification and characterization
(2-2)

<table>
<thead>
<tr>
<th>Climate resilient feature</th>
<th>Climate resilient (sub)feature</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Scale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Object</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>District</td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>City</td>
<td></td>
<td>17</td>
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<tr>
<td>Up to the city</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Parks and gardens</td>
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<td>15</td>
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<tr>
<td>Structures associated to urban networks</td>
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<td>15</td>
</tr>
<tr>
<td>Nature Based Solutions</td>
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<td></td>
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<tr>
<td>Structures characterized by food and resources production</td>
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<td>13</td>
</tr>
<tr>
<td>Natural and semi-natural water bodies and hydrographic networks</td>
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<td>13</td>
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<td>Constructed wetlands and built structures for water management</td>
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<td>14</td>
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<tr>
<td>Green roofs</td>
<td></td>
<td>17</td>
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<tr>
<td>Urban planning strategies</td>
<td></td>
<td>12</td>
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<tr>
<td>Works on soil</td>
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<td>13</td>
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<tr>
<td>Vertical structures (Green walls and facades)</td>
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<td>15</td>
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<tr>
<td>Direct human interventions</td>
<td></td>
<td>12</td>
</tr>
</tbody>
</table>
3. Results (4-8)

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Methods classification according to:
1) RACER
2) their suitability to assess from climate trends to NBS effectiveness

1. RELEVANT
   e.g. closely linked to the objectives to be reached

2. CREDIBLE for non experts
   Unambiguous and easy to interpret

3. ACCEPTED
   e.g. by staff and stakeholders

4. EASY TO MONITOR
   e.g. data collection should be possible at low cost

5. ROBUST
   e.g. against manipulation
3. Results (5-8)

Methods classification according to:
1) RACER
2) their suitability to assess from climate trends to NBS effectiveness

Assessing urban climate related issues
Temperatures, rainfall, air quality

Analysing all the stages
From identification of threats to the analysis of NBS effectiveness

Consideration of different scales
Object, neighbourhood and city scales

Assessing NBS

Feasibility to apply the method
Data, tools, availability of information...
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3. Results (6-8)

<table>
<thead>
<tr>
<th>Method</th>
<th>RACER position</th>
<th>Methodology features covered (tot 32)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Envi-MET</td>
<td>1</td>
<td>21</td>
</tr>
<tr>
<td>Library of Adaptation Option</td>
<td>2</td>
<td>25</td>
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<tr>
<td>Design Builder</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>EPA Storm Water Management</td>
<td>4</td>
<td>18</td>
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<tr>
<td>Model (SWMM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enerkad</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Green Pass</td>
<td>6</td>
<td>23</td>
</tr>
<tr>
<td>HAVUKI</td>
<td>7</td>
<td>26</td>
</tr>
<tr>
<td>NEST</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>CITY-CAT</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Soil and Water Assessment Tool</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td>(SWAT)</td>
<td></td>
<td></td>
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<td>Climate-ADAPT web platform</td>
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<tr>
<td>Rayman</td>
<td>12</td>
<td>8</td>
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<tr>
<td>Fault tree analysis (FTA)</td>
<td>13</td>
<td>21</td>
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<tr>
<td>SIRVA</td>
<td>14</td>
<td>26</td>
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<td>Simile</td>
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<td>URB-CLIM</td>
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<td>EPESUS</td>
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<td>Enviro-HIRLAM</td>
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<tr>
<td>PLINIVS models</td>
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<tr>
<td>IVAVIA</td>
<td>20</td>
<td>27</td>
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<tr>
<td>IPCC projections</td>
<td>#NA</td>
<td>7</td>
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</tbody>
</table>
3. Results (7-8)

- understanding current situation (climate threats currently affecting the municipality) → already identified by the city.
- identify potential future impacts due to the climate change if there is no intervention (BAU) → Made with HAVURI methods.
- built NBS scenarios to try to minimize the potential impacts → developed together with the municipality.
- assess the scenarios → According to ENERKAD, NEST, CityCAT and EnviMET methods.
- select the most suitable NBS solutions according to their effectiveness → according to the results given by the previous methods.

Case Study Donostia/San Sebastian: coastal city located in the north of Spain
3. Results (8-8)

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- Understand the effectiveness of the NBS to adapt the neighbourhood to the expected temperatures increase
- Understand the NBS effectiveness to run-off reduction
- Understand the mitigation effects of the NBS in the energy demand of the buildings
- Understand the NBS effectiveness to reduce the climate impacts at the neighbourhood scale

**Case Study**

- **EnviMET**
  - Air quality
  - Adaptation
  - Object
  - Neighbourhood
  - Energy
  - Temperature reduction

- **Enerkad**
  - Mitigation
  - Object
  - Energy

- **NEST**
  - Mitigation
  - Neighbourhood
  - Runoff
  - Energy
  - Carbon sequestration

- **CityCAT**
  - Adaptation
  - Rainfall
  - Runoff
  - Object
  - Neighbourhood
  - City
  - Up to the city
4. Conclusions

There is a need to connect better mitigation and adaptation information to facilitate the municipalities taking robust decisions regarding the NBS implementation.

Scientific community must answer to this demand and must help the municipalities in the decision making processes regarding the most suitable NBS to be implemented.

Data needed for the methods and the treatment of it was similar in some cases.

If the introduction of NBS in the cities is supported the climate change effects will be minimized.
ESKERRIK ASKO
GRACIAS
THANK YOU
MERCI

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