Sources and export of nutrients in the Zambezi River basin
Status and future trend

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Nutrient enrichment has been on the rise in African water bodies

Water bodies currently suffer from
  – eutrophication at some locations
  – water hyacinth invasion

High population growth, increasing demand for food & water

How will water quality change in future?
Objective: to analyze the status and future (2050) trends of river export of nitrogen (N)

MARINA model (Strokal et al., 2016)

Estimate annual river exports of nutrients by source at the sub-basin scale

Zambezi river basin
1.4 million km²
Transboundary (8 countries)
Inh: 40 mil (2010) → 87 mil (2050)
Linking IIASA models to build up MARINA

Integrated Modeling Framework in IS-WEL project

2010
2050

BAU: SSP2&RCP6.0
RS1:
BAU + sustainability
RS2:
BAU + economy

Stakeholder engagement

RCP & SSP

Other data
GDP, Population, Sewer connection
N deposition, N fixation (nat)

RCP

Community Water Model

Hydrology
Burek et al., 2017

Land use & Diffuse sources
(Valin et al., 2013; Byers et al., 2018)

GLOBIOM.org

EPIC
Environmental Policy Integrated Climate model
Gassman et al., 2005

Gassman et al., 2005

Integrated Modeling Framework in IS-WEL project
Zambezi is delineated into 13 sub-basins.

Population growth between 2010 and 2050 (SSP2)
Total dissolved N (TDN) export to sea and its future changes are highly variable in space.

TDN export to sea by the sub-basins differs by a factor of 11.
Total dissolved N (TDN) export to sea and its future changes are highly variable in space.

TDN export to sea by the sub-basins differs by a factor of 37-40.
N export is dominated by natural sources with increasing contribution from human activities.

Dissolved inorganic nitrogen (DIN)

Dissolved organic nitrogen (DON)

Dominate sources

Fixation

Leaching

25-50% increase of TDN export

Mainly due to human activities

Wetting climate projection also plays a role.
Inter-annual variabilities of rainfall and discharge are very high in the basin.

Discharge plots from CWATM by Burek P.

Yearly discharge of 1979-2013
Influence of **climate variability** on N export is at similar level to that of increasing human activities.

-60% -30% 0% 30% 60%

<table>
<thead>
<tr>
<th>Year</th>
<th>Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>BAU: SSP2</td>
</tr>
<tr>
<td>2050</td>
<td>RS2: economy</td>
</tr>
<tr>
<td>2050</td>
<td>RS1: sustainability</td>
</tr>
</tbody>
</table>

Relative increase of N export @ wettest year 25-50%

Relative decrease of N export @ driest year
Take home messages

N export is dominated by **natural sources** with increasing contribution from **human activities** in Zambezi.

**Climate variability** is an important factor in N export.

N export in the Zambezi basin is **highly variable in space**.
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References


Gassman P, Williams J, Benson V: Historical development and applications of the EPIC and APEX models. Center for Agricultural and Rural Development, Iowa State University; 2005.