Comparison of satellite-derived chlorophyll-a and Turbidity measurements with probe data at Lake Rummelsburg, Berlin

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The aim of project “Flussbad Berlin” is to convert the tributary Kupfergraben of River Spree to a bathing area. Therefore a 750 meter long bathing area will be implemented into the historical city centre of Berlin.

Problem

- Urban waters have a high recreational potential (Dahm et al. 2014)
  - The bathing options at river Spree will increase in the near future
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- The operative Monitoring is not capable of covering the water quality with a high temporal and spatial frequency (Quick et al. 2016)

Similar results in Mecklenburg-Vorpommern by Dörnhöfer et al. (2018)
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Water remote sensing offers the only option of complex water quality monitoring regarding the short-term spatial-temporal dynamics of water bodies (Zumbroich et al. 2012)
Research question

To what extent does the extracted satellite data match with the Chlorophyll-a and Turbidity data of the in situ measurements?

What is the actual persistence of Chlorophyll-a and Turbidity at Lake Rummelsburg and how comparable is the data with satellite-based measurements?

Is the represented concentration distribution of satellite-based data for Chlorophyll-a and turbidity spatially correct? And therefore does the reflection at the benthic has an effect concerning the accuracy of the results?
Study area
Methodology

To what extent does the extracted satellite data match with the Chlorophyll-a and Turbidity data of the in situ measurements?

Regression analysis
Kruskal-Wallis-Test
Bonferroni-method
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What is the actual persistence of Chlorophyll-a und Turbidity at Lake Rummelsburg and how comparable is the data with satellite-based measurements?

Autocorrelation of the complete investigation period (RuBuS project)
Autocorrelation of the measuring period (10 days before and after)
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Flow-Chart-Diagram
→ Moran’s Index
→ Spatial correlation analysis
Methodology

To what extent does the extracted satellite data match with the Chlorophyll-a and Turbidity data of the in situ measurements?

Regression analysis
Kruskal-Wallis-Test
Bonferroni-method
Results

To what extent does the extracted satellite data match with the Chlorophyll-a and Turbidity data of the in situ measurements?

- The results of the regression analysis shows significant differences between the two datasets.
  - The biggest match were captured in the depth of 150cm and 200cm.
Results

To what extent does the extracted satellite data match with the Chlorophyll-a and Turbidity data of the in situ measurements?

- The results of the regression analysis shows significant differences between the two data sets
  - The biggest match were captured in the depth of 150cm and 200cm

- The test of mean differences shows also significant differences between the two data sets
  - The biggest match were also captured in the depth of 150cm and 200cm
Results

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- The biggest match were also captured in the depth of 150cm and 200cm

The post-hoc Bonferroni-method shows also significant differences between the two data sets.

<table>
<thead>
<tr>
<th>Datenreihen</th>
<th>T1_20cm</th>
<th>T2_50cm</th>
<th>T3_100cm</th>
<th>T4_150cm</th>
<th>T5_200cm</th>
</tr>
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<tr>
<td>T2_50cm</td>
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<tr>
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</tbody>
</table>

*p-Werte für Chlorophyll-a am 14.02.2015*
Methodology

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Autocorrelation of the measuring period (10 days before and after)
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Autocorrelation of the complete investigation period (RuBuS project)
Autocorrelation of the measuring period (10 days before and after)
Data: Sensor measuring chain

Time

11.02.2015 14.02.2015 17.02.2015
Results

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Data: Sensor measuring chain
Results

What is the actual persistence of Chlorophyll-a und Turbidity at Lake Rummelsburg and how comparable is the data with satellite-based measurements?

- The complete investigation period has a daily persistence of 3 days
  - Independent of depth
  - Turbidity is slightly more persistent

Autocorrelation of the complete investigation period (RuBuS project)
Autocorrelation of the measuring period (10 days before and after)
Data: Sensor measuring chain
The complete investigation period has a daily persistence of 3 days
- Independent of depth
- Trubidity is slightly more persistent

The daily persistence of the measuring period is considerably lower
- Chlorophyll-a  \( \rightarrow \) 2 days
- Turbidity  \( \rightarrow \) < 1 day
Is the represented concentration distribution of satellite-based data for Chlorophyll-a and turbidity spatially correct? And therefore does the reflection at the benthic has an effect concerning the accuracy of the results?

Flow-Chart-Diagram

- Moran's Index
- Spatial correlation analysis
Methodology

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Flow-Chart-Diagram
- Moran’s Index
- Spatial correlation analysis

Data: Bathymetry, EOMAP, YSI-Sonde data

Interaction between Radiation- and Reflection processes of the water column with the satellite sensor (Dörnhöfer & Oppelt 2016)
Results

Step 1: Moran's Index

Z-Score above 1.65 → Clustered
Z-Score below 1.65 → Dispersed

Step 2: Spatial Correlation
Bathymetry/Eomap

Correlation
No correlation

Step 3: Correlation
Bathymetry/YSI-Messungen

Positive?
→ Chl-content is higher at deeper measuring points

Scenario A: The higher concentration is due to reflection processes at the benthic

Negative?
→ Chl-content is lower at deeper measuring points

Scenario B: There tends to be more chlorophyll at shallow water areas in general

Scenario C: The chlorophyll concentration is independent by depth
Results

Is the represented concentration distribution of satellite-based data for Chlorophyll-a and turbidity spatially correct? And therefore does the reflection at the benthic have an effect concerning the accuracy of the results?

- Step 1:
  - 3 of 4 raster data sets are clustered

Flow-Chart-Diagram
→ Moran’s Index
→ Spatial correlation analysis
Data: Bathymetry, EOMAP, YSI-Sonde data

EOMAP Trübung 14.02.2015
Results

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- Step 1:
  - 3 of 4 raster data sets are clustered

- Step 2:
  - There is no correlation between the satellite data and the bathymetry
Results

Is the represented concentration distribution of satellite-based data for Chlorophyll-a and turbidity spatially correct? And therefore does the reflection at the benthic has an effect concerning the accuracy of the results?

- Step 1:
  - 3 of 4 raster data sets are clustered

- Step 2:
  - There is no correlation between the satellite data and the bathymetry

- Step 3:
  - There is a weak correlation between the multiparameters sonde data and the bathymetry
Results

Step 1: Moran's Index
- Z-Score above 1.65 → Clustered
- Z-Score below 1.65 → Dispersed

Step 2: spatio-temporal Correlation
- Bathymetrie/Eomap
  - Correlation
    - Scenario A: The higher concentration is due to reflection processes at the benthic
    - Scenario B: There tends to be more chlorophyll at shallow water areas in general
    - Scenario C: The chlorophyll concentration is independent by depth
  - No correlation

Step 3: Correlation
- Bathymetrie/YSI-Messungen
  - Correlation
    - Positive? → Chl-content is higher at deeper measuring points
    - Negative? → Chl-content is lower at deeper measuring points
  - No correlation
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All three statistical tests show significant differences between the two data sets.

The difference of three days between the recording dates is too large.

The distribution of concentration is displayed similar by both measurements and is therefore not influenced by reflection processes at the benthic.
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The time difference between the two recording dates is too large, and as a result of the literature research the kind of sonde that is used has absolutely to be taken into account.
Outlook

- Critical consideration of both measuring points
- Same recording date
- Standardized measuring methods (laboratory analysis)

- Data sets with higher spatial accuracy
- A complete time series for autocorrelation analysis (whole year)
- Study area with high concentrations of chl and turbidity (Iisha nas for instance)
Thank you for your attention!