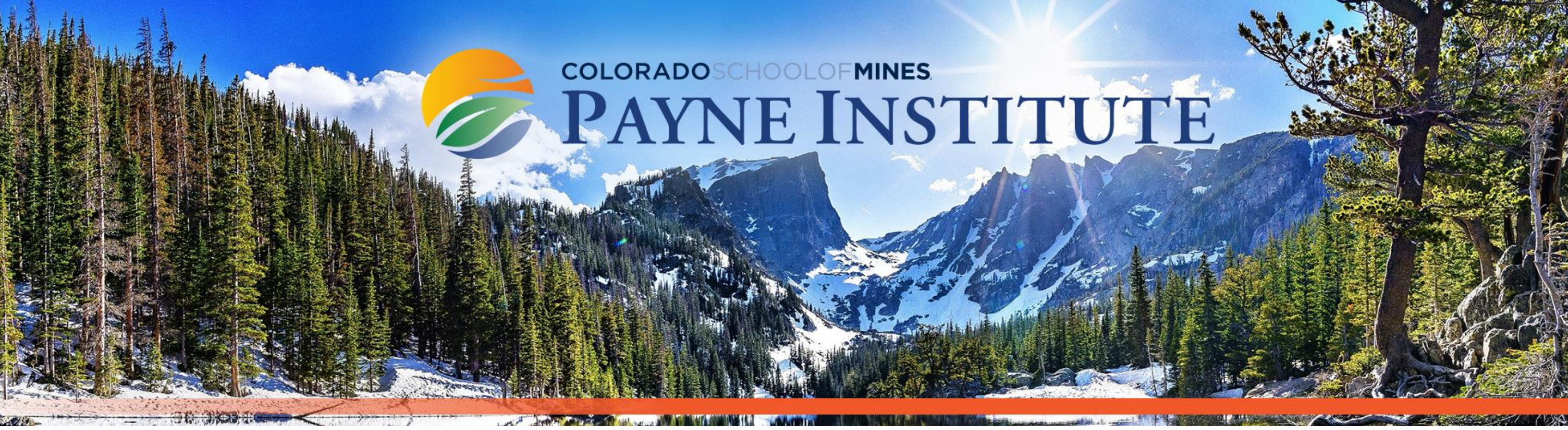

SUSTAINABLE FLOOD PREDICTION AND MITIGATION

PIRET PLINK-BJORKLUND

Why do floods pose a challenge?

Floods pose a major impact on society by loss of life, livelihood, infrastructure, agricultural lands, and water quality. Many floods are driven by meteorological events and thus linked to hydroclimatic conditions, such as rainfall distribution and intensity. Consequences of extreme weather events are intensified due to population growth, economic growth, urbanization and landscape disturbance. Extreme weather also appears to be growing more frequent across the United States and globally, and it follows that frequency, severity and duration of hydro-meteorological hazards will also increase. Thus, it is more essential than ever that we have the capability to deliver effective flood prediction and mitigation strategies.

What is the problem with current prediction and mitigation strategies?

- From the start of flood mitigation guidelines (e.g. USWRC, 1967), our ability to predict and mitigate floods has relied on 100-year flood scaling. According to this approach, mitigation structures are designed to the height of the 100-year flood inundation levels. However, the predicted 100-year flood scale is most likely not linked to actual 100-year recurrence intervals, as demonstrated in recent years with numerous 100-1000-year scale events occurring within a few months (see also Naylor et al., 2017; and the new USGS guidelines in England et al., 2017).

- This inundation or water level height is considered as the sole defining flood hazard (Sinha, 2009; Syvitski and Brakenridge, 2013; England et al., 2017) in all rivers globally, independent on their hydrological behavior. Yet only in some rivers, where floods build gradually, is the inundation height really the defining flood hazard. In other rivers, floods build instantaneously in response to meteorological events with an extreme increase in discharge and in water power that causes erosion of sediment and erosional damage to infrastructure. Rivers with different hydrology pose different flood hazards (Hansford et al., in review).

- Despite significant differences in river flood behavior, flood mitigation is globally approached by barrage (levee) and dam construction. Yet for many rivers, there is no evidence for appreciable flood moderation with such structures (Sinha, 2009; Syvitski and Brakenridge, 2013). On the contrary, these engineering structures, developed for one class of rivers, are likely to push other rivers close to their discharge capacity threshold, and allow even moderate meteorological events to trigger catastrophic floods, such as occurred in 2008 in Bihar, India (Sinha, 2008).

- The lack of hydrograph shape analyses is currently one of the main shortcoming in river discharge and flood analyses (Hirsch, 2017). Another significant shortcoming in flood prediction is related to the knowledge gap on how rainfall patterns (such as intensity, duration, amplitude) link to flood hazards, and how they differ in rivers with different hydrology (Hansford et al., in review).

- Under changing climate, extreme whether events become more frequent and more extreme, but we are currently unable to estimate how this affects river floods, because our current analytical methods return high uncertainties in longer-term changes and future flood trends (Hirsch, 2018).

What is a potential solution?

Develop a new river classification system based on river hydrograph shape, flood response and hydroclimatic drivers, to increase significantly the accuracy of flood prediction and effectiveness of flood mitigation. Using multiple data sources and data analysis methods, we can partition rivers globally into flood response types, and establish specific prediction, risk analyses and mitigation strategies and practices for each type. We can achieve this by developing new classifications for river behavior that account for flood response and a much more complete range of hydroclimatic drivers. These methods are not currently utilized, although prior pilot studies indicate their strength (Plink-Bjorklund, 2015; Davy et al., 2017; Joes, 2017; Hansford et al., in review). These methods can be applied to river discharge databases globally, and are especially applicable for the excellent US records. We can then analyze specific hazards associated with each flood response class and develop class-specific mitigation strategies and practices.

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