Simple and green synthesis of nitrogen-, sulfur- and phosphorus-co-doped carbon dots with tunable luminescence properties and sensing application
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Figures

Fig. S1 High-resolution XPS spectra on P 2p (a) and S 2p (b) in N/S/P-CDs.
Fig. S2 Fluorescence decay curve and the exponential fitting curve of N/S/P-CDs-100 (a), N/S/P-CDs-120 (b) and N/S/P-CDs-150 (c) recorded at room temperature in aqueous solution. The fitting formula:

\[ F(t) = A + B_1 e^{-t/\tau_1} + B_2 e^{-t/\tau_2} + B_3 e^{-t/\tau_3} \]

where, \( t \) is time, \( A \) is a constant background, \( B_1, B_2, \) and \( B_3 \) are fractional intensities, \( \tau_1, \tau_2, \) and \( \tau_3 \) are fluorescence lifetime. The amplitude-weighted average fluorescence lifetime, \( \langle \tau \rangle \), was calculated by:

\[ \langle \tau \rangle = \frac{B_1 \tau_1 + B_2 \tau_2 + B_3 \tau_3}{B_1 + B_2 + B_3} \]
**Tables**

Table S1 The quantum yield (QY) and average lifetimes of different N/S/P-CDs.

<table>
<thead>
<tr>
<th>Sample</th>
<th>QY / %</th>
<th>Average lifetimes / ns</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/S/P-CDs-100</td>
<td>2.42</td>
<td>2.83</td>
</tr>
<tr>
<td>N/S/P-CDs-120</td>
<td>3.25</td>
<td>2.65</td>
</tr>
<tr>
<td>N/S/P-CDs-150</td>
<td>1.72</td>
<td>1.85</td>
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</tbody>
</table>

Table S2 Results of Hg$^{2+}$ detection in river water using photoluminescent N/S/P-CDs-120 ($n=3$)

<table>
<thead>
<tr>
<th>Sample</th>
<th>Added Hg$^{2+}$ / µM</th>
<th>Found Hg$^{2+}$ / µM</th>
<th>RSD / %</th>
<th>Recovery / %</th>
</tr>
</thead>
<tbody>
<tr>
<td>river water 1</td>
<td>0</td>
<td>No detected</td>
<td>—</td>
<td>—</td>
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<tr>
<td>river water 2</td>
<td>20.0</td>
<td>20.2</td>
<td>1.7</td>
<td>101.0</td>
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<tr>
<td>river water 3</td>
<td>50.0</td>
<td>51.2</td>
<td>1.3</td>
<td>102.4</td>
</tr>
</tbody>
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