Prioritizing Pennsylvania Dams for Potential Removal

Introduction

Dams provide a potential benefit society by serving various important roles such as generating hydro-power, supplying drinking water, and minimizing the risk of floods; however, these benefits can come at a cost, as they frequently cause harm to the natural flow of rivers and to local ecosystems. Furthermore, many dams are old and no longer perform their initially intended functions.

Dam removal projects are growing in popularity throughout the United States, as awareness of the positive benefits becomes more widespread. Some of these benefits include the reduction of pollution and sedimentary deposition in watersheds, beneficial outcomes to ecosystems, as well as increased safety and recreational opportunities for fishing and wildlife enthusiasts. 2017 saw the removal of 86 US dams, and Pennsylvania led the nation with 16 dams removed [1].

Assessing dams for removal is a comprehensive task due to many social, ecological, and hydrologic factors to consider. A GIS based approach was developed to assess some of the main factors to be considered in prioritizing dam removal in Pennsylvania.

Methods

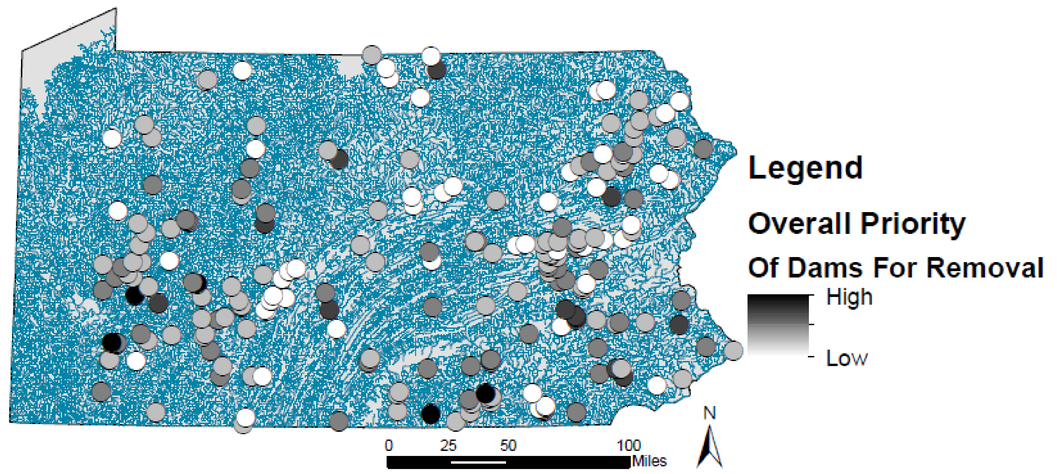
Purpose (map 1): The purpose of each respective dam was obtained from the National Inventory of Dams (NID) point data produced by the U.S. Army Corps of Engineers [2]. Purposes were weighted between 0 and 1. Attributes such as "hydroelectric" and "water supply" were ranked 0(low priority) and attributes such as "tailings" and "other" were ranked 1 (high priority) while "recreation", "irrigation", etc. were ranked in-between. This largely assessed the social weight of Pennsylvania's dams.

Pollution (map 2): Pollution data was obtained via a shapefile from the Pennsylvania Department of Environmental Protection (DEP), identifying sources of pollution and excessive pollutant loads where water quality goals are not currently being achieved [3]. Sources of excessive pollution both of known and unknown sources were buffered by 50 meters. Dams were spatially referenced by intersection with these buffered pollution layers. Dams identified in regions with non-excessive pollution (outside of the buffered pollution areas) received a weight of 0 while unknown excessive pollution received 0.5 and known excessive pollution received 1.

Imperviousness (map 3): The percent imperviousness within each watershed was obtained from a raster file found on the National Land Cover Dataset [4]. Dams with imperviousness of 10% or less were given a 0 and considered healthy, whereas dams with imperviousness of 11% or more were given a 1 and considered likely to result in excessive runoff . The Raster was first reclassified in order to isolate the values within the desired percentage range, and then converted into a polygon such that it could be spatially related to the dams.

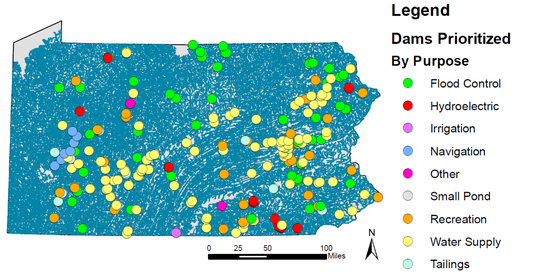
Anadromous fish (map 4): Stream flow velocity was obtained from the National Hydrography Dataset Plus (NHDPlus) and appended to the table of the hydrography layer such that the velocity of streams possessing dams could be determined with geoprocessing. The critical velocity for the spawning of American Shad and similar anadromous fish is 0.4m/s [5]. Thus, dams coinciding with velocities exceeding this threshold were considered suitable for anadromous fish as is and given a 0, while the other dams were weighted with a 1.

Social, Ecological, and Hydrologic Prioritization of Dams:

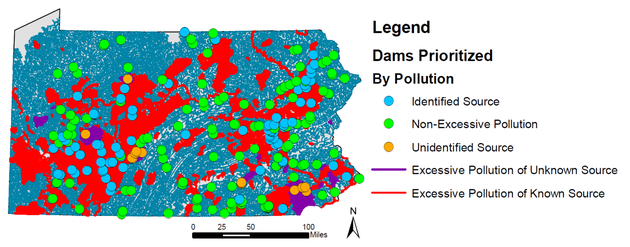


Map 5

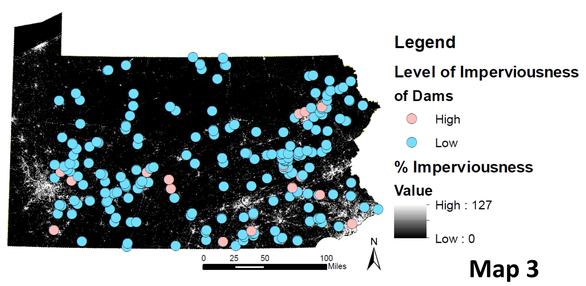
Four Criteria Used to Assess the Priority of Dam Removal :



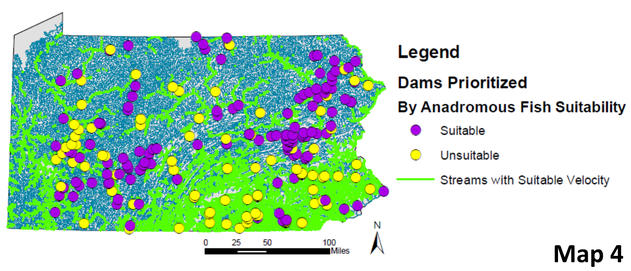
Map 1



Map 2



Map 3



Map 4

Results

Priority	Percent of Penssylvania dams
Low (<0.5)	25%
Moderate (>0.6<1.5)	43%
High (<1.5)	32%

It's worth noting that the majority of low priority dams were distributed across Pennsylvania's two main mountain ranges, the Allegheny and Pocono mountains. Higher priority dams, on the other hand, were concentrated closer towards the suburban regions of Pittsburgh and Philadelphia.

Conclusion

This GIS framework for prioritizing dams effectively assessed dams with respect to social, ecologic, and hydrologic metrics to ultimately obtain a comprehensive prioritization of Pennsylvania dams for potential removal.

The tool acts as an excellent preliminary screening tool for the large number of dams in the state however further assessment of these dams in the field and across additional factors—both general and site specific— would be necessary to ultimately determine the priority and feasibility of the removal of these dams.

References:

[1] https://www.americanrivers.org/2018/02/dam-removal-in-2017/

[2] http://nid.usace.army.mil/cm_apex/f?p=838:12

[3] http://data-padep-1.opendata.arcgis.com/datasets?q=Water+Pollution+Control&page=3&sort_by=relevance

[4] https://www.mrlc.gov/nlcd2006.php

[5] https://www.sciencedirect.com/science/article/pii/S0925857413005090

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