Floodplain Sedimentation

Investigating the Impacts of Floodplain Restoration on Flood and Sediment Dynamics in Urban River

FACTSHEET

Project area: *East Lents flood basin, Johnson Creek, Portland, Oregon, USA*
Intended readership: *Practitioners, academics, interest groups (floodplain restoration and management)*

Floodplains serve as a form of storage during high discharge in a river and can reduce downstream flood risk. In addition they also provide connections between habitats, provide safe refuge for fish and wildlife, and facilitate sediment transport and storage. Floodplains are generally lower energy environments and so sediment aggradation commonly occurs over time. This sediment trapping process will reduce the sediment loading in the main river. However, this process can also have a negative impact on the floodplain status. In urban rivers organic contaminants, heavy metals and pathogens generated from industrial and densely populated urban areas are attached to the fine sediment particles. As a result, floodplains can become a pollution hotspot over the period of sediment aggradation. Understanding the sediment flux dynamics in an urban watershed is important for river restoration and assessing the impact on the storage capacity of the flood basin due to long term sediment aggradation in the floodplain. These processes are commonly overlooked in flood risk assessments. The aim of this study was to investigate long-term sediment dynamics in the recently restored East Lents floodplain, Johnson Creek, Portland, USA, using a two-dimensional hydro-morphodynamic model.

Study Site & Methods

This study focuses on Johnson Creek, a tributary of the Willamette River (Figure 1). Johnson Creek is a highly urbanised stream known for frequent flooding and which contains sections that do not meet water quality standards under the U.S. Federal Clean Water Act.

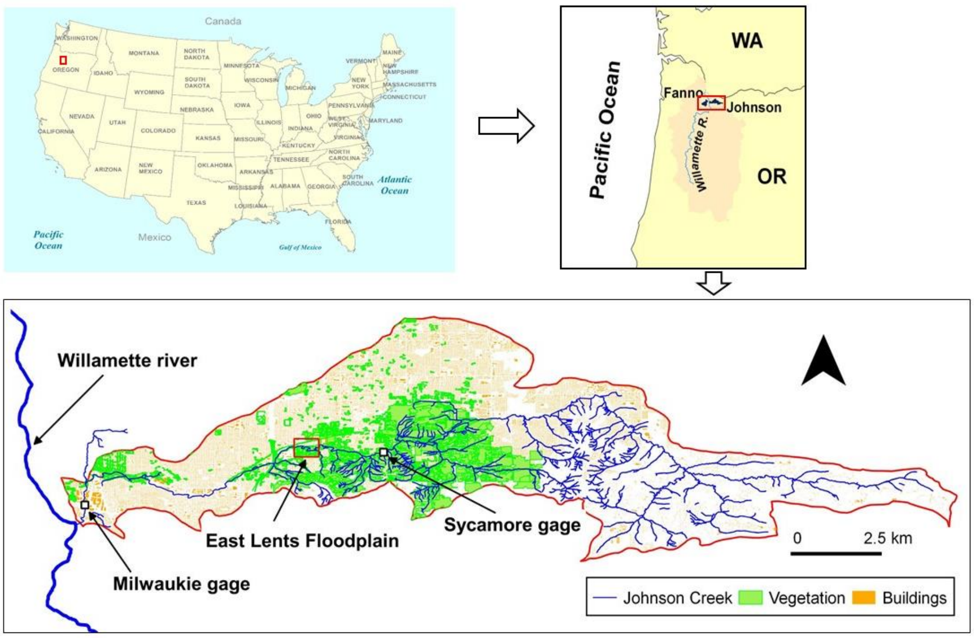

Figure 1 Johnson Creek watershed

Figure 2 East Lents flood basin

The study area comprises the East Lents reach, a downstream section of Johnson Creek, where the bank of the river has been reconfigured to reconnect the Creek to a restored floodplain on a 0.28 km^2 (28-ha) site to provide more space for the river to flow and be stored (Figure 2). Event-based (1:10, 1:50, 1:100 and 1:500 year) deposition modelling of flood events and long term modelling using 64 historical flood events between 1941 and 2014 were undertaken using a recently updated two-dimensional hydro-morphodynamic model (Guan et al., 2015) to investigate whether sediments from the watershed accumulate in the restored floodplain over a period of time or flush towards to the main Willamette River. Spatial variation of simulated sediment deposition of these events is shown in Figure 3.

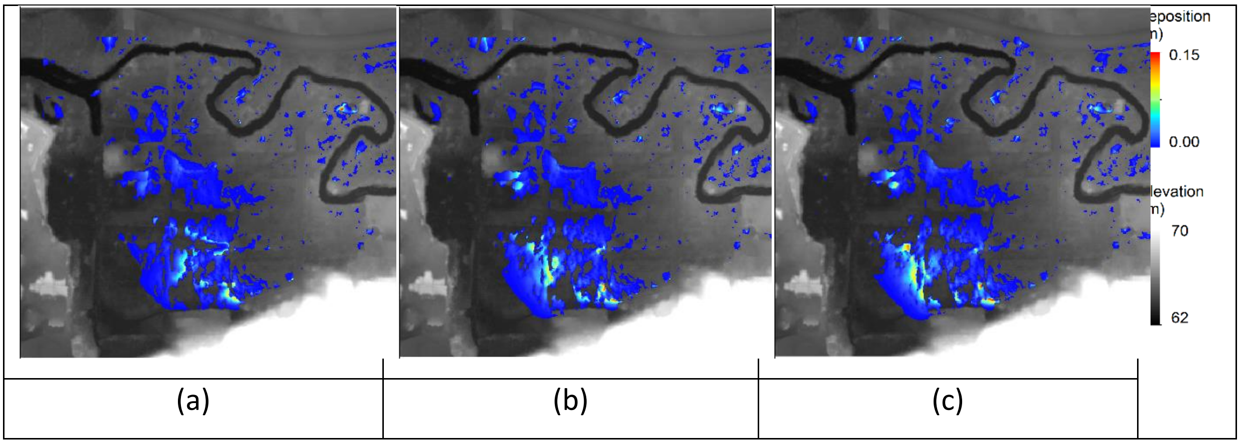

Figure 3 Sediment deposition for (a) 1:10, (b) 1:50 and (c) 1:100 year flood events

Key Research Findings

- **Flood peak attenuation**: Hydrodynamic simulation results indicate that the 1:500 year flood event (equivalent to flood peak discharge of 115 m^3/s) experiences a 28% flood peak reduction downstream (80 m^3/s – equivalent to flood peak discharge of the 1:50 year flood event). Thus, the common assumption that floodplain restoration is only effective up to medium flow events (1:50 year) does not always hold as it depends on a number of factors including system configuration of the flood basin and hydrograph characteristics.

- **Sediment trapping**: Hydro-morphodynamic results also indicate that ~ 20-30% sediment generated upstream is deposited in the East Lents floodplain. This sediment trapping considerably reduces the cumulative sediment loading into the Willamette River. However, as pollutants from industry and agriculture may be attached to the fine sediments, the East Lents flood basin could become a pollution hotspot over a long period of time.

- **Impact of sediment storage on flood attenuation**: At the end of the 64 long term continuous simulations, 2000 m^3 of sediment was deposited in the flood basin which is approximately 0.1% of the basin storage capacity. Hydrodynamic simulation shows that this sediment storage has very little impact on the total storage capacity of the flood basin and does not impact on the current flood attenuation.

- **Concluding Remarks:** Floodplain restoration projects should not only be driven by socio-economic drivers, they should also take into account the downstream effects and long-term impacts on the water and sediment systems. These types of numerical modelling studies will greatly increase the body of knowledge in floodplain restoration and may help managers better assess the time scale needed to determine whether a floodplain has been successfully restored. Download the accompanying paper (Ahilan et al., 2016).

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