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Sedimentation from an extreme event along an intensively managed fluvial system: Summer 2021 flooding along the Maas River, Netherlands

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New field data are reported for overbank sedimentation generated by the extreme flood event of summer 2021 along the Maas River, an intensively managed lowland river in the Netherlands. Flood duration was short (3-4 days) but flood magnitude was extreme, the highest stage and discharge (3,2650 m³/s) recorded in more than 100 years.

Flood sediments were sampled at 108 sites from the NL-BE border to the delta (195-km distance) over a range of depositional environments, including artificial flood basins created for the Room for the River flood management program. Flood deposits were sampled in August and September using conventional field sampling procedures, which included identifying recent sediment deposited atop buried soil and organic layers using field texture and density, and differences in soil color (recorded). The modal Munsell soil color value for flood deposits and the darker underlying soil were brown (2.5 Y 3/2) and light olive brown (2.5 Y 5/3), respectively. Sedimentation thickness (mm) of each of the 108 reported values is an average of three individual thickness measurements obtained within a ~0.5 m radius at each field site. Minimum flood water height was measured by identifying silt and trash lines in vegetation and fencing at multiple locations and ranged from 3.5-m to 0.3-m above low and high floodplain surfaces, respectively. Particle size of 84 flood sediment samples was determined by hydrometer analysis and wet sieving.

Average flood deposit thickness was 21 mm, and varied significantly according to geomorphic setting: low floodplains (28 mm), high floodplains (6 mm), channel banks (31 mm), inset banks (11 mm), and flood basins (42 mm). Maximum sedimentation was associated with discreet sand sheets (295 mm). Floodplain stripping (erosion) at some low floodplain sites included reworking and deposition of large clasts (gravel, cobble). Pronounced lateral decreases in sedimentation thickness persists despite flood water height, and rapidly declines beyond about ~30 m from the channel bank. Lateral changes in particle size, however, are less abrupt, and along some reaches very fine sand was deposited to the distal margins of the embanked floodplain. Some laterally distant sites > ~200 m from the channel bank underwent high amounts of sedimentation (38 mm, 25 mm, 43 mm) with pronounced vertical fining (very fine sand to silt) of flood deposits associated with slackwater sedimentation within basins engineered for the Room for the River flood management program. In contrast to many prior sedimentation studies a pattern of downstream fining (along same geomorphic surface) does not exist, likely due to high stream power and

reworking of older channel bed deposits.

The overall thickness of the 2021 flood deposits are considerably less than reported for large flood events in 1993 and 1995. This may be due to the shorter duration of the 2021 flood event, as well as the persistent decline in Maas River sediment loads since about the early 1950s, as well as differences in sampling strategy. Study results are further contextualized by considering corresponding event-based discharge - suspended sediment dynamics as well as sediment province.