LINKAGE BETWEEN LANDS AND OCEANS THROUGH WATER AND MATERIAL FLOWS BY RIVERS AND CLIMATE CHANGE IMPACTS

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Linkage between lands and oceans through water and material flows by rivers and climate change impacts

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Research interests

- Water and material (suspended solids and dissolved materials) flows from lands to oceans through rivers.

- How human activities including climate change impacts on water and material cycling, and ecosystems.

- How to regulate/mitigate anthropogenic impacts on water and material cycling, and ecosystems.
Today’s topic: Dissolved materials

Periodic Table of the Elements

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Map of the region around the Sea of Okhotsk, showing Armur River, Forest fire, Rich Wetland, Agriculture, Sea of Okhotsk, East Sakhalin current, and Oyashio. Map drawn by T. Kawaguchi.
**Food web in ocean**

Phytoplankton support marine resources

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**Sea of Okhotsk One of the most productive oceans in the world** (Imai et al., 2002; Sobe et al., 2002)

Iron supply processes

Iron from Dust supply  
Iron from Continental Shelf Sediment

and/or

Mshowald et al., 2005, GBC  
Moore and Braucher, 2008, Biogeosciences
Possible effects on iron production amount of the Amur River

1. Land cover change.
2. Forest fire
3. Climate change

Drawn by T. Kawaguchi
Land cover change in 20th century

2000

Data source: Ermoshin and Ganzey (2008)

Difference of major land-cover change between 1930s and 2000

Wetland→Farm land
Grassland→Farm land

Data source: Ermoshin and Ganzey (2008)
Land cover change in 20th century

Depth 10cm
- wetland
- paddy
- dryland

Depth 50cm
- wetland
- paddy
- dryland

Data source: Ermoshin and Ganzev (2009)

Total iron conc. in Naoli River, Sanjiang plain, China (mgL⁻¹)

Yan et al. (person. commun.)
Combination of hydrological model and iron production and transport

Modeling of dissolved iron production mechanism

TOP-FE algorithm
Validation of calculated dissolved iron (inter-annual)


Sta.1 Sta.2 Sta.3 Sta.4 Sta.5 Sta.6 Sta.7

Observed Calculated

Land cover conversion scenario

Wetland → Dryland

Forest fire

50% (wd50)

10% (fd10)

100% (wd100)

30% (fd30)
Conclusion

➢ Hydrological model incorporating dissolved iron producing mechanism is constructed.

➢ Constructed model is successful in simulating monthly discharge, and annual / monthly dissolved iron flux.

➢ Dissolved iron flux in 1930s’ might be 20% higher than present according to the wetland decrease.

➢ If the all wetland is converted to agricultural land, dissolved iron flux will decrease about 40% compared to present.

➢ Wetland in the lower part of the Amur River might be playing an important role in producing dissolved iron.

Fish Breeding forest
魚附林: Uo-Tsuki-Rin
Possible effects on iron production amount of the Amur River

1. Land cover change.
2. Forest fire
3. Climate change

Drawn by T. Kawaguchi

Long-term trend of dissolved iron concentration in the Amur River

△ Point for dissolved iron observation

a: Chernajevo, b: Blagoveshchensk, c: Zeya mouth, d: Bureya mouth, e: Ussuri mouth, f: Khabarovsk, g: Komsomolesk, h: Bogorskoye
Dataset specification

- Source: ROSHYDROMET
- Period: 1960 - 2007
- Frequency: 1-2/month (Except for winter)
- Method:
  - Pretreatment: Whatman GF/F, pH < 2 with HCl
  - Colorimetric method with 1,10-phenanthroline
- Notice: Some part of suspended form of dissolved iron might be included.

![Map of the Amur River with data points for Chernajevo](image)
Common characteristics of dissolved iron in the Amur River

- At every stations, largest peak were recorded in late 1990s’
- At many stations, a several peaks were recorded periodically. 1970-1980, late 1990s’
- Long-term variation of dissolved iron might be governed by large scale phenomena.
Correlation analysis with climate conditions

Dataset specification
- CRU TS v. 3.24 (Harris et al., 2014)
- Spatial resolution: 0.5° (approx. 50km × 50km)
- Time resolution: monthly
- Period: 1901 – 2002
- Method: Statistical interpolation of observed climate data
- Variables: pre, tmp, tmx, tmn, dtr, vap, cld, wet, frs

Correlation analysis
- Average values of watershed area of Khabarovsk
- Temperature, Precipitation

Analysis procedure by figure

- Delineate watershed area for each Fe measured station
- Extract CRU data inside the watershed
- In case of no discharge data, precipitation data is used.
- 5-year moving average of D-Fe and climate data are calculated and compared
Result

Table: Pearson's correlation coefficients between dissolved iron concentration at the Khabarovsk station and temperature and precipitation

<table>
<thead>
<tr>
<th></th>
<th>Temperature</th>
<th>Precipitation</th>
<th>Temperature</th>
<th>Precipitation</th>
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<tr>
<td>DJF</td>
<td>0.34</td>
<td>0.06</td>
<td>0.41</td>
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<td>MAM</td>
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<td>0.30</td>
<td>0.45</td>
<td>0.37</td>
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<td>May</td>
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<td>0.40</td>
<td>0.51</td>
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<tr>
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<tr>
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<td>-0.31</td>
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<tr>
<td>Dec.</td>
<td>0.14</td>
<td>-0.13</td>
<td>0.20</td>
<td>-0.14</td>
</tr>
</tbody>
</table>

Temperature of July and discharge weighted annual dissolved iron concentration

Figure: Trends of dissolved iron concentration at Khabarovsk and July temperature of its watershed in 5 year moving average values
Pearson's correlation coefficient between temperature, precipitation and dissolve iron concentration

Temperature vs. dissolved iron

Precipitation vs. dissolved iron

Groundwater table, depth, dissolved iron

July 3 – 17, 2016: Tyrma river survey data

Jessen et al. (2014)
Hypothesis

- Precipitation (Snow) → Thermal Insulation → Soil temperature → Air temperature
- Redox process → Soil moisture → Active layer → Dissolved iron load
- Dissolved iron
- Discharge

Questions:
1. ?
2. ?