

Climate Change Effects on Restoration Projects: Lessons from Glen Canyon and Lake Champlain Basin

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Abstract

Climate change effects on Earth are prevalent and increasing. As restoration practitioners, we need to both recognize this reality and be able to respond to it with effective planning, implementation and adaptation of projects: both anticipated and completed. I examine two cases of restoration projects: one anticipated in Glen Canyon in Utah and Arizona, and another implemented on the Winooski River for water quality improvement and increased flooding amelioration in the Lake Champlain Basin, Vermont. While all restoration projects are specific to place, human, and natural characteristics, these two cases offer a broad U.S. representation of both climate change effects as well as management strategies for effectually thinking about restoration in complex and rapidly changing conditions. Environmental change will be the hallmark of the 21st century. As a result, restoration scope, planning, and implementation will need to shift towards this new reality. I examine changes in hydrology and resultant planning, needed training and education, changes in safety and user desires and needs for these systems, as well as effectively guiding restoration projects with a long-term perspective in the context of a rapidly changing planet to best support and sustain communities and their surrounding ecosystems.

Background

Extreme hydrological events are not new to experience, but the increasing frequency of both flooding and drought/aridity present challenges to ecosystem management, let alone restoration projects. Interdisciplinarity, cooperation, and adaptability will be indispensable for implemented restoration projects to best meet the needs of today as well as future needs. Ecosystems will be asked to provide stability, supporting human systems, and restoration projects will need to balance basin needs and a changing environmental context (Gourevitch *et al.* 2021). New frames, longer geologic/climatologic contexts, and education fames will need to support the understanding of dynamic ecosystems under 21st century climate change.

Winooski River in flood stage post-Tropical Storm Irene, August 2011



Utah/Arizona and Vermont Lessons Learned

Both ends of the climate change spectrum are important for determining lessons learned. Lake Powell saw historic low water levels in 2022/2023. The reservoir was less than 30% of capacity. In 1983, historic flooding caused structural erosion of the bedrock around the dam as the spillway was brought online. For Vermont, the Winooski River Basin has experienced historic flooding during Tropical Storm Irene and more recently with two unnamed storm events in July and December 2023. It was three 1930s era flood control dams constructed by the U.S. Army Corps of Engineers after the 1927 Flood of Record that protected the largest human populations in the largest river basin in the state. It is conceivable that Glen Canyon Dam will be removed within the century. 1930s flood control technology needs revisiting.



Glen Canyon Dam with Lake Powell at low level, July 2022

Extreme Ends of the Climate Change Spectrum

July 2022 Low Water Levels at Lake Powell



December 2023 Flooding of the Winooski River



For every 1.8 °F warming, the atmosphere can hold 7% more moisture (currently 2.3 °F warming). The Northeastern U.S. has seen a 50% increase in rainfall intensity for the largest storms (USGCRP 2018). Likewise, when increasing aridity includes temperature increases, this drying of the West is more about climatic warming— soil parching and increased evapotranspiration, and not just long term drought (Overpeck and Udall 2020).

Conclusion

- Envision a larger climate context than existed in the 20th century (Stroup 2011). Historical/Geologic regional ranges for climate are better analogs to move forward under climate change.
- For restoration this is true as well. Rivers gonna do what rivers gonna do, and water resources are adjusting to the new climate, even if we as humans place limitations and demands.
- Flooding will be more intense, more frequent and more dangerous for several reasons: 1) a new climate 2) false familiarity 3) techno-optimism delaying adaptation.
- Move out of flood plains (they are larger now) and understand that anything in new floodplain is fair game to the river.
- New models acknowledging both environmental/human change in these basins, and that increasing aridity and flooding are likely, will result in more sustainable restoration projects.

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