Landscape Influences on Cyanobacteria Harmful Algal Blooms

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Background

• HAB factors - why do we care?
  • causes
  • mitigation

• We know underlying factors
  • nutrients
  • light
  • temperature
  • stagnant water

• How does landscape determine these?
Background

• HAB factors - why do we care?
  • causes
  • mitigation
• We know underlying factors
  • nutrients
  • light
  • temperature
  • stagnant water
• How does landscape determine these?

• Objective: develop a model to reveal major landscape factors
Study Area

- Lakes Included
- Study Area
Study Area

- Lakes Included
- Study Area
Modeling to rank factors

Cyanobacteria levels: MERIS satellite sensor

88 factors considered:
- Climate
- Nutrient application
- Landscape hydraulics
- Soil
- Lake morphology
- Land class
  - entire watershed
  - lake and stream buffers
Results
Results

Of top 20 factors:

• 14 agriculture  
  • 4 of top 8: nutrient or manure application
• 4 natural vegetation  
  • 5 buffer zone

↑ cyanos

↓ cyanos
Ecozones
Plains Ecozone
Plains Ecozone

Of top 20 factors:

• 9 agriculture  \(\uparrow\) cyanos
• 3 natural vegetation  \(\downarrow\) cyanos
• 4 buffer zone
Wooded Ecozone

Explore Minnesota
Wooded Ecozone

Of top 20 factors:

- 1 agriculture \[\uparrow\] cyanos
- 2 natural vegetation \[\downarrow\] cyanos
- 10 naturally occurring \[\uparrow\ \downarrow\]
- 4 buffer zone
Conclusions

• Agricultural inputs and runoff
• Natural vegetation
  • placement within watershed
• Factors vary
Acknowledgements

• CyAN and EPA Collaborators
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• NOAA
• U.S. Geological Survey Toxic Substances Hydrology Program
Thank you! Questions?

https://www.epa.gov/cyanoproject

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## Full Study Area

<table>
<thead>
<tr>
<th>Rank</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>% artificially drained</td>
</tr>
<tr>
<td>2</td>
<td>Soil erodibility of ag. land</td>
</tr>
<tr>
<td>3</td>
<td>% area crop</td>
</tr>
<tr>
<td>4</td>
<td>% area total forest</td>
</tr>
<tr>
<td>5</td>
<td>Sub-surface N-NH3 app. rate</td>
</tr>
<tr>
<td>6</td>
<td>Surface mineral P app. rate</td>
</tr>
<tr>
<td>7</td>
<td>Surface N-NH3 app. rate</td>
</tr>
<tr>
<td>8</td>
<td>Manure app. rate</td>
</tr>
<tr>
<td>9</td>
<td>% of ag. untreated by sink</td>
</tr>
<tr>
<td>10</td>
<td>Soil clay %</td>
</tr>
<tr>
<td>11</td>
<td>% area ag., row crops in 90 m stream buffer</td>
</tr>
<tr>
<td>12</td>
<td>% area wetland in 90 m lake buffer</td>
</tr>
<tr>
<td>13</td>
<td>% of sinks that treat ag.</td>
</tr>
<tr>
<td>14</td>
<td>% area deciduous forest</td>
</tr>
<tr>
<td>15</td>
<td>Runoff</td>
</tr>
<tr>
<td>16</td>
<td>% area hay</td>
</tr>
<tr>
<td>17</td>
<td>% area ag., hay in 90 m stream buffer</td>
</tr>
<tr>
<td>18</td>
<td>% area shrub in 90 m lake buffer</td>
</tr>
<tr>
<td>19</td>
<td>% area ag., row crops in 90 m lake buffer</td>
</tr>
<tr>
<td>20</td>
<td>Surface N-NO3 app. rate</td>
</tr>
</tbody>
</table>

### Agriculture
- % artificially drained
- Soil erodibility of ag. land
- % area crop
- % area total forest
- Sub-surface N-NH3 app. rate
- Surface mineral P app. rate
- Surface N-NH3 app. rate
- Manure app. rate
- % of ag. untreated by sink
- Soil clay %
- % area ag., row crops in 90 m stream buffer
- % area wetland in 90 m lake buffer
- % of sinks that treat ag.
- % area deciduous forest
- Runoff
- % area hay
- % area ag., hay in 90 m stream buffer
- % area shrub in 90 m lake buffer
- % area ag., row crops in 90 m lake buffer
- Surface N-NO3 app. rate

### Vegetation
<table>
<thead>
<tr>
<th>Rank</th>
<th>Variable</th>
<th>Variable</th>
</tr>
</thead>
</table>
| 1    | % artificially drained | 1
| 2    | Manure app. rate | 2
| 3    | % area crop | 3
| 4    | Surface N-NH₃ app. rate | 4
| 5    | % of ag. untreated by sink | 5
| 6    | Soil erodibility of ag. land | 6
| 7    | Runoff | 7
| 8    | Soil clay % | 8
| 9    | Sub-surface N-NH₃ app. rate | 9
| 10   | Longitude | 10
| 11   | % area shrub/scrub | 11
| 12   | % area ag., row crops in 90 m stream buffer | 12
| 13   | % area shrub in 90 m lake buffer | 13
| 14   | % area wetland in 90 m lake buffer | 14
| 15   | avg. dist. of ag. to stream through buffers | 15
| 16   | Water table depth | 16
| 17   | % area herbaceous in 90 m stream buffer | 17
| 18   | Road density | 18
| 19   | % area deciduous forest | 19
| 20   | Surface mineral P app. rate | 20

**Map:** Plains Ecozone

- **Agriculture**
- **Vegetation**
- **Development**
Wooded Ecozone

<table>
<thead>
<tr>
<th>Rank</th>
<th>Variable</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Soil erodibility</td>
</tr>
<tr>
<td>2</td>
<td>Precip., max. 72-hour period</td>
</tr>
<tr>
<td>3</td>
<td>Organic matter content</td>
</tr>
<tr>
<td>4</td>
<td>% area wetland</td>
</tr>
<tr>
<td>5</td>
<td>Water table depth</td>
</tr>
<tr>
<td>6</td>
<td>% area shrub/scrub</td>
</tr>
<tr>
<td>7</td>
<td>Soil clay %</td>
</tr>
<tr>
<td>8</td>
<td>Mean Lake Depth</td>
</tr>
<tr>
<td>9</td>
<td>Road-stream intersection density</td>
</tr>
<tr>
<td>10</td>
<td>Housing unit density</td>
</tr>
<tr>
<td>11</td>
<td>Population density</td>
</tr>
<tr>
<td>12</td>
<td>Precip., total seasonal</td>
</tr>
<tr>
<td>13</td>
<td>Ratio of lakeshed to lake area</td>
</tr>
<tr>
<td>14</td>
<td>% area ag., hay in 90 m lake buffer</td>
</tr>
<tr>
<td>15</td>
<td>Lake Volume</td>
</tr>
<tr>
<td>16</td>
<td>% lithological N content</td>
</tr>
<tr>
<td>17</td>
<td>% area developed: low + medium intensity in 90 m lake buffer</td>
</tr>
<tr>
<td>18</td>
<td>% area evergreen forest in 90 m lake buffer</td>
</tr>
<tr>
<td>19</td>
<td>% area deciduous forest in 90 m lake buffer</td>
</tr>
<tr>
<td>20</td>
<td>% area deciduous forest</td>
</tr>
</tbody>
</table>