Insights from Digitalizing LSM

Opportunities in Urban Larval Source Management
Bottom-Line, Up Front

- Malaria focused LSM operations can have beneficial effects on non-Anopheles mosquito reduction
- By digitalizing LSM activities, we can identify significant opportunities to reduce costs of LSM operations
  - For Mombasa, this looks like a healthier, greener, cleaner city!
- Opportunities to collaborate between MOH, other government departments departments and private entities
Deploying AI to combat malaria
Mobile App: Water Body Mapping & Reporting

- Survey 3%
- Water Bodies
  - Cistern
  - Swamp
  - Construction
  - Water channel
  - Stream fringe
  - Tire
  - Tire tracks
  - Irrigated agriculture
  - Pond
  - Puddle
  - Footprint
  - Rice field

- Sample Summary
  - Anopheles early (L 1–2): 35
  - Anopheles late (L 3–4): 27
  - Culex early (L 1–2): 71
  - Culex late (L 3–4): 94
  - Pupae: 4
  - 10/10 dips selected
Larval Source Management Pilot, Mombasa Island

**Area:**
- Intervention: 14.1 km²
- Control: 4.4 km²

**Period:**
- Initial Mapping: May - Jun
- Larvicide: Jun - Aug
- Monitoring & Evaluation: May-Nov

**Staffing:**
- CHWs: 200
- MOH: 8 Vector Control & 2 Entomology
- ZzappMalaria: 1 Project Manager
- KEMRI: 1 entomologist (as needed)

**Larvicide:** Aquatain AMF
- Application rate 1mL / m²
- Treatment every 20 days

**Operational Results**
- Mapped >82% sub-county
- **Identified 6,752 water bodies**
  - 472 water body / km²
- Sampling
  - 8,582 larval samples
  - 1,879 adult trap-nights
- Treatment:
  - 3 rounds of larvicide
  - 33% of water bodies “dried out”
    during dry season
Adult Mosquito Trapping

Trapping Operations:
- Intervention: 761 trap-nights
- Control: 718 trap-nights

Key Takeaways:
- LSM effectiveness across all mosquitoes, not only *An.*
- “Floor effect” for the *Anopheles*

<table>
<thead>
<tr>
<th>Anopheles Trap-Night Average</th>
<th>Before</th>
<th>After</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention</td>
<td>0.08</td>
<td>0</td>
<td>100%</td>
</tr>
<tr>
<td>Control</td>
<td>0.06</td>
<td>0</td>
<td>100%</td>
</tr>
<tr>
<td>Impact</td>
<td></td>
<td></td>
<td>NA</td>
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</table>

<table>
<thead>
<tr>
<th>Aedes Trap-Night Average</th>
<th>Before</th>
<th>After</th>
<th>Reduction</th>
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<tbody>
<tr>
<td>Intervention</td>
<td>0.90</td>
<td>0.15</td>
<td>63.3%</td>
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<tr>
<td>Control</td>
<td>0.49</td>
<td>0.34</td>
<td>30.6%</td>
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<tr>
<td>Impact</td>
<td></td>
<td></td>
<td>75.9%</td>
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Larval Sampling

Sampling Operations
- Intervention: 1,798 samples
- Control: 1,137 samples

Key Takeaways:
- LSM effectiveness across all larvae, not only *An.*
- **No** *An. Stephensii* larvae identified

<table>
<thead>
<tr>
<th>Anopheles Water Body Positivity (%)</th>
<th>Before</th>
<th>After</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention</td>
<td>1.9%</td>
<td>0.05%</td>
<td>97.3%</td>
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<tr>
<td>Control</td>
<td>6.0%</td>
<td>0.3%</td>
<td>95.0%</td>
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<tr>
<td>Impact</td>
<td></td>
<td></td>
<td><strong>47.37%</strong></td>
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<table>
<thead>
<tr>
<th>Non-Anopheles Water Body Positivity (%)</th>
<th>Before</th>
<th>After</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention</td>
<td>66.0%</td>
<td>10.9%</td>
<td>83.4%</td>
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<tr>
<td>Control</td>
<td>46.4%</td>
<td>17.4%</td>
<td>62.5%</td>
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<tr>
<td>Impact</td>
<td></td>
<td></td>
<td><strong>55.96%</strong></td>
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</table>
Water bodies by Type

- Tires 18.8%
- Tank 21.9%
- Sewer manhole 18.8%
- Channel 16.7%
- Puddle 7.3%
- Open container 7.3%
- Well 2.1%
- Other 4.2%
- Pond 3.1%
Anopheles Larval positivity by Water Body type

Anopheles+ water bodies
n=35

- Puddle: 34%
- Tires: 17%
- Pond: 11%
- Open container: 11%
- Tire: 17%
- Tank: 9%
- Channel: 6%
- Swamp: 3%
- Other: 3%
Non-anopheles Larval positivity by Water Body type

Non-Anopheles+ water bodies
n= 1,481

- Tires 33%
- Tank 17%
- Sewer manhole 9%
- Channel 11%
- Puddle 7%
- Open container 11%
- Other 6%
- Pond 4%
- Swamp 1%

Images of different water bodies with larval positivity.
Tire Aggregation Opportunity

Discarded tires
- 17% An+ water bodies
- 33% positive non-An+ water bodies

Key Players:
- Mombasa Ministry of Health
- Bamburi Cement
- Local Communities

Permanently removed over 3,000 high-risk water bodies, for good
Tires Collection Operation

- 3,280 tires collected (~40-60%)
- 6 staff, 2 vehicles
- 25 work days

Comparison, 5 Year LSM Operation

<table>
<thead>
<tr>
<th></th>
<th>Larviciding</th>
<th>Tire Removal</th>
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<tr>
<td>Total Cost</td>
<td>$528,000</td>
<td>$5,850</td>
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<tr>
<td>Cost / WB</td>
<td>$78.22</td>
<td>$2.78</td>
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</table>
Opportunities

- Malaria focused LSM operations can have beneficial effects on non-Anopheles mosquito reduction.
- By digitalizing LSM activities, data visualization can help identify significant opportunities to reduce costs of malaria control efforts.
  - For Mombasa, this means a healthier, greener, cleaner city!
- Collaboration between different government departments and private entities are possible, if profitable.
Acknowledgements

Thanks to all the partners, fieldworkers, community leaders and members who made this operation possible!

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