Nutrient and sediment concentrations and corresponding loads during the historic June 2008 flooding in eastern Iowa

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U.S. Department of the Interior
U.S. Geological Survey
6/9/2008 Charles City, IA (Cedar River)

Photo by Jon Nania
Coralville, IA (Iowa River)
Background

- December 2007 to May 2008 - 2\textsuperscript{nd} wettest in the period of record for eastern Iowa (1895 to 2008) (NCDC, 2008)

Source: Iowa Mesonet: Iowa Daily Erosion Project Map by Kasey Hutchinson
Background

- June 2008 - the 2nd wettest June in the period of record for Iowa (1895 to 2008) (NCDC, 2008)
Map showing location of 37 USGS streamgages with flood probability estimates for the 2008 flood less than 1 percent.
Background

- Iowa 1\textsuperscript{st} in harvested acreage and corn for grain production; 2\textsuperscript{nd} in soybean production (2004) (USDA NASS, 2005)
- Over 59\% of Iowa is used for corn and soy production (USDA NASS, 2008)
- Iowa is a major contributor of nutrients/sed. to the Mississippi River (Goolsby et al, 1999; Royer et al., 2006; Alexander et al., 2008)
- 1993 flood - a missed opportunity
**Sampling**

- Near peak-flow (within 24 hrs) water samples collected at 29 locations in Iowa during June 2008; many locations had multiple samples
- Grab samples from the centroid of flow –
  - weighted bottle sampler and a 1 Liter baked amber glass bottle; 2 samples Equal Width Increment (EWI) (USGS, 2006)
- Concurrent grab samples and EWI were collected at two sites at different discharges to document sample bias
Methods

- Samples were analyzed for total phosphorus (TP), total nitrogen (TN), nitrate, ammonia, orthophosphate (ortho-P), and suspended sediment (SS)

- Data Analysis
  - Concentrations and Instantaneous loads
  - 16-day transport yields - four Mississippi River tributaries
  - Percentage of the annual yield - three sites according to two different study estimates.
Concentration (mg/L)

- Ammonia (mg/L)
- Ortho-p (mg/L)
- Total Phosphorus (mg/L)

† indicates EWI sample
Results

Concentration (mg/L)

- Ammonia
- Ortho-p
- Total P

Load (kg/hr)

- Ammonia
- Ortho-p
- Total P

1979-2007:
- Ammonia 239 kg/hr
- Ortho-p 430 kg/hr
- Total P 998 kg/hr

2008:
- Ammonia 5,580 kg/hr
- Ortho-p 13,300 kg/hr
- Total P 48,200 kg/hr

Concentration (mg/L)

- Nitrate
- Total N
- SS*10

Load (kg/hr)

- Nitrate
- Total N
- SS*10

1979-2007:
- Nitrate 38,400 kg/hr
- Total N 56,000 kg/hr
- SS*10 265,000 kg/hr

2008:
- Nitrate 395,000 kg/hr
- Total N 416,000 kg/hr
- SS*10 1,980,000 kg/hr
Results – TN Near Peak Daily Yields
Results – TP Near Peak Daily Yields
Results – SS Near Peak Daily Yields
Results

- 16-day TN transport load could fertilize 843,000 acres of cropland – over 6 counties
- 16-day TP could fertilize 152,000 acres
- 16-day SS could fill 143,000 dump trucks

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Discharge (m³/s)</th>
<th>TN (kg)</th>
<th>TP (kg)</th>
<th>SS (kg)</th>
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</thead>
<tbody>
<tr>
<td>Wapsipinicon River near De Witt, IA 05422000</td>
<td>8,870</td>
<td>4,860,000</td>
<td>163,000</td>
<td>7.48 E7</td>
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<tr>
<td>Iowa River at Wapello, IA 05465500</td>
<td>42,600</td>
<td>22,000,000</td>
<td>1,300,000</td>
<td>5.64 E8</td>
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<td>Skunk River at Augusta, IA 05474000</td>
<td>12,600</td>
<td>4,990,000</td>
<td>408,000</td>
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<td>Des Moines River at Keosauqua, IA 05490500</td>
<td>33,900</td>
<td>17,700,000</td>
<td>1,040,000</td>
<td>1.04 E9</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>98,000</strong></td>
<td><strong>49,500,000</strong></td>
<td><strong>2,900,000</strong></td>
<td><strong>1.95 E9</strong></td>
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</tbody>
</table>
## Results – 16-day Yields

Note: the Des Moines River site used in Goolsby et al. (1999) is Des Moines River at Francisville, MO (05490600), approximately 50 km downstream of Keosauqua, IA.

<table>
<thead>
<tr>
<th>Site Name</th>
<th>STAID</th>
<th>2008 WY m3/s</th>
<th>WY Annual Mean m3/s</th>
<th>Constituent</th>
<th>16-day Yield</th>
<th>Annual Yield</th>
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<tr>
<td></td>
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<td>(m3/s)</td>
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<td>Yield (kg/km²)</td>
<td>Yield (kg/km²)</td>
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<td>Nitrate</td>
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<td>Ortho-p</td>
<td>11.3</td>
<td>37.1</td>
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<td>Iowa River at Wapello, IA 05465500</td>
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<td>Ortho-p</td>
<td>14.0</td>
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</table>
1993 vs. 2008

- Daily peak-flow was higher in 2008
- Different hydrographs

Steve Kalkhoff
Summary

- Concentrations may be similar to average concentrations but loads are much larger during extreme events.
- Floods very important to average annual yield – 2008 flood up to 46% of average annual yield!
- Implications of Midwest flooding to the Gulf of Mexico hypoxic zone:
  - Lasting effects of 1993 on the Gulf hypoxic zone
  - July 2008 hypoxic zone ranks 2nd
Future Work

- Each flood is different
- Need more data – characterizing floods and modeling
- Concentrate on one basin next flood?
Questions?

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