Restoring Fluvial Corridors as a Fundamental Strategy to Buffer Hydrologic Impacts of Climate Change

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Climate Change Impacts
**Climate Change Impacts on Hydrology**

**Entiat River - 2080s**

- **Increases in Peak Flows**
- **Decreases in Low Flows**

Peak flows in Western WA could more than double
Low flows may decrease by 20%

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Climate Scenario A1B (moderate emissions), Entiat River near Ardenvoir
UW Climate Impacts Group (Hamlet et al., 2010)
at http://warm.atmos.washington.edu/2860/
Water Storage to Buffer Changes in Extremes?
 Restoration to Buffer Changes in Extremes

Resilient fluvial corridor →
Buffers peak flows and low flows

Cle Elum River Floodplain Reconnection Project post construction 2016, Central WA
Legacy Impacts
Legacy Impacts on Geomorphology

Log Jam on the Newaukum River, Chehalis Watershed, WA

Sediment Stored behind Log Jam
Sullivan Creek, NE WA

Slope Lower Behind Jam
Legacy Impacts on Geomorphology

Incision and widening on Big Beef Creek, near Hood Canal, WA
Legacy Impacts on Geomorphology

Peak flow increases in urbanized landscapes are well documented. Channel response is incision and widening.

Kelsey Creek, near Bellevue, WA
Legacy Impacts on Geomorphology

Incised channels reduce hydrologic connectivity

South Fork Chehalis River, WA

East Fork Corral Creek, Shea Meadows, ID
Legacy Impacts on Geomorphology

Incised & straightened channels increase downstream flooding & decrease hyporheic exchange

Existing Condition

Approximate Historical Condition

South Fork Chehalis River
Simplified Channels Will Increase Downstream Flooding

Anabranching Channel ➔
Increase capacity at high flows and increase velocity refugia

Ellsworth Creek, WA
Side channel and floodplain connectivity attenuate downstream flooding, conversely lost connectivity increases flooding.

14% reduction in peak due to floodplain attenuation, not accounting for increased flow from tributaries (12% increase in drainage area)
Conservation of large floodplain area along Otter Creek in Central Vermont played a major role in minimizing catastrophic flooding resulting from hurricane Irene in 2011.

56% reduction in peak due to floodplain attenuation, even with 51% increase in drainage area.
Legacy Impacts
+
Climate Change Impacts
Increased Streamflow -> Additional incision & widening

\[ \text{Depth} = aQ^b \]
\[ \text{Width} = cQ^d \]

Channel depth \((d)\) and width \((w)\) **INCREASE**
with increased streamflow \((Q)\)

(empirically shown - Regime Theory)
Wider Channels Will Degrade Water Quality

Wider channel -> Shallower flow & warmer water
Incised Channels Reduce Baseflows

Water surface elevation lowered with channel -> Drains groundwater
Lowering table reduces low flows and increases water temperatures

a. Existing conditions

b. Restored conditions

Restorable Alluvial Water Storage
Incised Channels Reduce Baseflows

Restoration of alluvial water storage → Summer streamflow

Sierra Nevada Stream Restoration Project – Tague et al., 2008
Restoring Fluvial Corridors for Climate Change Resilience
Restoration of Incised Channels

Re-Aggrade South Fork Nooksack Larson’s Reach
→ Reconnected Floodplain
Restoration of Incised Channels
Re-aggrade Toppenish Creek, WA
➔ Increase connectivity with wetlands and terrestrial habitat
Restoration of Incised Channels
Re-aggrade Toppenish Creek, WA
→ Increase connectivity with wetlands and terrestrial habitat
Restoration of Incised Channels

Re-aggrade Mission Creek, WA → Increase alluvial water storage

2 miles of restoration ≈ 25 acre-ft
Restoration of Incised Channels

Re-aggrade Mission Creek, WA →
Increase alluvial water storage

2 miles of restoration ≈ 50 acre-ft
Restoration of Incised Channels

Re-aggrade Mission Creek, WA →
Increase alluvial water storage

Preliminary cost estimates →

Widespread restoration is \[1/2 \text{ to } 1/10\] the cost of reservoir storage, not including multiple benefits
Restoration of Incised Channels

Re-aggrade Sullivan Creek, WA
→ Re-initiate large wood recruitment
Restoration of Fluvial Corridor

Resilient fluvial corridor

¬ Stores water, wood, and sediment
¬ Buffers peak flows and low flows

Cle Elum River Floodplain Reconnection Project
Thanks!
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