RECONSTRUCTION OF EXISTING CONVENTIONAL STORM DRAINAGE SYSTEM IN DEVELOPING COUNTRIES WITH INCLUSION OF BMPs ELEMENTS: A CASE STUDY

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Introduction

- Storm drainage practice—to evacuate excess water “as soon as possible”
- Paper shows potential effects of conventional system reconstruction on:
  1. stormwater quantity
  2. stormwater quality
  3. cost decrease,

with inclusion of BMPs elements:
  a. dry detention ponds
  b. vegetated swales

- Case study: three mathematical model setup simulation results comparison
Methods

- Simulations of rainfall-runoff processes in StormNET
- Simple pollution model included (pollution build-up/wash-off process) - TSS, TP and BOD concentration simulated
- One raingauge assigned - various rainfall events (50%, 20% and 10% prob. of exceedance)
- Model’s sub-catchment characteristic, conveyance length and pollution input data are the same
Case study-present state

12 sub-catchments

Input data

a. Pervious area depression depth \( 4 \text{ mm} \)
b. Impervious area depression depth \( 1.5 \text{ mm} \)
c. Soil conductivity \( 36 \text{ mm/h} \)
d. Manning's roughness for pervious areas \( 0.35 \)
e. Manning's roughness for impervious areas \( 0.018 \)
f. Suction head (for Green-Ampt method) \( 61 \text{ mm} \)
g. Initial moisture deficit (porosity minus initial moisture) \( 0.25 \)
I Conventional model
II Conventional with source control

- Same as previous except impervious surfaces are decreased - roofs are connected to pervious areas.
III Alternative model

- Reconstructed model II
- D1 131m³
- D2 35m³
- Swales 260m instead of pipes
Pollution model

- Typical pollution removals for chosen BMPs elements:
  - TSS 30-65%,
  - TP 15-45% and
  - BOD ~30%.
Cost analysis

- Comparison of construction costs
  - Conventional system prices
  - Alternative system prices
Results

- Runoff hydrographs comparison
Results

- Catchment runoff v. rainfall duration and model setup
Results

Percentage of peak flow and runoff volume decrease in comparison to conventional model.
Results

- Pollution removal in alternative model
Results

- **Cost analysis**

<table>
<thead>
<tr>
<th>Construction work</th>
<th>Cost [€]</th>
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</thead>
<tbody>
<tr>
<td>Construction site preparation</td>
<td>13.112,00</td>
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<tr>
<td>Earthworks</td>
<td>65.149,00</td>
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<td>Concrete works</td>
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<td>Masonry</td>
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<td>Pipe purchase and installation</td>
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<td>Other (additional) works</td>
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<table>
<thead>
<tr>
<th>Construction work (conventional elements)</th>
<th>Cost [€]</th>
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<td>Earthworks</td>
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<td>Concrete works</td>
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<td>Pipe purchase and installation</td>
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<td><strong>Σ</strong></td>
<td>118.769,00</td>
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<table>
<thead>
<tr>
<th>BMPs element</th>
<th>Size</th>
<th>Unit</th>
<th>Cost [€/units]</th>
<th>Cost [€]</th>
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</thead>
<tbody>
<tr>
<td>Detention pond (1+2)</td>
<td>166</td>
<td>m³</td>
<td>12</td>
<td>1992</td>
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<tr>
<td>Swales</td>
<td>304</td>
<td>m²</td>
<td>8</td>
<td>2432</td>
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</table>

Save 42,000€ or 26% cheaper
Conclusions

- Impact of urbanization and design of conventional drainage system enlarge catchment runoff for almost 5 times
- With simple source control both peak runoff and runoff volume are decreased for cca 30%
- Alternative system with included sustainable decreases peak runoff and runoff volume for cca 45%,
- Pollution are removed for 8-30%
- Cost savings are 26%
- Reconstruction of conventional system is simple with huge positive effects
THANK YOU FOR YOUR ATTENTION

Reconstruction of existing conventional storm drainage system in developing countries with inclusion of BMPs elements: Case study

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