Studying Fluvial Tipping Points with Remotely Sensed Observations and Hydroclimatic Data in the Selenga River Delta

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Studying the Long-Term Changes in Spatial Surface Water Extent by Remotely Sensed Observations and Hydro-Climatic Data in the Selenga River Delta

Objectives:

1. To discover changes in surface water extent in Selenga River Delta from 1987 to 2019
2. To categorize the detected changes not only in two epochs within the entire 33-year period but also in each season.
3. To identify the relationship between climatic data (and the change in water discharge) and the surface water change in the Delta.

Methods:

- Supervised classification on historical Landsat imagery (Level-2 data of surface reflectance) from 1987 to 2019 (Landsat 4,5,7,8: OLI, ETM+, and TM).
- Normalized Difference Vegetation Index, Normalized Difference Water Index and three spectral bands (NIR, SWIR, and Blue) are the primary sources of the classification.
- We put the classification maps in two categories (before 2003 and after 2019). Then, we monthly averaged the value of each pixel. The pixels of the maps have a value of either one or two that represents the lack or presence of water on a certain day.

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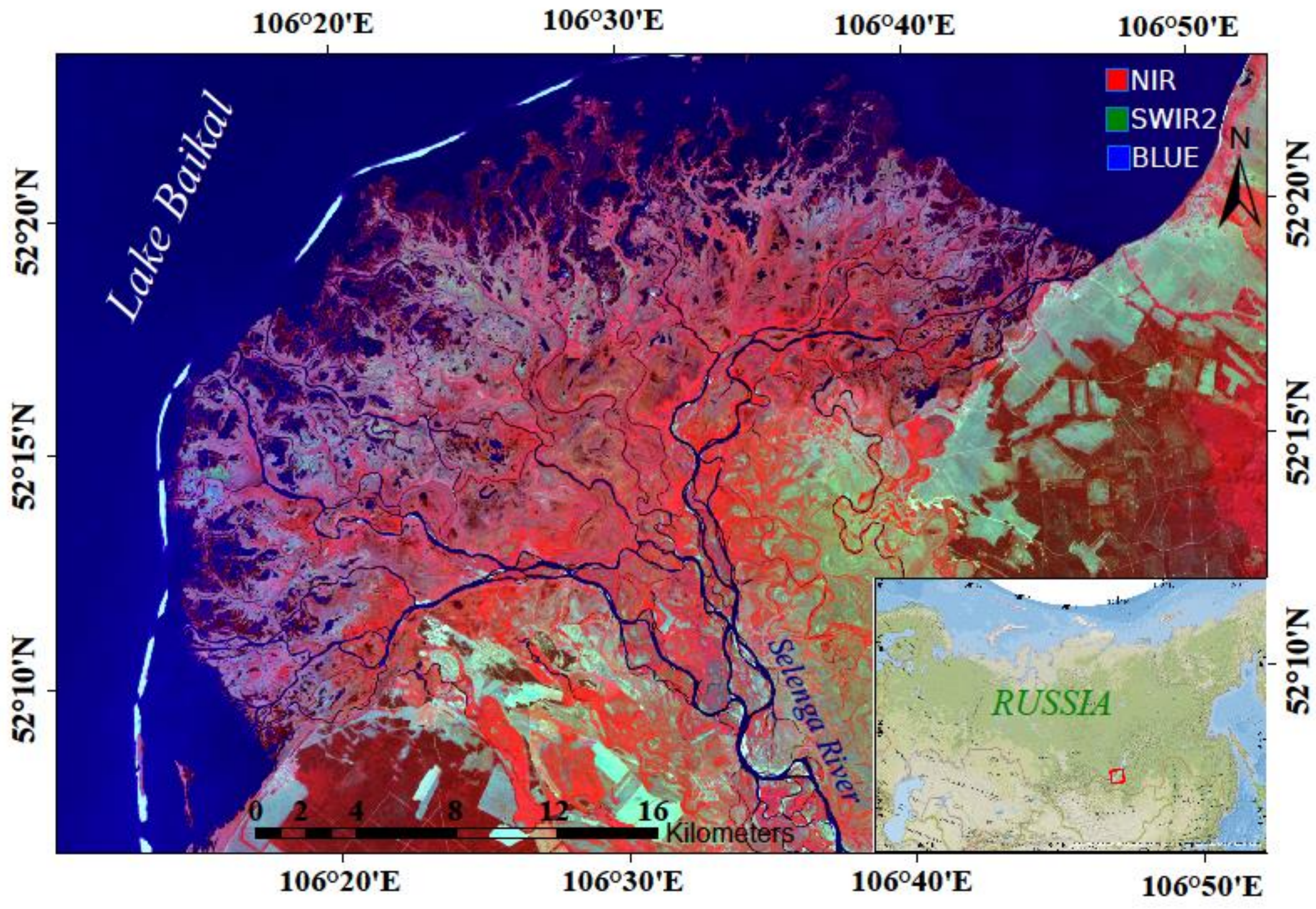

Landsat 8 (OLI) image acquired on 2017/06/30

Lake Baikal, located in eastern Russia, is the oldest (25 million years) and the deepest (~1800 meters) lake in the world. Many rivers are flowing into the Lake Baikal (~ 365 rivers), of which the Selenga River is the most important one being responsible for almost 55% of the runoff water into the system and also 60% of the transported sediments. It originates in Mongolia from the south and flows north-direction towards the Lake Baikal.

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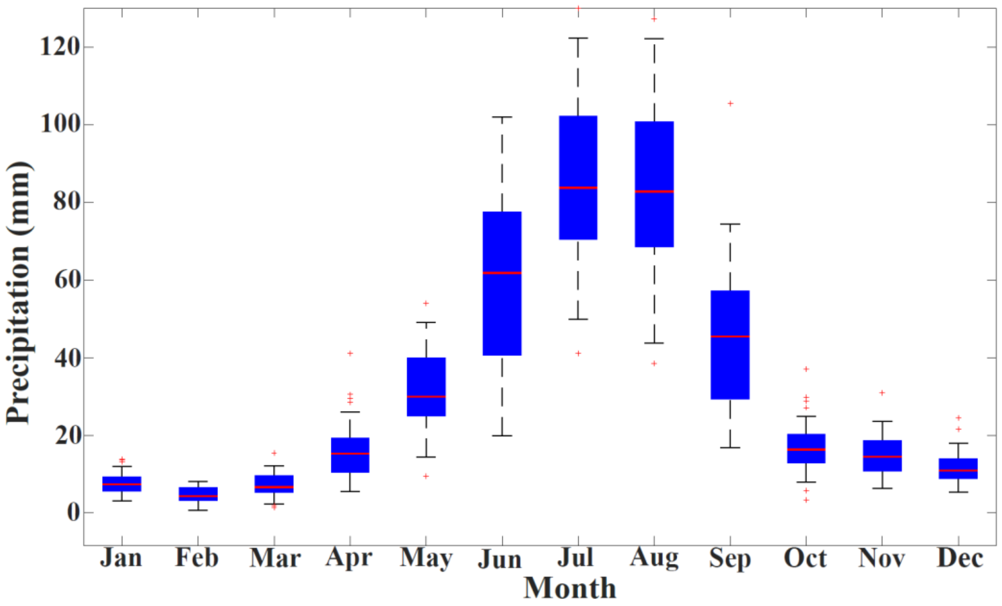
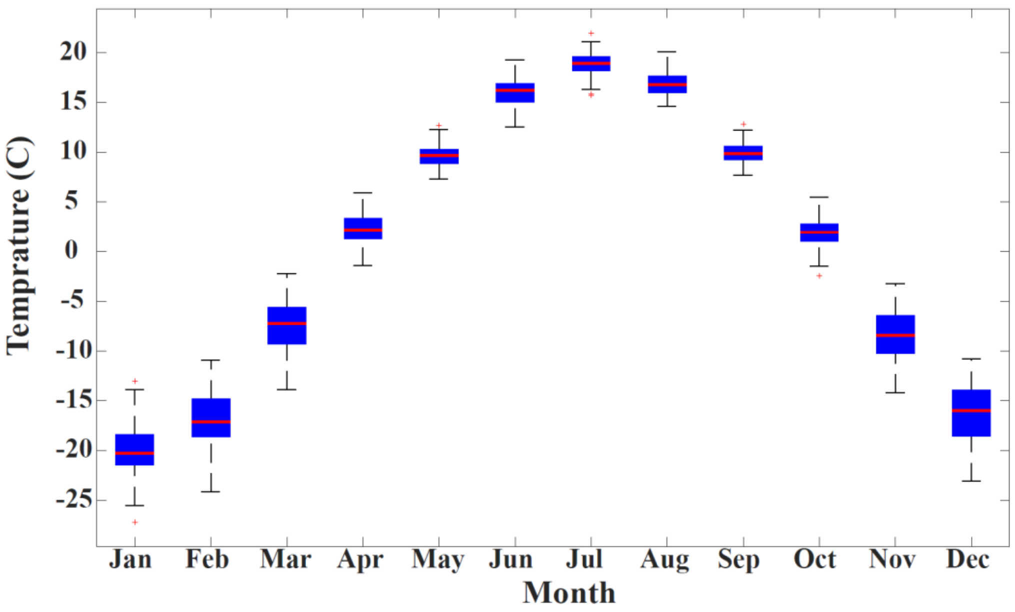
B

A





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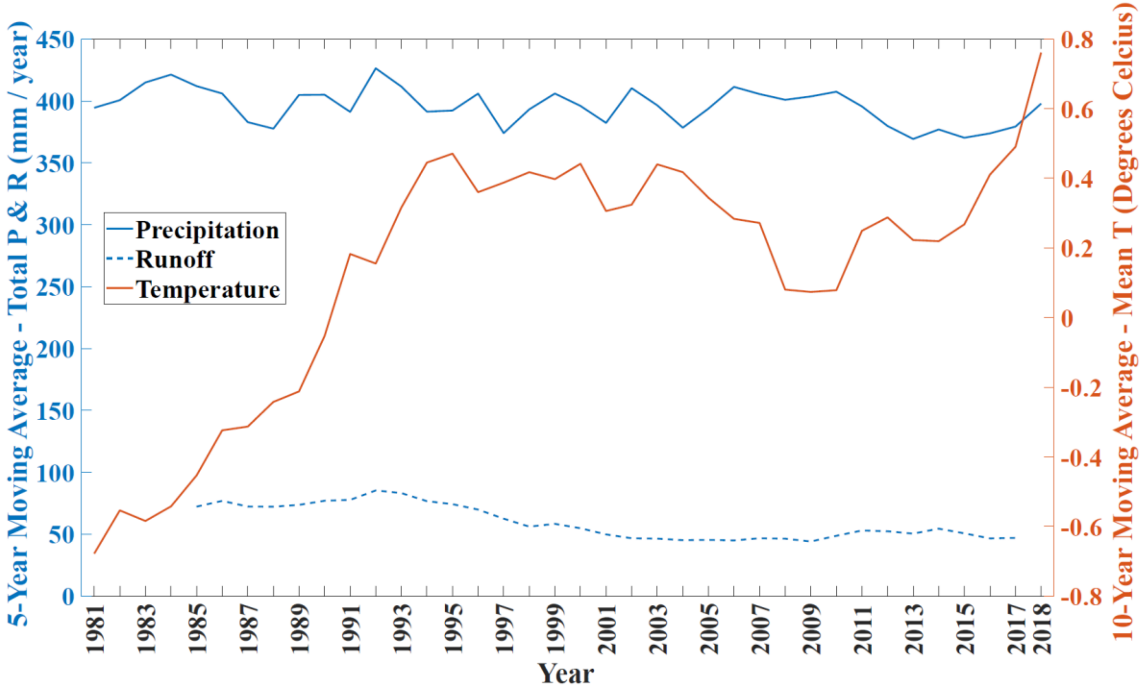
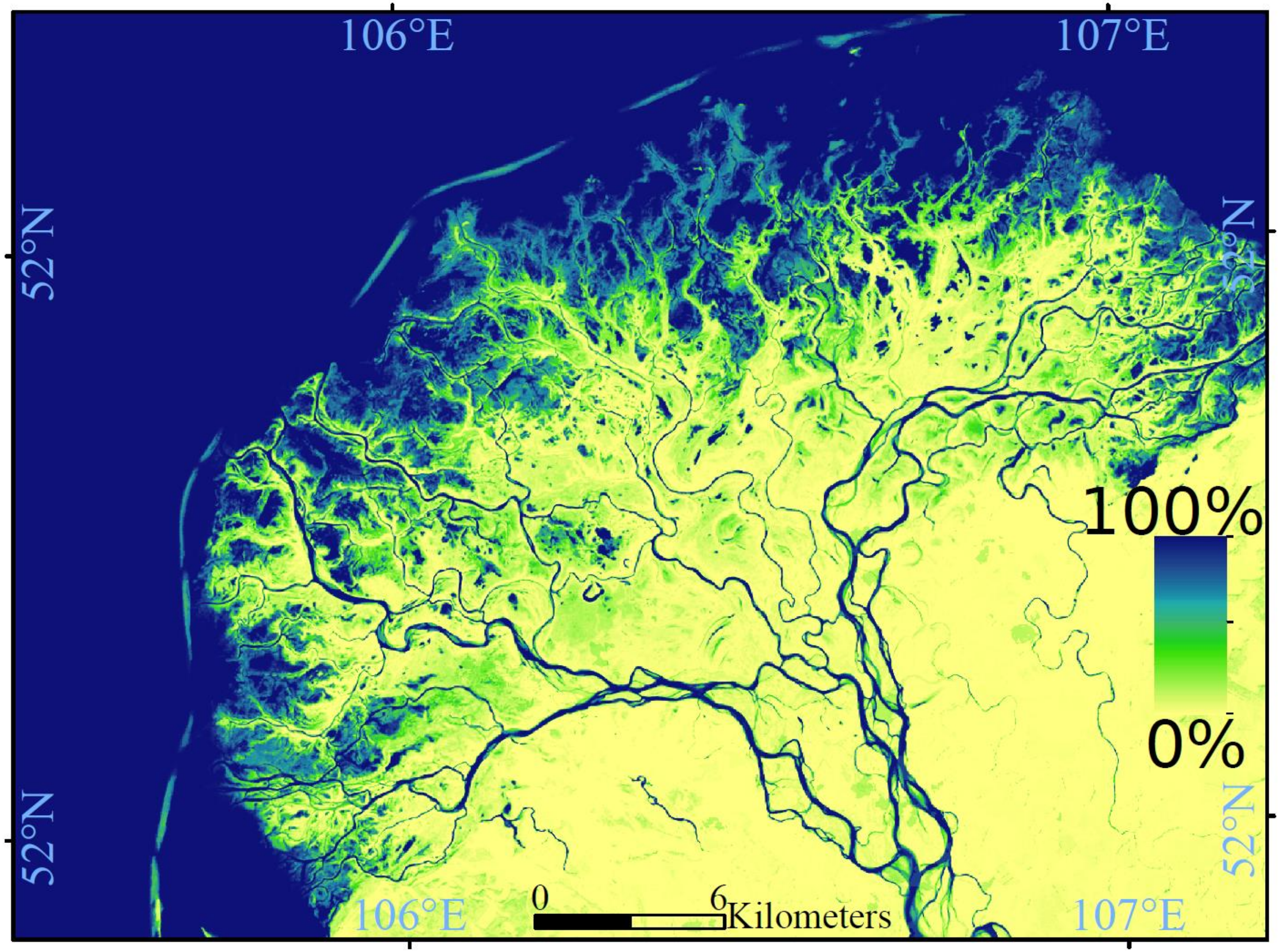


A) The monthly box-whisker plot of the precipitation. The highest precipitation in the Delta happens in the summer and fall, and the most annual changes also occur in the summer and fall (bigger boxes and higher differences between maximum and minimum).

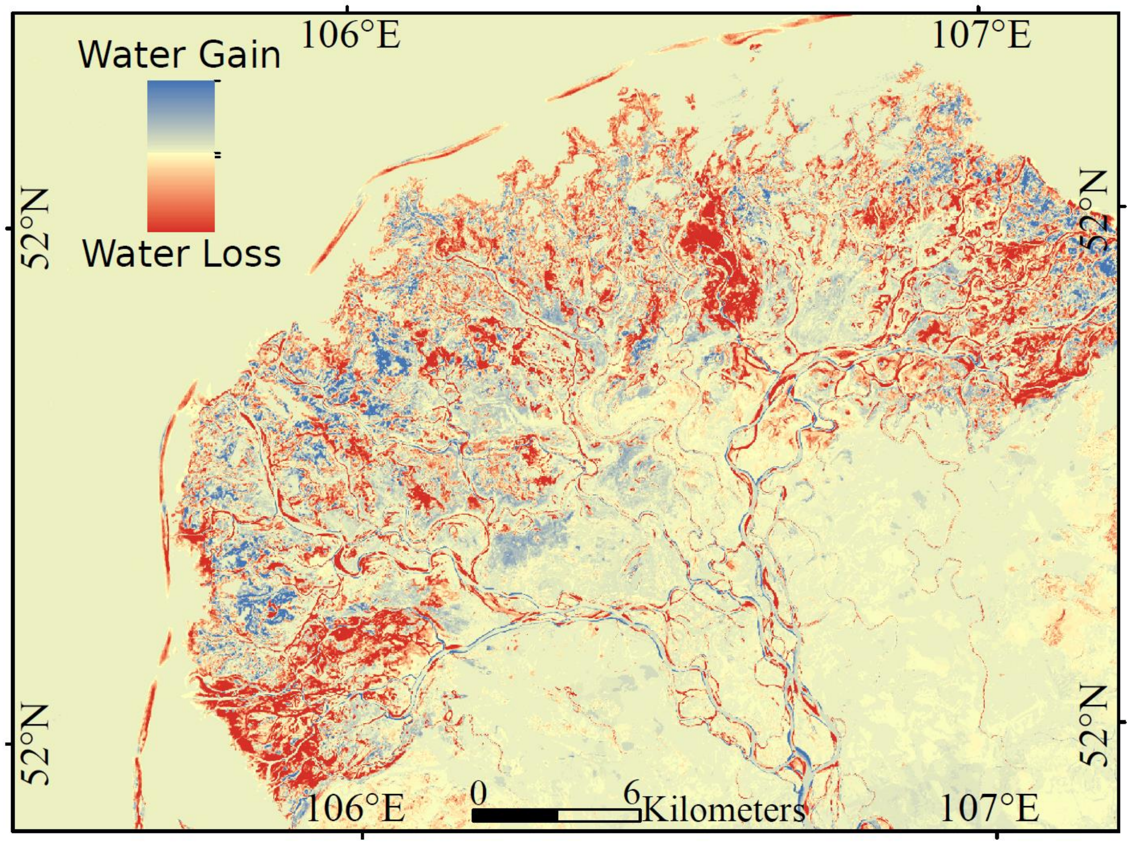
B) The monthly box-whisker plot of the temperature. Although the highest temperature in the Delta is in the summer, the most annual changes occur in the winter (bigger boxes and higher differences between maximum and minimum)

C) 5-year moving average of the monthly precipitation(P) and runoff(R) on the left axis, and 10-year moving average of the temperature on the right axis. As a consequence of climate change, we see a rapid increase in temperature and a decline in precipitation although there are extreme peaks in the recent years. The decline in the runoff can be due to both climate change and human pressure on the River (agriculture, tourist attraction, urban sprawl)



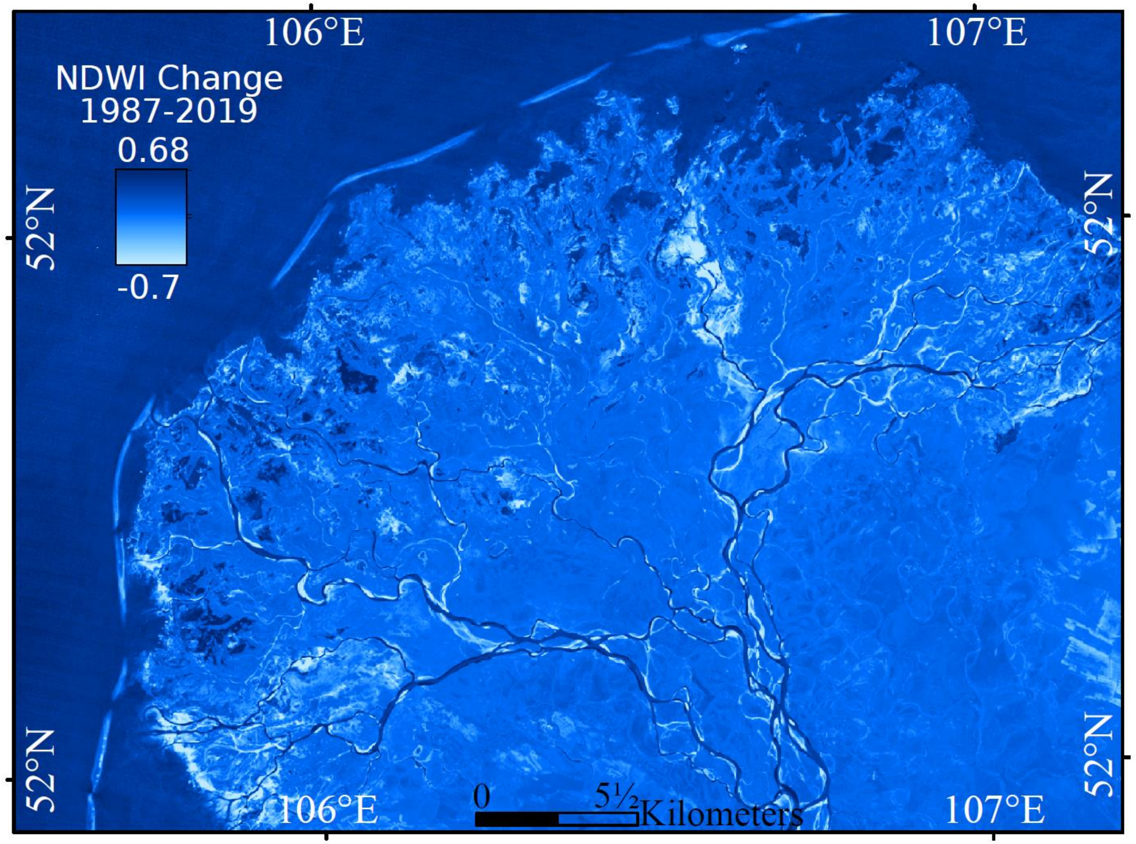
Possibility of water occurrence between 1987 and 2019 (weighted average to cancel out the seasonality effect).

- Mainstreams have high values (near 100%) except on the bends that shows the planform migration.
- Lake Baikal and permanent lakes inside the Delta are in dark blue, while the light blue and the dark green show the temporary lakes or streams.
- Green areas indicate temporarily flooded locations and agricultural lands since the water presents in there less frequent than in temporary lakes and streams.
- Light blue lines indicate the thin streams which either dry out in dry seasons or are covered with vegetation in leaf-on seasons.
- The more an area is prone to seasonal inundation, the more changes of the water occurrence between the river bends and river centerline are visible.

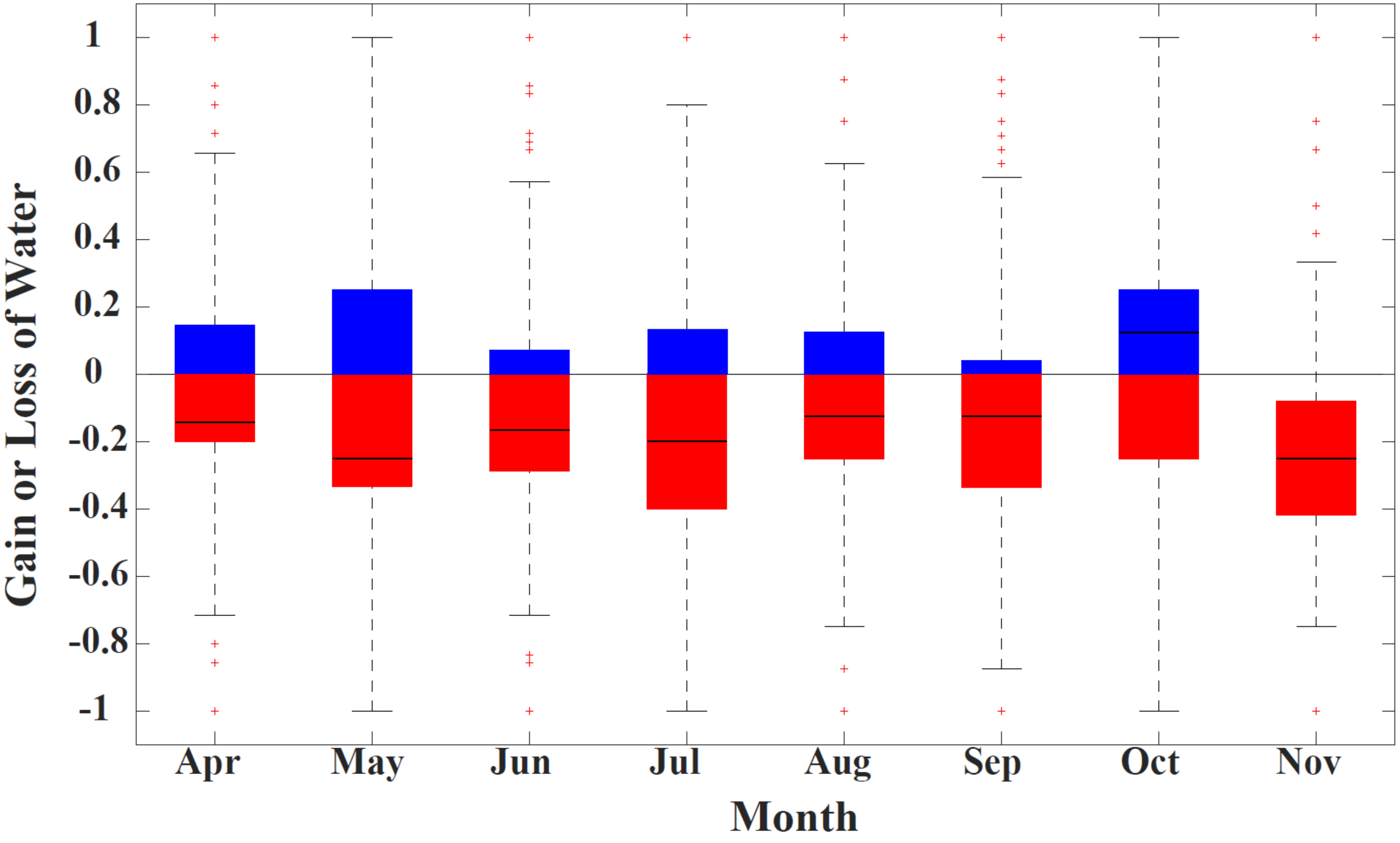


Change of the water occurrence between two epochs, 1987-2003 (Gain and Loss of water)

- The bank in front of the Delta has become thicker.
- The loss and gain of water near the main streams' bends show the river planform migration.
- Generally, a decline in surface water can be seen on the map.
- One of the mainstreams in the northeast of the Delta has wholly changed its paths; the older path is red, and the new one is blue. (maybe we can add a zoom figure of that area)



Change of the NDWI between two epochs, 1987-2003 and 2003-2019. similar findings with fewer details, and sharper changes can be seen in it.



Box-whisker plot of the changes in surface water occurrence for all pixels with the minimum change

- The most variation of surface water extent is in May, July, and November that all of them are linked to losing water (red box) rather than water gain (blue box).
- The only month in which most pixels, all the years, gained water is October.
- Regarding the water loss, Increasing the difference between the values in Jul and Oct can be due to vegetation phenology that covers and uncovers the surface water at the beginning and the end of summer and affects the classification results.
- Alternatively, they can be due to unexpected floods.

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Thank you for your Attention

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