High-resolution mapping of lake and floodplain topography from space

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doi.org/10.5194/egusphere-egu2020-142
INTRODUCTION

TOPOGRAPHY OF LAKES is a **key information** for hydrological, ecological and geomorphological studies. It can be estimated using **altimetry data** and **flood extent** images.

**PREVIOUS STUDIES:**
Delimitation of the shorelines (isobath) of lakes over time.

**LIMITATIONS** in areas with many lakes, such as floodplain lakes: This delimitation have **high processing costs**, in addition to inherent **difficulties** due to connections among lakes.
INTRODUCTION

There is no systematic topography mapping of lakes and channels in large and complex floodplains using remote sensing data.

Flat surface in water bodies
OBJECTIVE

We present a systematic method for estimation of near shore topography for water bodies based on a flood frequency map and time series of water levels.

Test cases are performed for two lakes and 12 reservoirs, and in the central Amazon floodplain.
OBJECTIVE

1

We present a systematic method for estimation of near shore topography for water bodies based on a flood frequency map and time series of water levels.

2

Test cases are performed for two lakes and 12 reservoirs, and in the central Amazon floodplain.
FLOOD FREQUENCY-BASED METHOD

How the method works?

1. Flood frequency map
   - From flood extent maps

2. Water level duration curve
   - Input

Water level

Exceedance probability
FLOOD FREQUENCY-BASED METHOD

It considers the equivalence between flood frequency and water level exceedance probability.
DEM with defined bottom level ($z_1$ to $z_4$); Water surface increases each time step ($T_1$ to $T_4$).
Flood frequency for pixels with bottom level $z_3$ is 25% of the time.
EXAMPLE

Probability that the water level exceeds $z_3$ is 25% of the time

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EXAMPLE

Therefore: equivalence between flood frequency and water level exceedance probability at a given area.
Flood2Topo app converts water levels and Landsat based flood frequency into water body topography.

INPUT:
1. One water level time series
2. Flood frequency map

OUTPUT:
1. Topography map
2. Active storage-area-elevation relationships

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Flood frequency map from JRC Global Surface Water
Monthly Water History v1.0
Pekel et al. 2016
APPLICATION IN LAKES

3D topography:
Lake Poopó
Lake Curuai

Level-area-active volume:
12 Reservoirs
APPLICATION IN LAKES

Bottom level Poopó/Curuai lakes:
Bias = 5.68/60 cm
RMSD = 18.5/146 cm
$R^2 = 0.93/0.36$

Active storage 12 Reservoirs:
NRMSD = 2% to 11% for 11 reservoirs.
Average of 6.39%

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Application using a time series of water level for each floodplain pixel, i.e. the water surface elevation is variable in the area.

Water level in the floodplain estimated by interpolation of the water level along the Amazon River.
1. Altimetry in the Amazon river and floodplain;
2. Cross-sections in the Amazon river;
3. **Bathymetric survey in the Curuai floodplain.**
RESULTS
Curuâi floodplain

Bottom level:
Bias = 0.79 m
RMSE = 1.30 m
Pearson’s correlation coefficient of 0.73

Accurate representation of spatial patterns

Improved accuracy using distributed water level in the floodplain
River bathymetry obtained from nautical charts; RMSE of 7.5 m
AMAZON FLOODPLAIN

SRTM x Observed:
RMSE of 3.55
Pearson’s coefficient of 0.22

Improvements relative to the SRTM DEM

Estimated x Observed:
RMSE of 1.30
Pearson’s coefficient of 0.73
CONCLUSIONS

A flood frequency-based method was proposed and validated for estimating the topography and active volume of water bodies.

The method can be applied to any area seasonally flooded: it is applicable in 35.8 % (86%) of the global water surface area mapped by occurrence map from GSW dataset, when considering the number of pixels with occurrence between 0 and 95% (99%) over 35 years.

Topographic mapping of the central Amazon floodplain can be used in hydrodynamic simulation and ecological and geomorphological studies.

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Thank you!

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