Extreme multi-basin flooding linked with extra-tropical cyclones [Poster]

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1. ABSTRACT

Fluvial floods are typically investigated as ‘events’ at the single basin-scale, hence flood management authorities may underestimate the threat of flooding across multiple basins driven by large-scale and nearly concurrent atmospheric events. We pilot a national-scale statistical analysis of the spatiotemporal characteristics of extreme multi-basin flooding (MBF) episodes, using peak river flow data for 260 basins in Great Britain (1975-2014), a sentinel region for storms impacting northwest and central Europe. During the most widespread MBF episode, 108 basins (46% of the study area) recorded Annual Maximum (AMAX) discharge within a 16-day window. Such episodes are associated with persistent cyclical and westerly atmospheric circulations, atmospheric rivers, and precipitation falling onto previously saturated ground, leading to hydrological response times <40 and documented flood impacts. Furthermore, peak flows tend to occur after 0.13 days of very severe gales causing combined and spatially-distributed, yet differentially time-lagged, wind and flood damages. These findings have implications for emergency responders, insurers and contingency planners worldwide.

2. DATA AND METHOD

- **Peak Flow** (m³/s) Annual Maximum (AMAX) data, for all GB during 1975-2014 time period (water years), from NIWA and SEPA.
- A new simple and pragmatic approach based on the count of concurrent basins reaching their AMAX within a given time window has been developed.
- Time window (n) = n days before dmax
- Event-set A: single AMAX dates
- Event-set B: extreme MBF episodes (based on no. of basins, nj) next 10 subsequent
- Event-set C: extreme L = 13-days episodes per each water year based on multi-basin flood yield (m³/year)
- Event-set D: extreme L = 13-days episodes per each water year based on total drained area (TDA)
- Event-set E: extreme MBF episodes based on nj

3. RESULTS

- 5 temporally distinct extreme MBF episodes have been identified (event-set E).
- Number of basins concurrently involved from 65 (L = 1) to 108 (L = 16) and total basins area drained from 14.3% (L = 2) to 46.5% (L = 16).
- The episodes tend to occur mostly during the Df winter, with a clear peak in January for all event-sets.
- 10 U/NTs identified within event-set E. C. (Cyclonic), SW. (Southwesterly), W. (Westerly), CSW. - NW-type more frequent than expected for all event-sets with C-type 3 times more frequent (event-set E).
- Event set C episodes correlate with the no. of days with VGS in that particular year (p-value <0.01) and co-occurrence of extremes is 67% more likely than expected by chance (10 co-occurrences, p-value <0.05). For 5 of 10 co-occurrences, the extreme multi-basin floods occurred on the same day of VSG and of 10 within 1-13 days after a VSG (p-value <0.001).
- The distribution of AMAX peak flow occurrences is homogeneous within the study area for event sets B, C, D and E.
- Larger (A > 1,000,000 m³) basins join the episode essentially the same time as small (A <1,000,000 m³) ones (joining times 2 atanal). Larger basins have a time to peak <40h;
- 4 out of 5 temporally distinct extreme MBF episodes occurred on the same day as an Atmospheric River (AIR) [4] impacting the Great Britain (p<0.001).
- SPI 24-1-Month is significantly above the overall mean, increasing with time window length, during the event-set B episodes.

4. CONCLUSIONS

- A new pragmatic method with different metrics for identify multi-basin flooding episodes has been introduced and due to its simplicity and few data required it is easily applicable also beyond the study area.
- A national-scale return period of widespread flooding can be estimated independently of the metric used.
- Multi-basin flooding have similar physical drivers as single-basin floods but duration for the former is larger (i.e. ~13 days), indicating that a memory in the physical system is required (e.g. wet soil or persistent U/NTs);
- ETCS are linked with multi-basin episodes, through type LWTs, VGSs and AIRs, bringing combined flood-wind impacts that could exceed the 0.3 billion of insurance losses reported in UK domestic properties.
- Emergency managers and related resources may be put under high stress during extreme MBF episodes concurrently impacting large areas.