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Using a mixed method approach to determine the multiple benefits provided by Sustainable Drainage Systems

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Introduction

• **Sustainable Drainage Systems (SuDS)**
  • SuDS are the urban drainage systems that are constructed with the aim of managing surface water in a natural way

• **Ecosystem Services (ES)**
  • Ecosystem services are the benefits that people receive directly or indirectly from the environment

A mixed method approach can help to determine the ecosystem services provided by SuDS
Aim and Objectives

• **Aim:** To assess the natural and societal value of SuDS by determining the Ecosystem Services provided by them and to develop a valuation approach

• **Objectives:**
  - Identify the multiple benefits provided by SuDS
  - Use mixed method approach to determine the social and cultural goods and benefits provided by SuDS
  - Develop a communication tool
Methodology

• A mixed method approach – social and physical science methods
• Quantitative and qualitative analysis

• Methods:
  • Visual inspection
  • Public perception survey
  • Public participatory geographical information systems (PPGIS) method
Case Study Sites

• Ardler, Dundee, Scotland, UK – pilot case study

• Dunfermline Eastern Expansion (DEX), Scotland, UK – main case study

• Waterlooville, England, UK – communication tool test site
Ardler Case Study

- Located at North of Dundee, Scotland
- Ardler village – redeveloped multiple times
- The SuDS were established in early 2000
- Well established and well designed SuDS
- SuDS at Ardler include ponds, detention basin and swales
SuDS at Ardler

a) Swale

b) Detention basin

c) Pond
Results from Ardler

• Visual Inspection:
  • Regulating services identified at Ardler were climate regulation, water regulation, erosion control, and water purification
  • Cultural services identified at Ardler were educational value, spiritual value, aesthetics, recreation, and biodiversity
Ardler results contd.

• Public Perception Survey:
  - Greenspace visit – everyday (50%), 2-3 times a week (28%), once in fortnight or less (26%)
  - Greenspace preference – Grassed area (47%), planted areas (25%), ponds(34%)
  - No flood risk – 63%
  - Willingness to Pay – 50%
  - Reason to choose the location – Commuting to work (3%), greenspace (8%), Neighbourhood (5%), school (6%), family ties (8%) other (15%)

<table>
<thead>
<tr>
<th>Cultural Benefits at Ardler</th>
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<tbody>
<tr>
<td>Aesthetics</td>
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<td>Biodiversity</td>
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<td>Recreation</td>
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<td>Health</td>
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<td>Educational value</td>
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<td>Tourism</td>
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<td>Heritage</td>
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<td>Cultural value</td>
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<td>Religious wellbeing</td>
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<td>Social Value</td>
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• Public Participatory GIS study

Public participatory GIS map at Ardler

Most favourite area – Ardler West Pond (83%)
Least favourite area – Ardler East pond (60%)
DEX, Dunfermline Case Study

- Dunfermline Eastern Expansion (DEX), Dunfermline, Scotland
- DEX is a 550 hectare site
- Previously agricultural development
- Commercial and residential developments
- SuDS development started in 1994
- SuDS at DEX include wetland, ponds, detention basins, swales, permeable paving and filter drains
SuDS at DEX

a) Wetland

b) Basin

c) Pond

d) Swale
Results from DEX, Dunfermline

• Visual Inspection:

  • Regulating services identified at DEX SuDS systems were climate regulation, water regulation, erosion control and water purification

  • Cultural services identified at DEX SuDS systems were educational value, spiritual value, recreation, aesthetics and biodiversity
• Public Perception Survey:
  • Greenspace visit – everyday (28%), 2-3 times a week (33%), every two weeks or less (33%)
  • Greenspace preference – grassed area (21%), shrubs and trees (25%), ponds(10%)
  • House prices – high near SuDS systems (56%), not high near SUDS systems (34%)
  • SuDS knowledge – aware of SuDS (62%), not aware of SuDS (36%)
  • Reason to choose the location – commuting to work (41%), greenspace (36%), neighbourhood (35%), school (18%), family ties (15%) and other (19%)
Public Participatory GIS study

PPGIS Map at DEX
Most Favourite place: Wetland (27%)
Least Favourite place: Linburn Basin (10%)

Wetland at DEX:
Residents perception – Good (74%), OK (22%) and Bad (4%)
These results were combined from:
- Literature review
- Visual inspection
- Public perception survey
- Public participatory GIS study

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<thead>
<tr>
<th>Cultural Benefits</th>
<th>Vegetated SUDS (where, H-High, M-medium, L-Low)</th>
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<tbody>
<tr>
<td></td>
<td>Wetland</td>
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<tr>
<td>Education</td>
<td>H</td>
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<td>Health</td>
<td>L</td>
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<td>Aesthetics</td>
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<td>Biodiversity</td>
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<td>Recreation</td>
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<td>Well-being</td>
<td>M</td>
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<td>Pet walking</td>
<td>H</td>
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<tr>
<td>Community Activities</td>
<td>L</td>
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<td>Other</td>
<td>L</td>
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</tbody>
</table>
These results were combined from
- Literature review
- Visual inspection
- Pond and wetland survey
Communication Tool for ecosystem services associated with SUDS

Preliminary Stage:
- Area: Site characteristics, Development characteristics, Community regeneration, Links to existing greenspace
- Driver: Policies, Flood mitigation, Water quality improvement, Green Infrastructure Provision

Cultural Service Benefits:
- Wetland: Education (H), Health (L), Aesthetics (M), Biodiversity (M), Recreation (H), Well-being (M), Pet walking (H), Community Activities (H), Other (L)
- Pond: Education (H), Health (M), Aesthetics (H), Biodiversity (H), Recreation (H), Well-being (H), Pet walking (H), Community Activities (H), Other (H)
- Basin: Education (L), Health (M), Aesthetics (M), Biodiversity (M), Recreation (H), Well-being (H), Pet walking (H), Community Activities (H), Other (L)
- Swale: Education (L), Health (M), Aesthetics (M), Biodiversity (M), Recreation (H), Well-being (H), Pet walking (H), Community Activities (H), Other (L)

Regulating Service Benefits:
- Wetland: Water Quality (H), Water Quantity (M), Erosion Control (M), Climate Regulation (L)
- Pond: Water Quality (H), Water Quantity (M), Erosion Control (M), Climate Regulation (L)
- Basin: Water Quality (H), Water Quantity (M), Erosion Control (L), Climate Regulation (L)
- Swale: Water Quality (M), Water Quantity (H), Erosion Control (M), Climate Regulation (M)

Decision stage
- SUDS Design

Final stage
Berewood Homes at the west of Waterlooville, Hampshire, England

247 hectare, Waterlooville Major Development Area (MDA)

The SuDS construction started in 2008

Well-established SuDS site

SuDS at Waterlooville include swales, ponds, lagoons and ditches
SuDS at Waterlooville

a) Pond

b) Swale
Results from Waterlooville

- Professional survey - 20/36 responses
- Landscape architects (45%), researchers (15%), engineers (10%), policy officer (10%), designer (5%), drainage officer (5%)
- Swales image – 35% agree to the scores given in communication tool, 15% did not agree and 40% partially agreed
- Ponds image - 20% agree to the scores given in communication tool, 10% did not agree and 55% partially agreed
- Ecosystem services got high value in SuDS design (85%)
- Communication tool got high usefulness in SuDS design (30%)
Conclusion

- SuDS provides multiple benefits
- Vegetated SuDS contribute to ecosystems services
- Non-monetary evaluation of the multifunctional benefits provided by SuDS
- The communication tool helps landscape architects, engineers, planners and policy makers with respect to decision making
- A mixed method approach helps to collect the evidence base for cultural and regulating services
Thank you!

Any Questions?

References: