The Quantitative Analysis of Synchronized River Flood on the Global Scale Considering Multiple Flood Peaks

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Introduction

- An increase in the frequency of fluvial floods

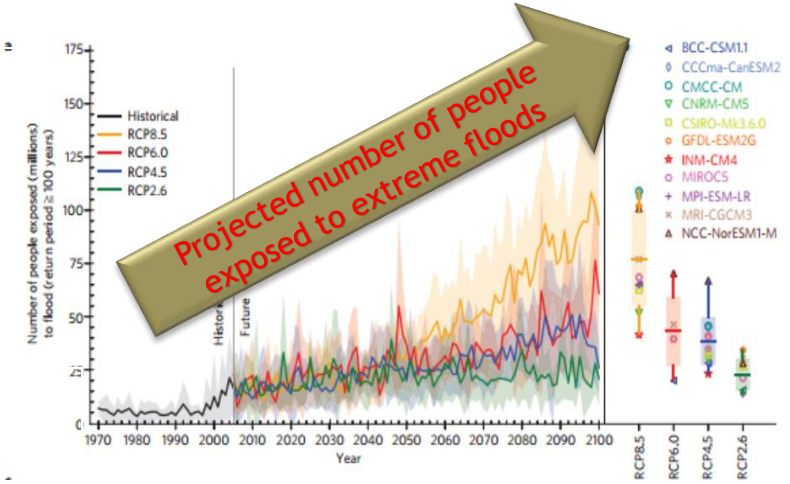
  [Hirabayashi et al., 2013 ; Cisneros et al., 2014, Hirabayashi et al., 2008]

- Compound flood has increased significantly

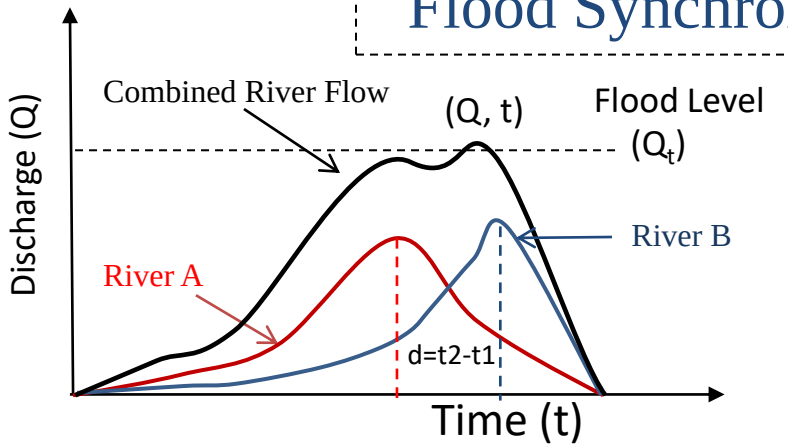
  [Wahl, et al., 2015 ; Brakenridge et al. 2013]

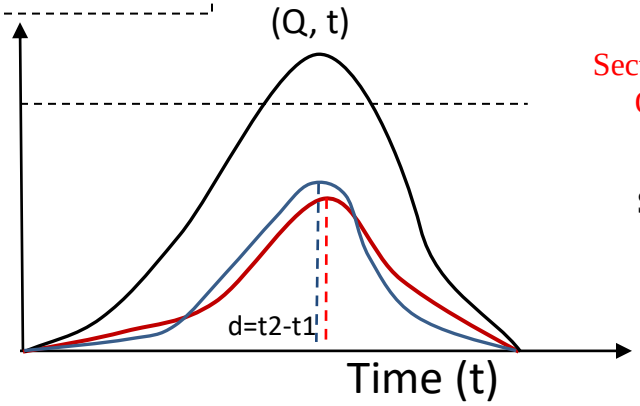
- Observed Flood Timing Change in Europe(1960-2010);

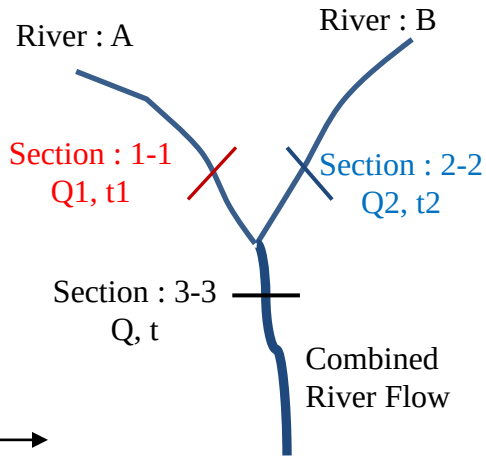
  [Günter Blöschl et al. 2017;]



Flood Synchronization







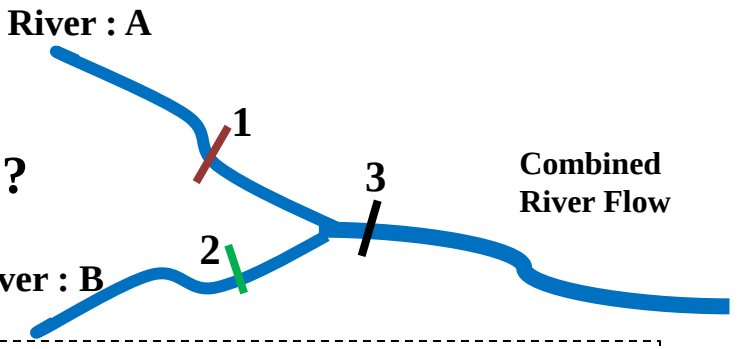
Compound event

Flood parameter (Q, t, A) rapidly increase

Common mainly d/s of deltaic rivers

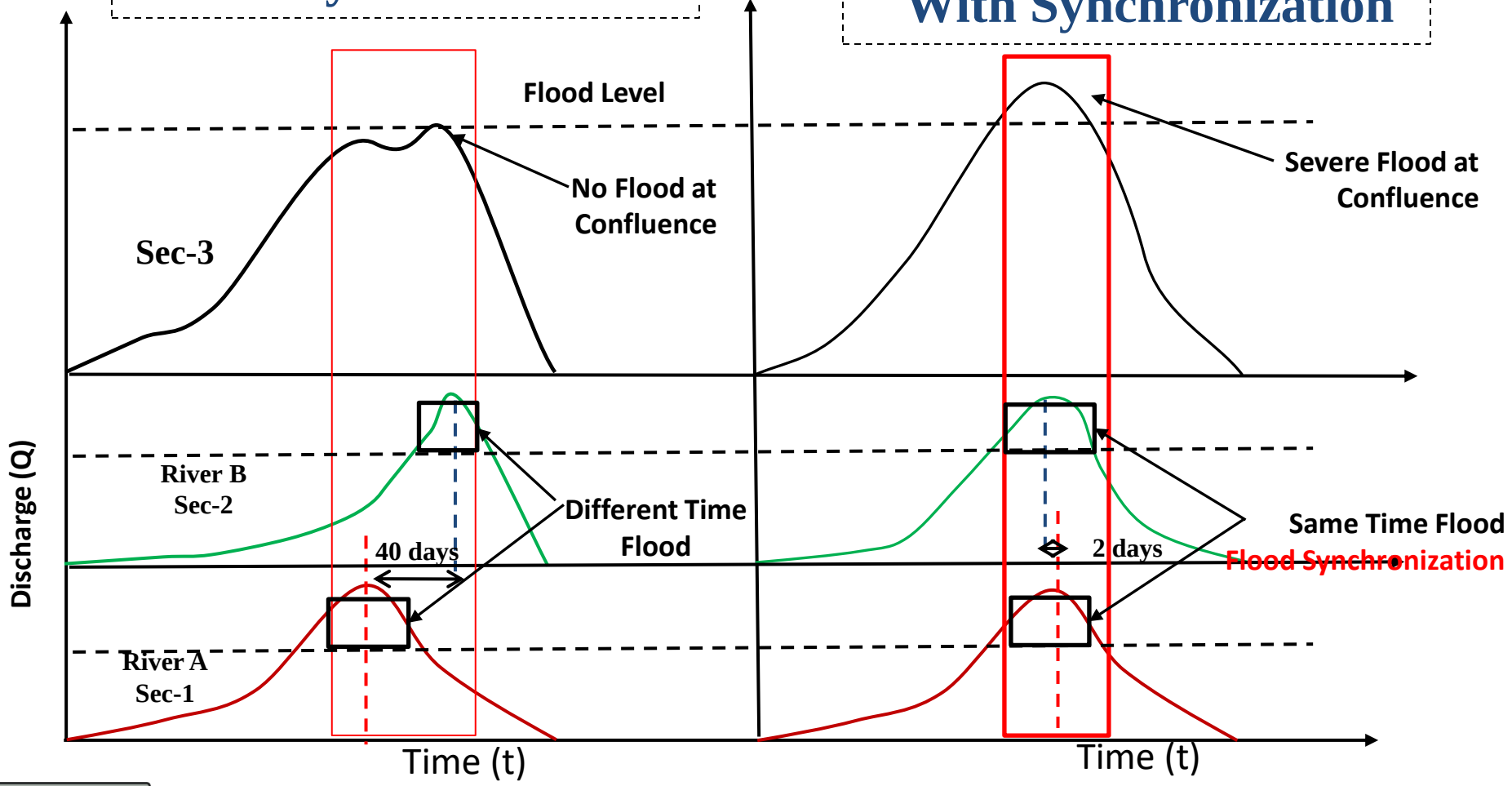
Background

How Flood Timing of sec1 &2 affect flood in sec-3?



W/O Synchronization

With Synchronization



Background & Research Gap

The worst floods in the history of Bangladesh during 1988 and 1998 occurred when the peak discharges of the Ganges and Brahmaputra rivers coincided within a few days of each other (Islam et al. 2010; Mirza 2002; Rahman 2013). In this study, the

16. Thus the flood of 1903 was caused by two early storms which centered over the Ohio watershed followed by a general storm over the Ohio, upper Mississippi, and Missouri watersheds which resulted in a fair degree of synchronization of crests from the upper rivers.

-The Mississippi River Flood, Hearings

- Previous studies [**Mohammed et al.2018, Berghuigs et al.2019]** focuses on Yearly peak (**Not Multiple Peak**) synchronization at local scale **(Not Global Scale).**

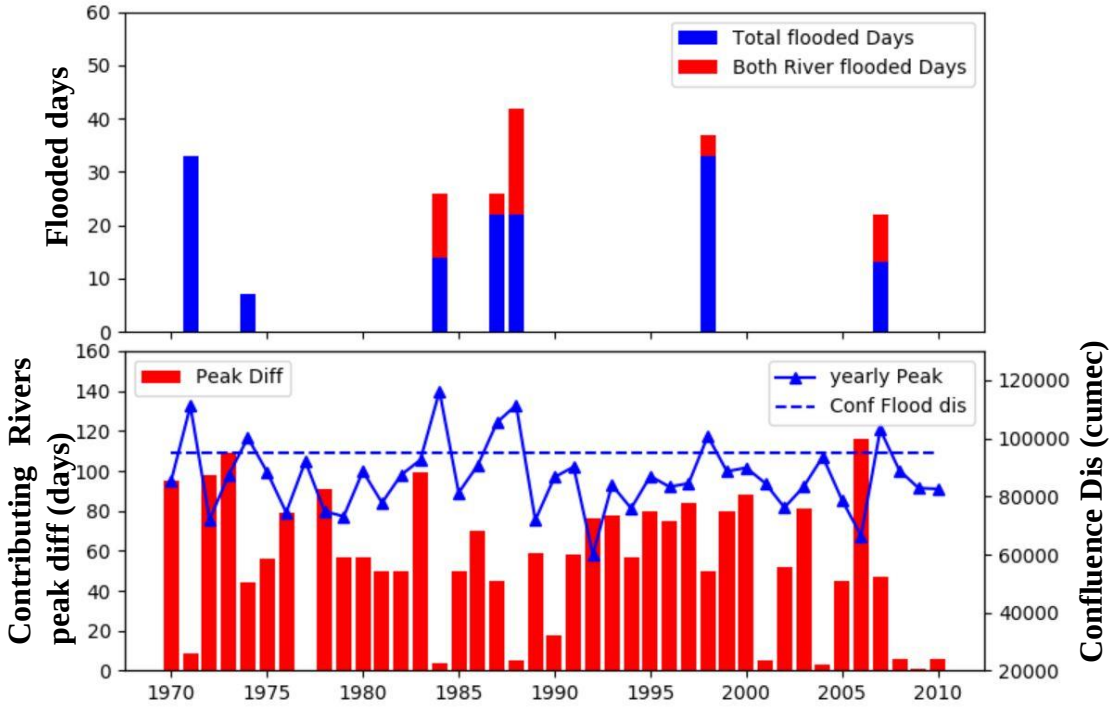
✓Does not check the **Danger Limit/ Flood Level**.

-Over estimated the flood event

✓Only one peak in a year; Did not consider **multiple peak**.

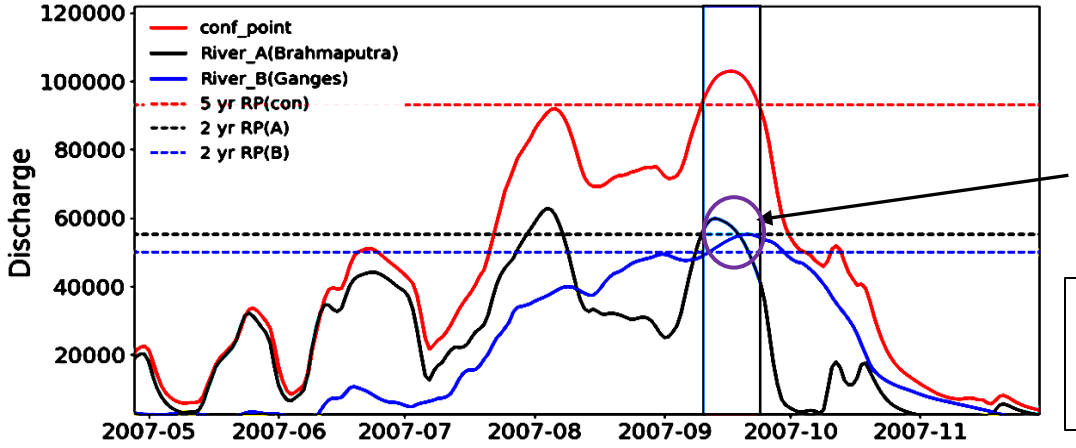
-Under estimate the synchronization event

Flood Synchronization at Ganges Brahmaputra confluence



✓ The flooded event which more than 50% days both river are flooded, considered as synchronized flood. Here **3 out of 7 are synchronized flood.**

✓ About 70% years when yearly peak synchronization occurred but there in no flood at confluence zone.



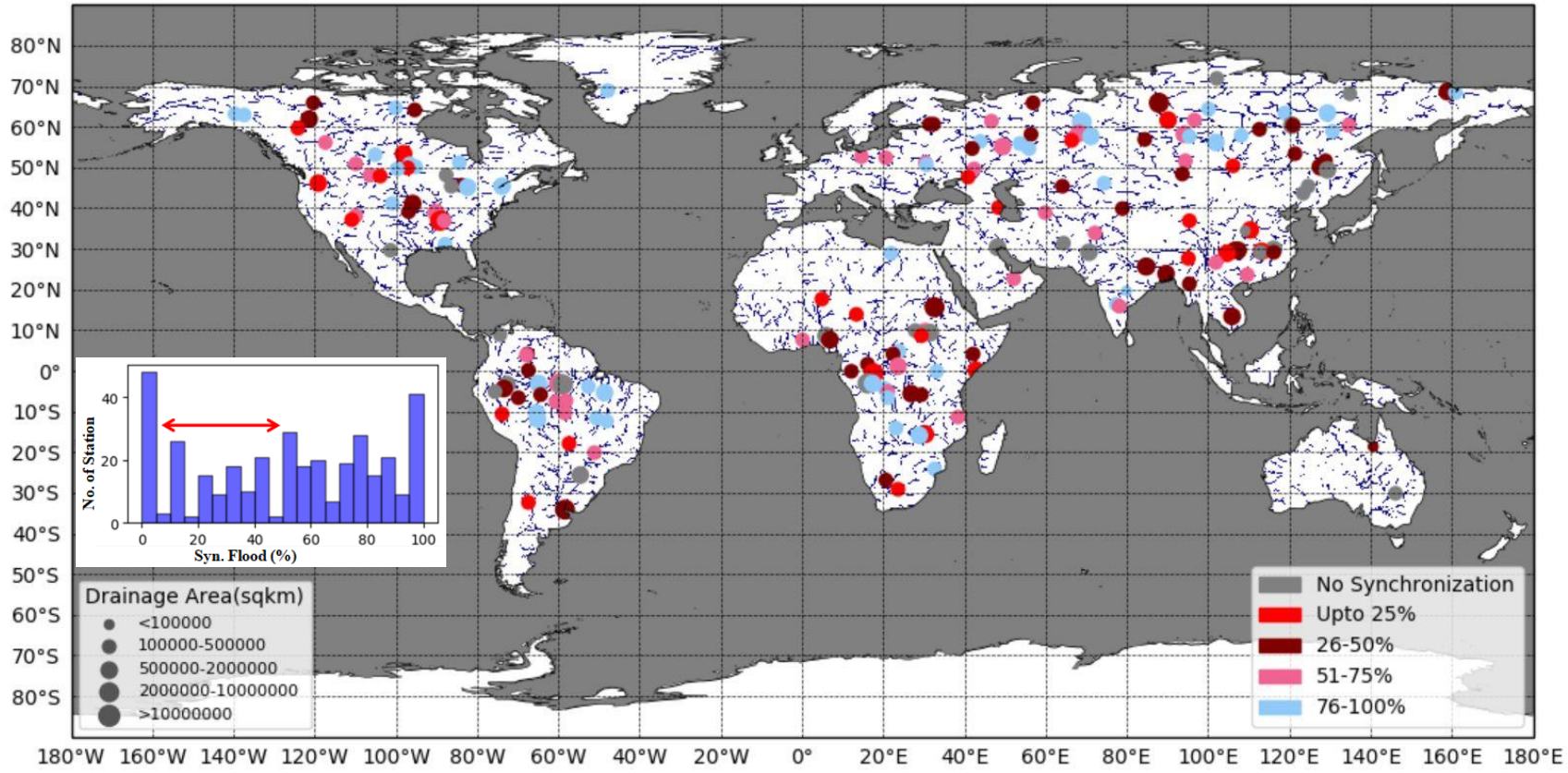
Both River Flooded same time
Synchronized Flood

✓ Flood synchronization in 2007 without yearly peak synchronization

Flood Synchronization globally

$$\text{Synchronized Flood}(\%) = \frac{\text{No. of Synchronized flood event}}{\text{Total No. of flood event}} * 100$$

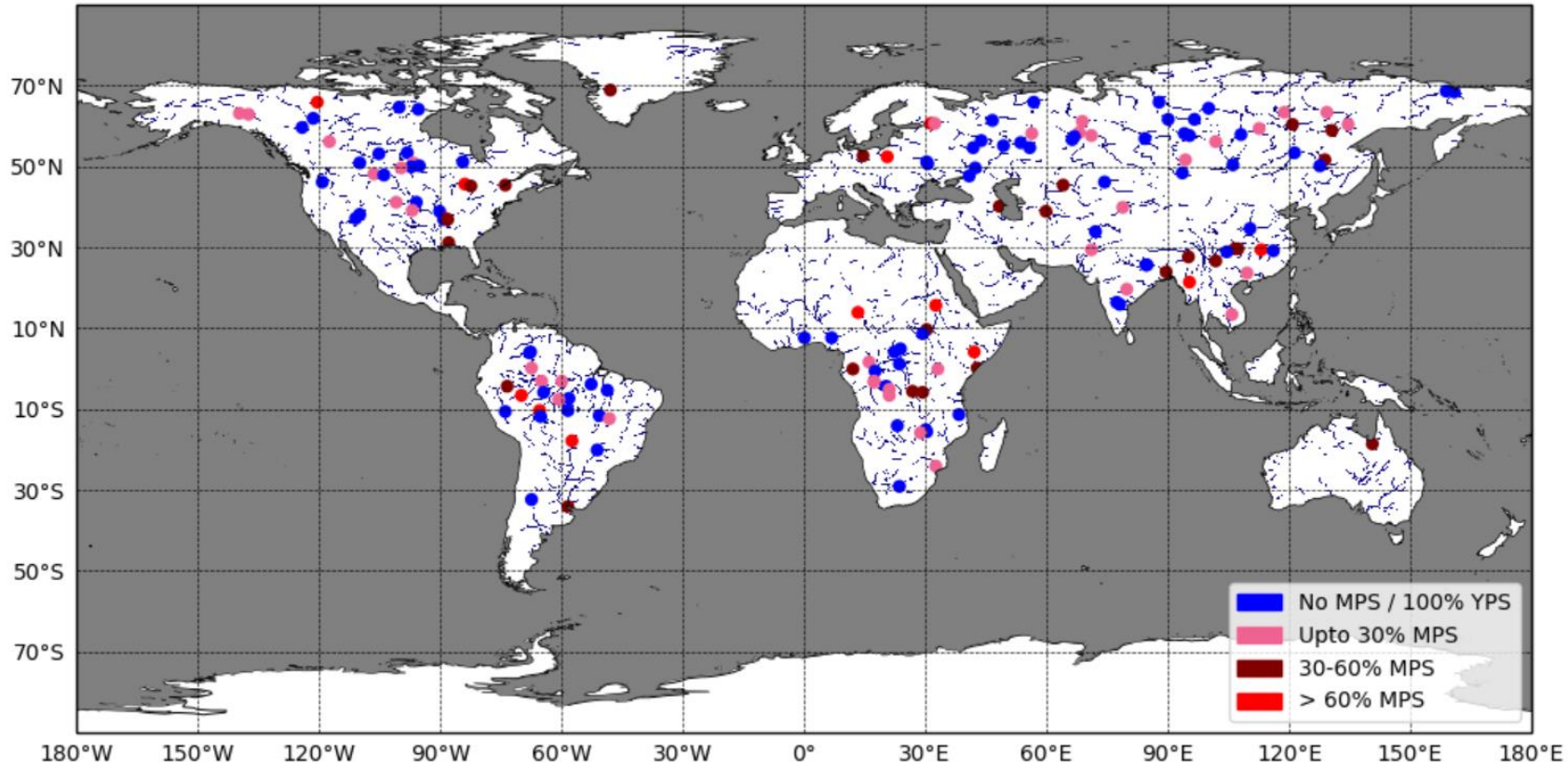
When river-A and river-B both Drainage area>200 X 200 sqkm.



- ✓ About 87% confluence point shows different degree of flood synchronization.
- ✓ Concerned confluence points have (>0 to <50)% synchronized flood.

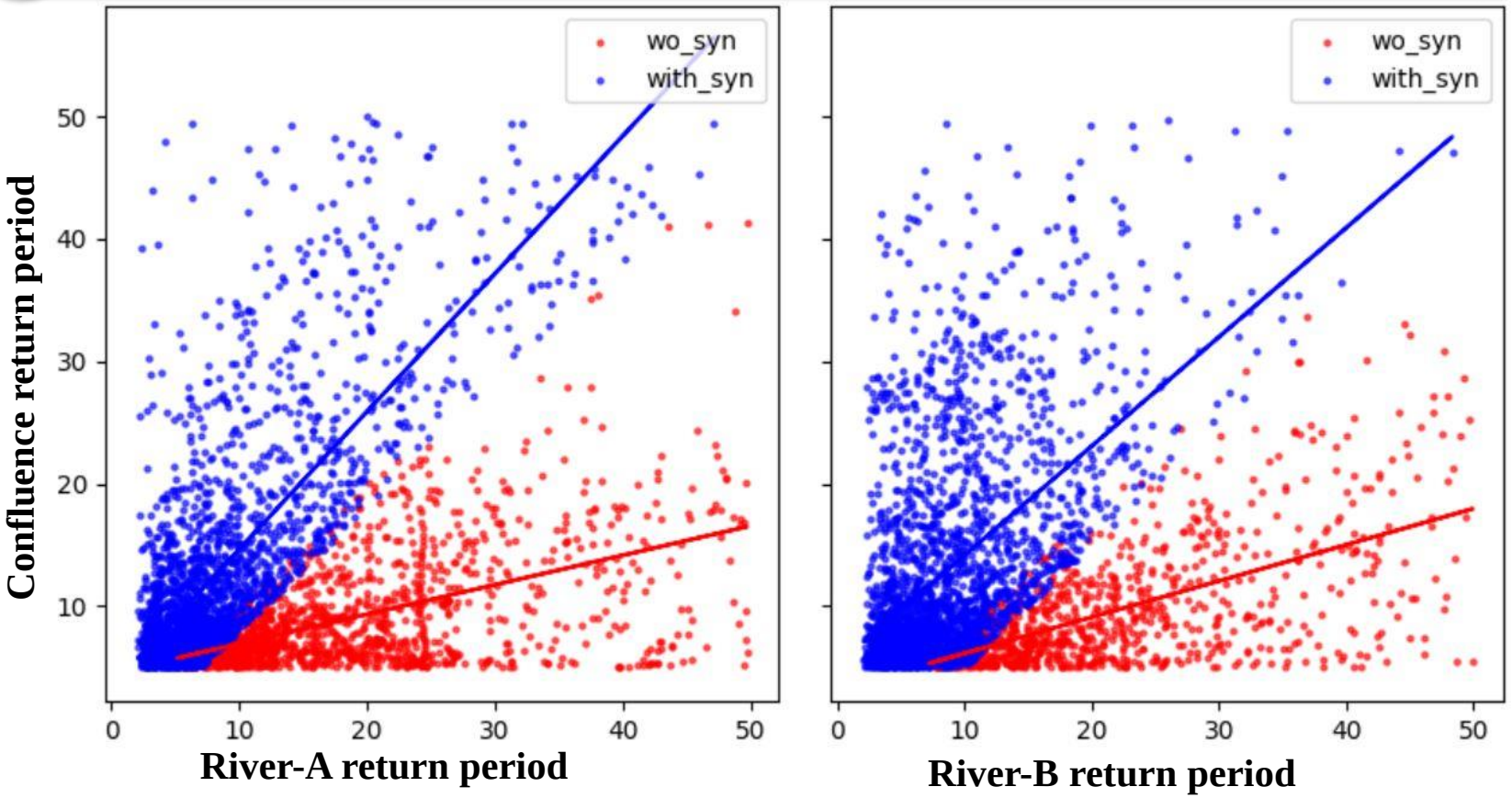
Flood Synchronization Mechanism Globally

Total Synchronized flood No. = Yearly Peak synchronized (YPS) flood No. + Multiple peak synchronized (MPS) flood No.



✓ **About 50% confluence point shows different degree of multiple peak synchronization (One river yearly maximum + Other river 2nd highest/3rd yearly peak).**

Flood Intensification due to Synchronization



✓ Synchronized flood return period **rises about (3 to 3.5) times** on average than normal flood.

✓ River-A dominated synchronized flood generate more intense flood than River-B because River-A flood discharge greater than river-B.

✓ Intensification of synchronization mostly depend on both contributing river flood level coincidence.

Where Synchronization Dangerous due to Climate Change

$$Total\ Flood\ Change\ (\%) = \frac{N(fut) - N(hist)}{N(hist)} * 100$$

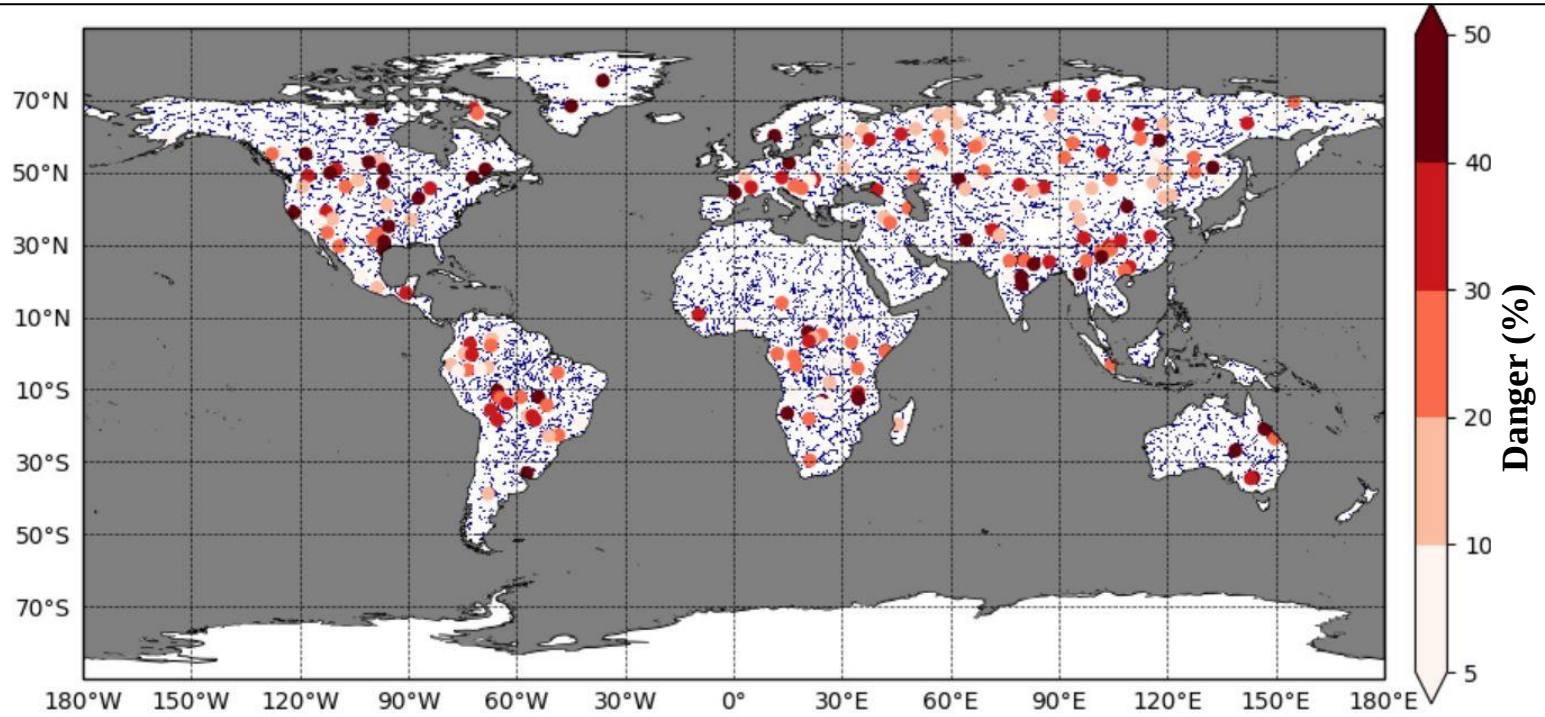
$$Syn\ Flood\ Change\ (\%) = \frac{N1(fut) - N1(hist)}{N(hist)} * 100$$

N = Total Flood No.
N1= Syn Flood No.

If Syn Flood change (%) > Total Flood Change (%)

Danger(%) = Syn Flood change (%) - Total Flood Change (%) ;

Exclude all point where historical synchronized flood (%) more than 75%



Flood will be increased due to only flood synchronization

Conclusion

- The river flood synchronization occur when two rivers at flooded condition **(function of flood magnitude, not yearly peak).**

-The current approach reveals for the first time where fluvial flood occurred due to river flood synchronization on global scale, where managers should consider flood synchronization more critically.

- Furthermore, synchronized floods are more intense flood than normal flood in the confluence zone.

-Observed flood timing is changing [Günter Blöschl et al. 2017]. **Only due to change of flood timing rather than change of rainfall, snow contribution and runoff process**, some confluence point may show more synchronized flooded events. Therefore, the risk of flood for those confluence point will be multi-folded **due to climate change.**