Green Infrastructure: 
Using a holistic approach

Promoting Avoidance through Cost
Effective Routing of Linear Infrastructure

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Presentation Outline

• Introduction
• Study Goals
• Methods
• Results
• Conclusions
• Recommendations
• Acknowledgements
**Development Project Context**

- Uganda Population 34.9 million (174 people/sq.km); growth rate 3% p.a.
- 19.5% below poverty line
- Over 6.5 billion barrels of oil (MEMD, 2014)
- 21 oil and/or gas discoveries to date
- Natural gas reserves estimated: 350 billion cubic feet.
- 14,000 Km² of high petroleum potential areas remain unlicensed.
- US$800 million from tourism
Project’s Environmental Context

• AR: half of Africa’s bird & 40% of mammals
• M-S landscape: 37 species endemic to AR; 49 threatened
• Ramsar sites e.g. Murchison Falls & Albert Nile delta
• Impacts of Infrastructure development
  – Land fragmentation
  – Habitat destruction
  – Increased resource offtake (legal and illegal)
• Impacts are external costs to infrastructure project
Study goal

Mitigation Hierarchy

- Avoid
- Minimize

AIM

To demonstrate a method of identifying linear infrastructure routes that avoid areas that would impact on important conservation features.

Methods: (1) Marxan Analysis

To identify the best areas for conservation
- Set features and targets
- Socio-econ. cost based on proximity to settlements, roads; towns
Methods: (2) Least Cost Path (LCP)

Financial cost proxies:
- Consulted various experts
  - Land cover
  - Rivers
  - Slope
  - Roads

Methods: Example of cost proxies - LCP

Financial Factors: Land cover, Rivers, Slope, Roads

<table>
<thead>
<tr>
<th>Factor</th>
<th>Standardised values</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Land cover</td>
<td>20</td>
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<tr>
<td>Open water</td>
<td>15</td>
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<tr>
<td>Wetland</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Built up</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Forest</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Plantation</td>
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</tr>
<tr>
<td>Farmland</td>
<td>3</td>
<td></td>
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<tr>
<td>Wooded</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Barren (Grassland &amp; Bushland)</td>
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</tbody>
</table>
Methods: Least Cost Path (LCP)

Environmental Cost Layer

Environmental Factors:
- Environmental dimensions of social factors PLUS:
  - Wildlife Corridors
  - Areas of high BD – Level 1
  - Areas of high BD – Level 2

Example of environmental cost proxies

Environmental Factors: Land cover, Rivers, Slope, Roads
PLUS Wildlife Corridors, Areas of high BD – Levels 1&2

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<td>Barren (Grassland &amp; Bush)</td>
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</table>
Results: Two routes compared

– Environmental avoids high BD area
Results:

- Financial LCP 137km for the Financial
- Financial plus environmental LCP length - 117km
- The Financial with Environmental Consideration scenario resulted in a 54% increase in relative financial costs

Results: Impact on conservation features

<table>
<thead>
<tr>
<th>Conservation Feature</th>
<th>Impact (% area) within ROW</th>
<th>Impact (% area) in &lt;1km of ROW</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Scenario 1 Fin. LCP</td>
<td>Scenario 2 Fin. w/env. LCP</td>
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<tr>
<td>Hippopotamus</td>
<td>4.81</td>
<td>4.57</td>
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<tr>
<td>Giraffe</td>
<td>4.74</td>
<td>4.5</td>
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<td>Elephant</td>
<td>4.02</td>
<td>3.81</td>
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<td>Mangabey</td>
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<td>Nahan’s Francolin</td>
<td>1.62</td>
<td>1.29</td>
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<tr>
<td>Lion</td>
<td>1.22</td>
<td>1.22</td>
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<td>Shoebill</td>
<td>0.65</td>
<td>0.43</td>
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<tr>
<td>Hyena</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
<td>Grasslands</td>
<td>5.65</td>
<td>4.22</td>
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<tr>
<td>Woodlands</td>
<td>3.87</td>
<td>3.35</td>
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<tr>
<td>Tropical High Forest</td>
<td>2.71</td>
<td>2.43</td>
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<tr>
<td>Wetlands</td>
<td>1.21</td>
<td>0.58</td>
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</tbody>
</table>
Conclusions

• There is significant scope for reducing environmental impacts using this approach
• Consideration of environmental factors resulted in a shorter but more expensive route in financial terms
• Inclusion of socioeconomic variables, precise financial and environmental costs at landscape level would be helpful

Recommendations

• Use more recent data with higher resolution
• Further analysis to assess impacts in detail – micro routing
• Consider subterranean features such as seismic activity and hydrology
• Incorporate species habitat fragmentation effects
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- Hedley Grantham
- Aaron Bruner
Thank You

Questions?

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