The Role of the Courts in Environmental Property Rights Disputes:

An Empirical Analysis of U.S. Army Corp of Engineer Dams

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Abstract

Federally managed dams are designated specific purposes in the legislation associated with their construction. Dams constructed and managed by the U.S. Army Corp of Engineers are typically focused on transportation and flood control, although they can have multiple other purposes including water supply for agriculture, hydroelectric power generation, and recreation. These purposes are often competing and some of them were added post construction. This research examines the use of the courts as a venue for defining property rights over dam services. A hazard regression identifies system characteristics that make a legal case regarding dam operations more likely. The analysis then considers how formally the USACE incorporates a new or altered purpose into their rule curves.

Introduction

Environmental resources have been, and will continue to be, highly contested all over the world due to their value to societies. The political and social conflict that result can be destabilizing with grave social, economic, and environmental consequences. Therefore, it is important to understand how the design of institutions tasked with managing environmental resources affects the overall level of conflict and its resolution. The myriad ways that individuals and groups representing various interests advocate for change can be difficult to observe. What can be observed is when a conflict results in legal action where one party sues an environmental manager. Lawsuits are expensive and, therefore, can be viewed as a conflict that has reached some significant scale. Constructing and analyzing a data set with variation in management and lawsuits can be used to test hypotheses about relationships between conflict and institutional design.

Federally managed dams are designated specific purposes in the legislation associated with their construction. Dams constructed and managed by the U.S. Army Corp of Engineers are typically focused on transportation and flood control, although they can have multiple other purposes including water supply for agriculture, hydroelectric power generation, and recreation. These purposes are often competing, and some are added post construction.

Dams provide value by retiming the flow of water in a river from a period of low value to high value. For water supply in arid regions, this typically entails storing up water during the wet winter season so that it can be used by industries like agriculture during the summer. Flood control benefits are provided by emptying the reservoir during the winter to provide space to hold back water during the spring when streamflow peaks. Considering just these two cases, there is a direct tradeoff between water supply and flood control. The optimal policy can be identified by characterizing and solving the constrained optimization problem. This is the process, with varying levels of complexity, that is followed when agencies like the USACE characterize operational rule curves.

Defining property rights over dam services entails characterizing the relative priority of the purposes. In our simple two purpose case, this is necessary to specify the problem formally. Both purposes could enter the objective function with weights. Alternatively, if flood control is given absolute priority over water supply, then flood control may enter as a constraint in the problem. Whichever case it is, if property rights are fully defined then there is no reason those with a particular interest would pursue legal action because it is costly and there would be no benefit from doing so.

This assumes that the rule curve, which is a type of contract, is complete in the sense that all potential states are known ex ante, and the actions to be taken in each state are specified. However, as is always true in practice, dam rule curves are incomplete contracts – the contract does not specify all actions under all potential states of the world – for multiple reasons. First, surface water environmental systems are highly complex, and it is not feasible to assume that all potential flow regimes are known particularly given climate change. Second, the political process that determines priorities over dam services is constantly evolving and changing. While legal precedence matters, it is also true that laws change in response to political advocacy that alters the relevance of previous decisions. Also, political action is affected by realized streamflow states and management decisions. Farmers experiencing lower water allocations due to flood control being prioritized may cause them to advocate for a change in priorities whereas they felt no need to take action in preceding years when they received full allocations.

While there is a widely held sentiment that conflict resulting from competing claims over environmental resources is costly and should be avoided, particularly when it results in legal action, it is possible that some environmental managers would invite being sued. Why? Being granted wide discretion to meet multiple competing objectives invites extensive political lobbying leading up to a decision and blowback from groups whose interests receive less priority. Handing off

This research examines the use of the courts as a venue for defining property rights over dam services. A hazard regression identifies system characteristics that make a legal case regarding dam operations more likely. The analysis then considers how formally the USACE incorporates a new or altered purpose into their rule curves.

“With regard to multiple missions, the USACE is a convenient target because of its responsibilities for multipurpose reservoir operation, comanagement of navigation channels, and environmental protection” (Grigg, 2020).

Legislative and Legal Background

The objective of this section is to describe the legal context within which Federal dams operate. Our motivation is to provide a basis for Grigg’s (2020) statement that designating dams as multipurpose inevitably leads to property rights conflict that will result in lawsuits. While this paper is focused on empirically testing this, we provide some background on whether lawsuits are costly and a sign of a poorly designed system, or if they demonstrate a well-designed system where interest groups have recourse to exert their property rights through legal action.

To consider the implications of designating multiple purposes for a dam, it is worth considering why Congress formally designates a purpose for a dam at all. An agency such as the USACE could simply be put in charge of operating a dam, making operational decisions as they see fit based on their expert judgement of the value of meeting a range of needs. Dam purposes are specified due to the legislative process in Congress that follows informal rules and practices that have evolved over a long period of time resulting from the authority specified in the U.S. Constitution granting Congress the “power of the purse” (Saturno, 2023). The key aspect of this is the two-step process of authorization followed by appropriation. The authorization step is a statutory provision – a law or regulation enacted by a government – giving the government authority to act. In the case of a dam, this is a description of the legal authority assigned to an agency, such as the USACE, to act towards specified objectives, or purposes. This is followed by the appropriation step where a federal agency is given budget authority to make payments for specified purposes. In other words, Congress follows standing rules, as opposed to bylaws that are more legally binding, that limit appropriations to purposes that have already been approved (Saturno, 2023). In short, it is necessary to specify purposes in order to receive budget authority.

A lawsuit may be based on either authorizing legislation or the Constitution of the United States. The Supreme Court of the United States (SCOTUS) has ruled that the Constitution does not oblige the government to provide social goods but does provide protections against government actions that cause harm (Grigg, 2020). The Fifth Amendment to the U.S. Constitution states within the Just Compensation Clause that the government may not take private property without just compensation (Cutting, 2001). The so-called Takings Clause has been paramount in the management of flood control dams. It can be the basis for a claim of liability (torts) or a taking. Liability rules apply when an externality causes harm whereas a taking has to do with a loss of private property. Both can be thought of as alternative approaches for enforcing property rights (Calabresi and Melamed, 1972; Guan, 2021), which can be compared from an economic perspective (Kaplow and Shavell, 1996). While the Takings Clause prohibits the government from causing harm, this negative responsibility does not provide grounds for suing the government for not having constructed a dam to eliminate naturally occurring flooding. However, Congress creates obligations for a federal agency in authorizing legislation specifying the construction and operation of a dam. This could provide the basis for a lawsuit if a party deemed them to not be met.

The main issue highlighted by Grigg's is that anytime that Congress creates a new affirmative responsibility for a dam it increases the likelihood of litigation if meeting it reduces the ability of managers to meet the demands of preexisting purposes under the Takings Clause. This is not a prima facie argument against tasking dam operators with meeting environmental goals, increasing diversions to farmers, or increasing hydropower production that reduce capacity for pre-existing purposes such as flood control. There is an extensive literature in both economics and law applying Coase's Theorem to consider alternative arrangements for compensation and bargaining in the context of ecosystem services and private property (Ruhl, Craft, and Lant, 2007, Ch. 4). It may be that tort or takings cases against the USACE are simply the process of determining compensation for injured parties representing interests associated with pre-existing purposes, but that the social benefits accrued from meeting the new purpose exceed these costs. Of course, litigation may be an inefficient means of determining compensation. A market or some other negotiated agreement could have been set up. It is a critical question going forward as to whether an alternative venue for bargaining and compensation can be arranged that is less costly than courts. That is outside of the scope of this paper. Our goal is to empirically verify that lawsuits are positively correlated with the number of operating purposes of a dam.

This section further explores the legal risks faced by the USACE and the scope of federal cases involving the USACE. The USACE has 51 offices in the continental US and a team of 500 attorneys to navigate their legal involvement. The primary legal vulnerabilities of the USACE reservoirs are environmental laws namely, NEPA the national environmental policy act, Clean Water Act, and Endangered Species Act. Flood and water management laws also pertain to the corps. Suits based on flood damage or water rights pertain as well. The USACE could be liable if negligence is the cause of flood damage or they create a water right conflict through improper allocation. Negligent discretion is a standing basis for legal action against an USACE operative. The Flood Control Act of 1928 grants a level of immunity to the corps which can be undermined by the presence of negligence. Determining the legal immunity of the USACE is incomplete in its precedence. The Supreme Court's decision of Central Green Co. v. United States (2001) ruled the scope of immunity shall be determined by an examination of environmental context in tandem with project purposes. The characterization of discretionary behavior in the context of rule curves as negligence is left to the judgement of the court system. The legal efforts required for a dam manager to defend themselves is externalized to a district or division and for this reason the quality of legal defense should be consistent across dams.

The merit of assessing legal vulnerability in many contexts pertains to contract theory. The norms of contracting with the USACE through their reservoir operating purposes presents transaction participants with incomplete contracts. To clarify incomplete contracts are contracts that do not specify actions for every possible contingency (Grossman 1986). Norms of business also imply a degree of contract ambiguity such that bargaining or a settlement of sorts may occur as a substitute for legal action (Hill 2009). Arguments for this style of contract design declare that for contract formation to proceed when an agreement over a spectrum of conditions is unlikely, it is necessary to deliberately embed obscurity into contracts (Hill 2009). This design which provokes judicial involvement is based on the probability of contingency materialization; in simpler terms, a dam operator that believes an event is unlikely will be less precise about that event in their contract. In this way our insight about case activity is instructive about the ways in which the USACE establishes their contracts.

However, the impact of deliberately obscured contracts is not clear. Such contracts invite litigation, and litigation is costly. When the USACE appears in court they bear an expense. Investing in contract design can reduce the enforcement burden of the court and reduce costs for all parties (Scott 2006). The tradeoff of upfront costly yet comprehensive contract design versus standard commercial frameworks at the risk of extended litigation persists for dam managers. The institutional norms and preferences of USACE contracting are ongoing in their development. Our study partially ascertains the standard of USACE contracting by evaluating the consistency or lack thereof of case resolutions and frequencies for water projects.

Understanding the reaction of dam management to case enactments strengthens the line of communication between environmental system managers and social planners. Perhaps dam operators invite lawsuits to make their own decisions easier in the long run. In the context of flood damages, determining if dam operations shift following litigation will enlighten the way our communities mitigate future flood risks. Ultimately, evaluating the efficacy of our judicial system to impact a self-regulated federal body, the USACE, is paramount to the maintenance of justice (Michael 1993).

USACE Operations

The purpose of this section is to establish a foundation of the functional variation within dam operations and the methods dam managers employ to design and achieve their goals. The oversight of these activities is internalized as the USACE is a self-regulating institution. The key operational purposes outlined by the National Inventory of Dams (NID) are: Flood Risk Management, Navigation, Water Supply, Power Generation, Irrigation, Recreation, and Fish & Wildlife Conservation. The USACE incorporates additional purposes beyond those in the NID: Water Quality, Low Flow Augmentation, and Other. A straightforward method of observing USACE activity at a project level is to observe the record of elevation and volumetric storage in a given reservoir. The USACE develops plans for the scheduled releases and accumulations of water in water control manuals and these reservoir attainment targets correspond to rule curves. A rule curve is a function which describes to the dam manager how much water to release over a period to attain a desired water level, also known as an operational target, given inflow data. In this way the rule curve prescribes water levels for the dam for the calendar year. The public nature of the rule curve means that dam stakeholders may form their expectations on water appropriation and flood risk from a rule curve. Dams are environmental systems without perfect forecasting and no dam has a perfect record of meeting its lifetime of operational targets. USACE operational guidelines tolerate deviations from their rule curves in a discretionary fashion, in some instances these deviations are even planned. The interconnectedness between operational target adherence and stakeholder expectations promotes the inclusion of reservoir behavior in our analysis. A natural preliminary research question is "Does court participation relate to future target adherence?" and the first step towards answering these questions is afforded by this research's effort to assemble a database of caselaw data.

Data

We construct a dataset to test hypotheses related to legal action on dam operations by constructing a database of case law pertinent to the USACE and dam characteristics. Two alternative sources of case law are Court Listener and PACER (Public Access to Court Electronic Records (pacer.gov). Court Listener provides a selection of content on cases based on information provided by PACER. For example, Court Listener includes the summary opinion but not the full decision transcript that is provided in PACER. We used Court Listener because of the cost of using AI tools to interpret full court decisions.

Court Listener is a web-based resource that includes both a database of case law and a batch search tool, as well as a search API. The query to retrieve relevant cases is a list of all USACE dam names, which is a batch search. This was done rather than "USACE" alone to avoid non-dam related cases involved the USACE. A single query creates a single JSON file, which is a format for text data that includes attribute-value pairs. For the court listener API JSON return, attributes assign specific fields to key values including case name, the court level and region, date filed, and a brief summary of the opinion called a snippet. The single JSON file can include information for multiple separate cases. To expedite searching, a batch search is used that automatically queries every USACE dam by name. A single JSON file is created for each individual search query. This process catalogs several unwanted cases. The nomenclature of dam names frequently references existing institutions, places, and people so many cases which contain the exact name of a dam are about something else entirely. To cut unwanted cases from the data cases are dropped if they don't contain key words "dam" or "USACE" or "army corps of engineers". Despite modest legal vernacular the opinion text is plain enough to understand establishing confidence the cases in our selection are relevant.

All of the JSON files are then merged and converted into a single comma separate values (CSV) file. The nine attributes in the JSON file are the column headings in the CSV file. This dam dataset includes redundancies since more than one dam can be involved in a single case. Each case has a unique docket ID value that is used to remove redundancies in the case dataset. A new column is then created called "dam involved", which takes the value of the relevant reservoir. The opinion snippet text data creates a series of dummy variables for relevant case law. Key word searching each snippet for "NEPA", "Clean Water Act", "Administrative Procedure Act", "Federal Power Act" and more create the basis for the context behind each case. The snippets are manually compiled through Claude, an AI evaluated to perform better than counterpart Chat GPT in terms of legal analysis (Stanford HAI 2024). The snippet is pasted at the end of a prompt designed to produce consistent outputs from the AI tool with explicit requests about if the case is related to the USACE, how many and which dams are involved in the case, which laws are relevant, and the case outcome. Based on the AI response irrelevant cases are dropped from the data set and cases involving multiple dams are appended to the dataset to reflect case enactment against more than one dam. The dam name is paired with its corresponding NIDID and the caselaw dataset is complete.

Following the collection procedure, the two resulting data frames at hand are the dam database and the caselaw database. From the caselaw database an aggregate summary of each dam's court participation is assembled by counting the occurrences of each dam NIDID. As each row represents a different case duplicate NIDID's represent repeat court participation of a given dam. This count of occurrence is appended to the dam database which creates our variable number of cases. From this count statistic a dummy variable is created in the dam database representing any legal involvement by having a value of 1 if the number of cases variable is greater than 0. A time statistic is needed for the survival analysis. The date filed variable in the caselaw database must be formatted correctly with "lubridate" prior to this step. The minimum function is applied to the aggregate summary to reveal the earliest case for each dam. With the earliest case recorded and matched to the dam database through NIDID the difference between the date filed and year-built variable is taken to produce a time to event statistic representing the age of the dam when it's first case was enacted. This variable is called years to case. The other variables created in the dam database are dummy variables for region based on the "division" column from our downloaded reservoir characteristics file. Each division is represented with a separate dummy variable and generated based on if the division string matches a given text. For example if the division string has a value equal to "SWD" then the southwestern division dummy variable is assigned a 1.

Aggregate target adherence statistics are calculated for key decades and the lifetimes of dams based on averaging target adherence by NIDID. The timing of the dams and legislation is important to consider which motivates the decade variable. The majority of dams were built in the 1930s through the 1960s. The federal power act is from 1920, the administrative procedure act 1946, NEPA was established in 1970 and the clean water act in 1972. There are 10 different flood control acts, 8 between 1936-1948, and the others in 1950 and 1965. Based on the above considerations key decades are the 1930's - 1970's which represent the major years of dam construction and legislation passage. The value of the key decade dummy variables are 1 if the dam was built in that particular decade. Target adherence is calculated as the difference between the recorded reservoir elevation and the target elevation normalized by the target. In this way target deficits are negative values and target deviation is proportional to reservoir size. Mean target levels are calculated before and after cases to see if the rule curve changes following cases. The remainder of the columns used as explanatory variables in the estimations are unedited from the reservoir characteristics file. These variables are the number of operating purposes and dummy variables for each purpose.

Summary Statistics

This passage describes summary statistics for both the reservoir characteristics which are time invariant dam level details and the caselaw database summary of information. The procedural dam name search yielded 247 federal cases involving the army corps of engineers and specific dams. Cases involving multiple dams picked up bureau of reclamation dams and even some dams which were never built, likely in part due to the case outcome. Restricting the dataset to dams with NIDID's recorded in our USACE reservoir characteristics data the case number drops to 232. Although there are 232 cases some dams face multiple legal proceedings and only 156 dams have cases or 29%. The maximum number of cases a dam in our set has faced is 5 with an average of .42 and a median of 0.

The summarization of reservoir characteristics starts here. The average number of operating purposes in our data is 2.81 with a maximum of eight and 30% of dams being single purpose projects. 68% of dams are flood control, 34% are navigation, 15% hydroelectric, 31% water supply, 37% fish/wildlife, 29% water quality, and 47% recreation. The average/median build date of our dams is 1958/1962 and start dates are 1973/1979.

The caselaw summary statistics are discussed in this section. During the case law data formation there was a keyword identification process for specific laws namely, NEPA, Clean Water Act, Administrative Procedures Act, Flood Control Act, River and Harbor Safety Act, and the Federal Power Act. Key words were also identified in the opinion snippet for the various operating purposes of the dams. If the opinion did not mention the purposes or specific laws the assignment of "other" is given to the case although these cases are known to be primarily maintenance/construction contracting disputes and land condemnation cases. The median case references 1 law with the maximum citation of 4 federal acts. Among them the most common combination of policies is Clean Water Act, Endangered Species Act, NEPA, and Fish and Wildlife. With this in mind 55% of cases have no identifiable legislation and are therefore “other”. The earliest and most recent cases are from March 1893 and October 2022 respectively. The mean/median cases are from 1981/1979. While the most historic dam in our data set was built in 1884. The distribution of cases across divisions is relatively mixed and generally representative of the whole reservoir distribution. Figure 1., the first pie chart, represents the caselaw division makeup and Figure 2, the second pie chart, the USACE division makeup. Another feature of the caselaw dataset is the record of which docket IDs involve multiple dams. 32 of the 162 cases or about 20% involve two or more distinct projects.

The temporal distribution of cases reveals consistent legal action against reservoirs with periods of concentration between the 60’s and 80’s and fewer cases in the past 20 years. The following chart, Figure 3, also demonstrates these cases occur throughout each USACE division and for dams with different purpose composition. There is a relationship between the division and the composition of operating purposes for USACE dams. Northwestern dams tend to have a greater degree of multifunctionality and the Mississippi river valley hosts more single purpose navigation dams.

Our time to event analysis describes the general likelihood of case enactment for the sample and is available as Figure 4. The estimation alludes to roughly 10% of dams experiencing case enactment within their first 15 years of operation. Our data explicitly includes seven dams where there was a case enacted in their first year of operation or rather the years to case variable has a value of 1. Our maximum value based from a 1884 dam with no case against it has a survival time of 140 years. The average years to case in our analysis is 23. The minimum time to case enactment is 1 year and the maximum time is 102 years.

In Figure 5. A treatment was applied to the survival analysis indicating single purpose dams where the value of the number of operating purposes variable is 1. Single purpose dams are not monolithic although there are trends. There are 165 single purpose dams 52 flood control, 106 navigation, 2 hydropower, 1 water supply, 2 recreation, and 1 other. The resulting survival analysis illustrates the untreated group, dams with more than one purpose, have lower survival rates or a higher estimated likelihood of case enactment. An alternate survival analysis for the sake of robustness was conducted which inverted the treatment group.

Figure 6. graphs the treatment group constitutes dams with 3 or more purposes and the untreated group single and dual-purpose dams. The purpose composition of the 100 dual-purpose dams maintains variety with approximately 70 flood control dams, around 30 of each hydropower, navigation, and recreation and the less common purposes making up around 10 of the other two purpose reservoirs. This secondary survival graph is consistent with the first demonstrating greater case participation for multipurpose dams.

Empirical Methods and Results

Court Opinion Analysis

The use of AI to assess legal documents has a tumultuous history. Large language models are prone to hallucinations and experts at Stanford have assessed multiple AI tools to evaluate their propensity to err. The researchers document several occasions of successful summarization and comprehension. Chat GPT has passed the uniform BAR exam, this is an impressive feat benchmarking the acumen of AI as of 2024. When coupled with prompt engineering tactics the use of AI to retrieve pertinent information on case resolution, case participants, and act relevance is possible. Lexis Nexis has been shown to hallucinate less frequently than GPT-4 (Stanford HAI 2024).

Responsible usage of AI tools for a replicable process is paramount to this study. We document a protocol for our prompt design. As a secondary precaution our final dataset processes the text data through different AI programs: Claude, LexisNexis, and NotebookLM to assess the result consistency. A manual sample verification is conducted to benchmark the accuracy of our methods and confirm case outcome veracity.

Hazard Regression frameworks and Count Data Models

The application of a general hazard regression model is our starting point. The Cox proportional hazard model is flexible and an appropriate baseline for evaluating the likelihood of legal enactment against USACE dams. A requirement of our specification is the inclusion of time dependent covariates, namely the level of target deviation and hazard models welcome this inclusion. The hazard regression for fixed covariates is straightforward in its application and for our case the fixed variables will be the operational purposes of a dam and its division. For our time-dependent covariate, target deviation we will need to specify a functional form of the variable's distribution. (Fisher 1999). Interpreting the predictive nature of target adherence on case enactment must be done in light of the assumptions about the way that target adherence interacts with case enactment.

A count data model to assess the number of cases a dam experiences in its lifetime broadens the scope of our analysis. Beginning with a negative binomial regression we can exploit the lifetime data availability of our USACE dam dataset to create estimates on court activity across a reservoir's existence. The implicit restriction of the Poisson model, which asserts the variance equals the mean of our distribution, makes the usage of the negative binomial a standard choice for our basic count data model (Greene 2007).

The empirical analysis consists of two parts. First, a hazard regression is estimated where the event is the filing of a case against the USACE. The unit of observation is an individual dam. This follows from the fact that the USACE is sued regarding their operation decisions at the dam level. A complication is that some lawsuits are made pertaining to multiple dams, or all dams within an entire basin. Poisson and negative binomial regressions serve as the baseline to the insight of the estimates. Natural independent variables are the number of operating purposes and the geographic division of the dam. In the two specifications one regression is simply a binary dummy for if there is a case "casedummy" and the other is a count of the number of cases for the dam "Cases". These regressions feature 537 observations. The objective of our empirical method is to understand the use of the courts in claiming property rights over dam services. The central hypothesis is management complexity, as measured by the number and type of purposes as well as environmental conditions correlates to greater likelihood of federal case enactment. The preliminary regressions assess the likelihood of case enactment represented by a binary dependent variable equaling 1 if the dam experienced a case. The explanatory variables are the number of operating purposes, dummy variables for each USACE division, and dummy variables for each key decade. The key decades are largely unrelated to the purpose composition of dams with the exception of the 1930's where 20 dams built are all navigation dams. The Poisson and negative binomial regression are functionally represented below and the tabular results are available in the appendix Table 1. and Table 2.

Count of Cases = ß*Operating Purposes + ß*FloodControl Dummy + ∑ßi(Division) + ε

CaseDummy (1 or 0) = ß*Operating Purposes + ß*FloodControl Dummy + ∑ßi(Division) + ε

The resulting estimation produces a statistically significant positive coefficient on the number of operating purposes indicating a positive relationship between dam multifunctionality and case enactment likelihood. Alternative specifications which explicitly include specific purposes like "Hydropower" produce statistically significant results suggesting hydroelectric dams are more likely to experience legal involvement. The estimated coefficient of our Flood Control variable indicates flood risk mitigation as a purpose is less prominent in federal USACE court cases. Lastly, each division is estimated to significantly impact case likelihood.

Following from the logic considered in the theoretical model, hazard regression permits testing of multiple hypotheses.

- H1: Lawsuits are more likely to occur for dams whose operations provide more discretion.
- H2: Lawsuits are more likely to occur for dams with fewer purposes.
- H3: Lawsuits are more likely for dams on river systems with greater interannual variability in streamflow.

Conclusion

Our result is partially inconsistent with our initial hypothesis. The negative statistically significant coefficient on flood control dams predicts flood control reservoirs are less prone to court involvement.

The first hypothesis asserts discretionary operations are positively related to lawsuits, while our measure for discretionary operations is imperfect, the analysis focused on flood control projects is particularly informative. Discretion is embedded into the operation of dams with multiple purposes as the managerial obligations may require conflicting water allocation. Flood risk mitigation is the operational purpose used as a proxy for discretion, as flood control operators face tradeoffs for this obligation even in single purpose projects. Flood control can be provided in two ways. Firstly, a reservoir can protect a floodplain against a sudden massive inundation by reserving space in their conservation pool for inflows. Alternatively, downstream stress may be relieved by a dam which gradually accumulates water but in doing so has less excess volume for a future inundation. Both methods are intentional ways of diminishing flood risk left to the discretion of the USACE. Our estimation result is inconsistent with our hypothesis as we found flood control dams have lower likelihoods of case enactment and fewer cases. Our measurement of USACE court success, where the judge finds in favor of the corps, is unavailable for the majority of cases and excluded from the central analysis however the suspicion that a historic propensity for USACE success in flood cases discouraging future cases prompted a preliminary analysis. We found no relationship between the likelihood of USACE prevailing and the keyword legislation "Flood Control Act".

Our results document a positive relationship between the likelihood of federal court participation and dam multifunctionality. The mechanism behind this result is likely based on the influence of multifunctional dams on property values. Knowledge of our sample cases informs us many hydroelectric court proceedings involve foregone utility profits. Another common archetype of case features land value degradation as a result of flooding or irrigation channels. Additionally, the burden of wildlife conservation applied to dams necessarily broadens the vulnerability of reservoir operators to certain legislation. Perhaps some combination of the aforementioned rationale renders our result inconsistent with our second hypothesis. Furthermore, from our estimation the division of the project is significantly correlated to case likelihood. There are several unaccounted factors that may drive this relationship. For one, several cases involve native/tribal land commendation, and these cases naturally depend on where reservations are distributed. Another force at play is extreme weather variability. Certainly, there is variation in projected streamflow forecast quality based on areas with snow melt expectations or volatile coastal precipitation which stresses reservoirs to varying degrees and influences flood risk. This quality is consistent with our third hypothesis. South Pacific dams had higher estimated likelihoods of case enactment and have high interannual streamflow variation. Another potential force is the wildlife circumstance which varies nationwide. Some of our cases involve endangered species protection and the geographical distribution of wildlife absent from the estimation.

Our data has specific limitations. Our identification process which ties legislation to cases is based on key words. The extent to which any given case marked as an environmental case is actually a matter of NEPA or the Clean Water Act is unknown. If a legal party motioned for consideration around these laws and the court found them inapplicable the key words would have been identified in our search. Our sample size is a limitation of the study. Although the search procedure was objective in its inclusion of cases undoubtedly some cases were missed. The small number of cases combined with the unavailability of reservoir measurements for the Great Lakes Ohio River Valley division prompted the exclusion of target deviation as an explanatory variable in the analysis. There are 537 reservoirs operated by the USACE and we have complete target and water attainment data either through elevation or storage statistics for roughly half of the dams. Halving our sample was an untenable decision.

Extensions

The dataset assembled primes a future research endeavor focused on the time varying managerial behavior of dams as it pertains to federal court involvement. The preliminary exercise conducted by this paper used lifetime target adherence as an explanatory variable and the estimate was statistically insignificant. One might think that a dam which deviates from its rule curve frequently and therefore subverts the expectations of is stakeholders would find itself in the courtroom more often. An alternative understanding would perhaps be that discretionary water allocation which defies the prescribed agenda within the rule curve avoids short run suboptimal allocation and delights stakeholders that would otherwise pursue legal action. The weakness of the lifetime aggregation is that it confounds the effect if any of the legal case on rule curve adherence with behavior prior to case enactment.

The second research opportunity of our future analysis examines whether a change in property rights over dam services resulting from a lawsuit prompts a change in rule curves or an increase in deviations from existing rules. A change in the structure of rule curves cannot be observed by reviewing the interannual operational targets variation as these levels are forecast driven in some cases. Determining a shift in managerial practices seems to require a review of the water control plans for each dam as these manuals are updated. This process is unautomated, and the materials inhabit a bevy of USACE sources.

A complete understanding of the judicial relationship to federally managed environmental systems would require our analysis to incorporate the Bureau of Reclamation projects into our study. We have already identified several cases which jointly involve the USACE and BOR but the search process didn't include the names of reclamation dams. A preliminary court listener search of BOR dams revealed the majority of cases are applied to entire projects rather than individual dams. This is consistent with our understanding of bureau dams coordinated basin wide management. Stakeholder conversations eluded to disparate attitudes towards court involvement across USACE and BOR managers. A data driven approach to analyze the variation in cases across the regimes is necessary to inform our understanding of the relationship between these agencies, the people, and water resources.

Appendix

Division Abbreviation Guide: NAD North Atlantic Division, MVD Mississippi River Valley Division, LRD Great Lakes Ohio River Division, SWD Southwestern Division, SPD South Pacific Division, SAD South Atlantic Division, NWD Northwestern Division.

Figure 1.
Pie chart representing the divisions of the cases in the data.

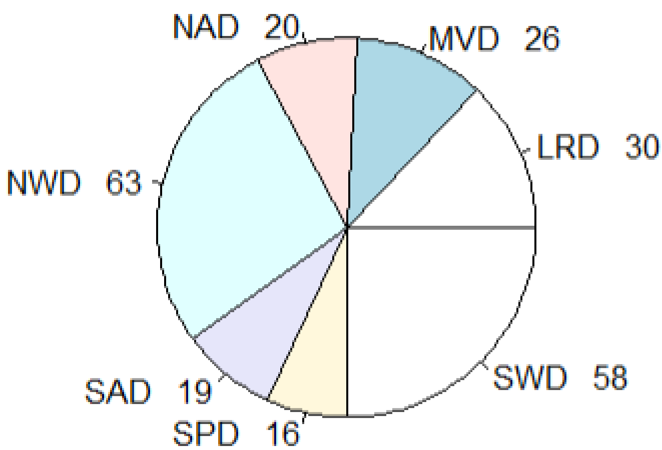

Figure 2.
Pie chart representing the number of dams in each division

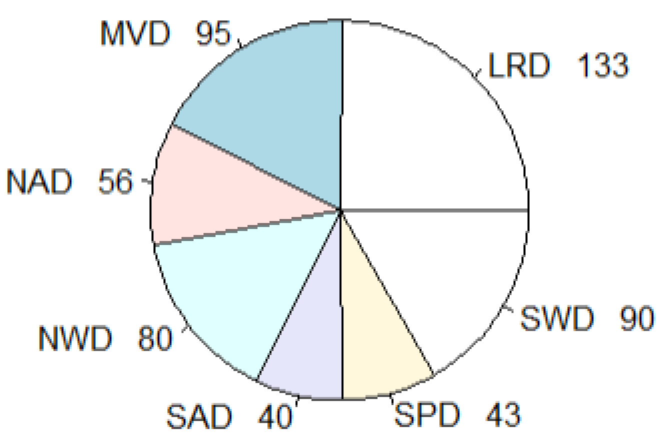

Figure 3.
Scatterplot of cases over time by division and number of operating purposes

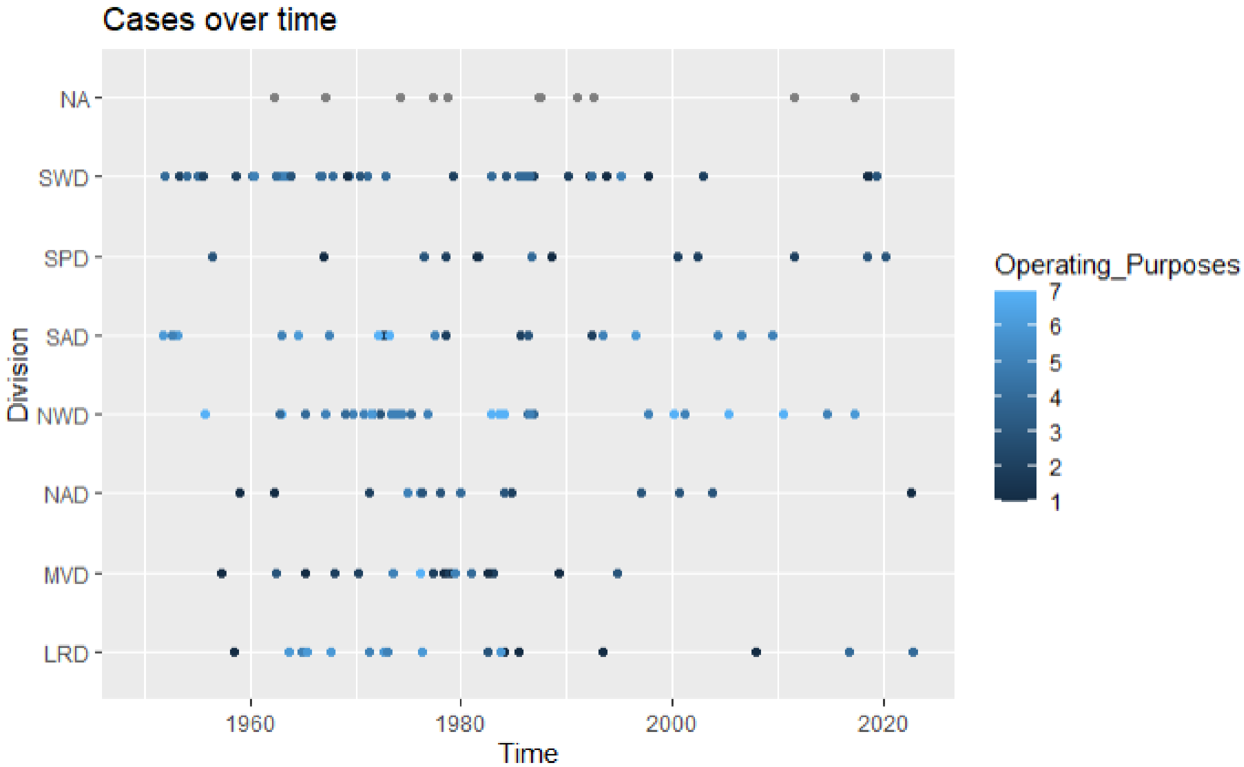

Figure 4.
Estimated survival for all USACE dams with no treatment where the event represents case enactment

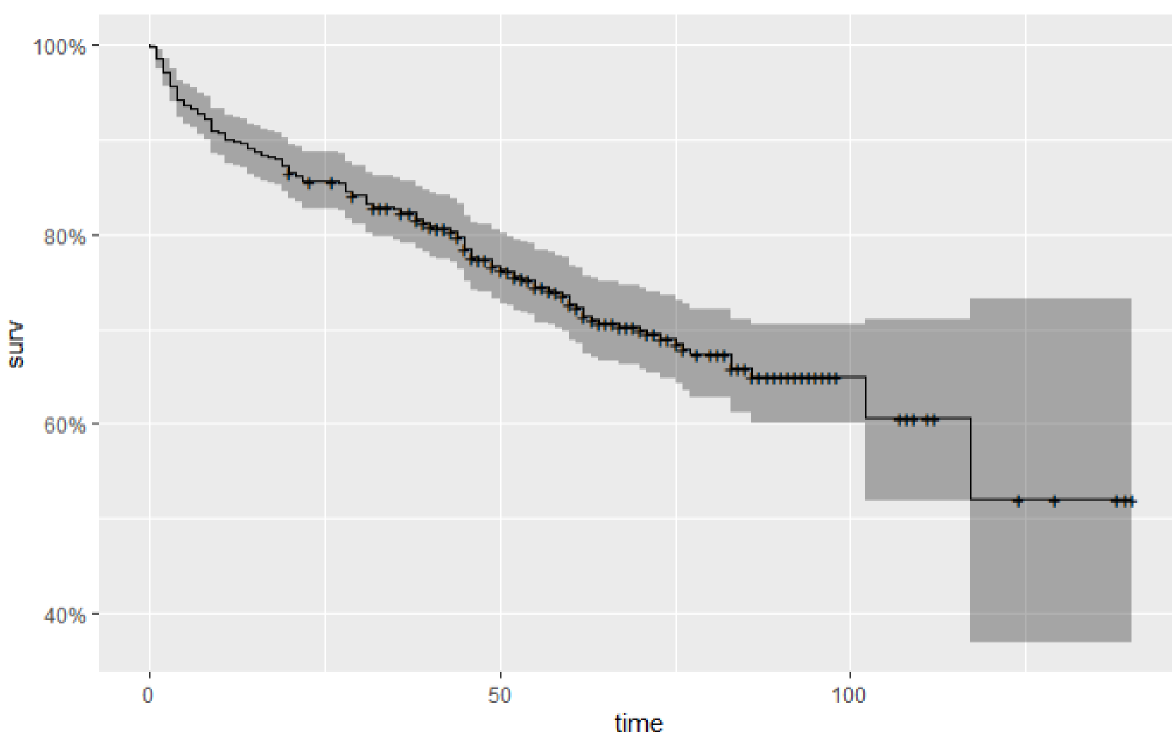

Figure 5.
Estimated survival for USACE dams where treatment =1 for single purpose dams.

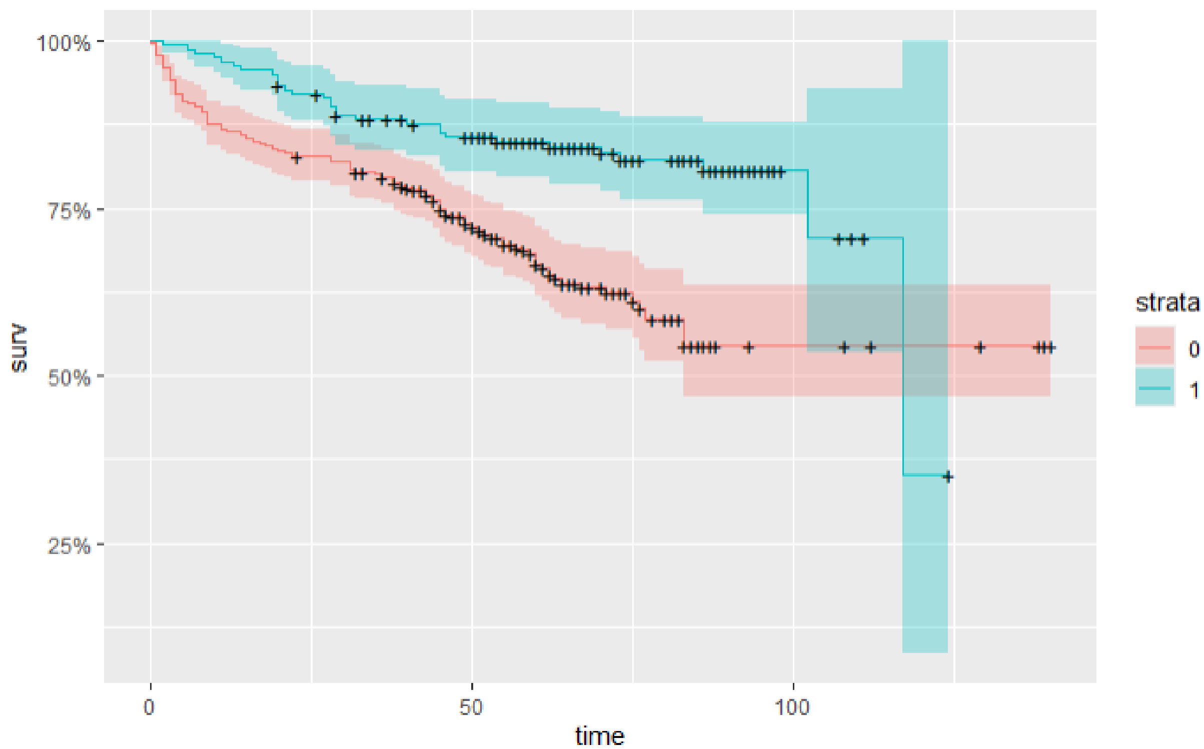

Figure 6.
Estimated survival for USACE dams with alternate treatment for dams with 3 or more purposes treatment =1.

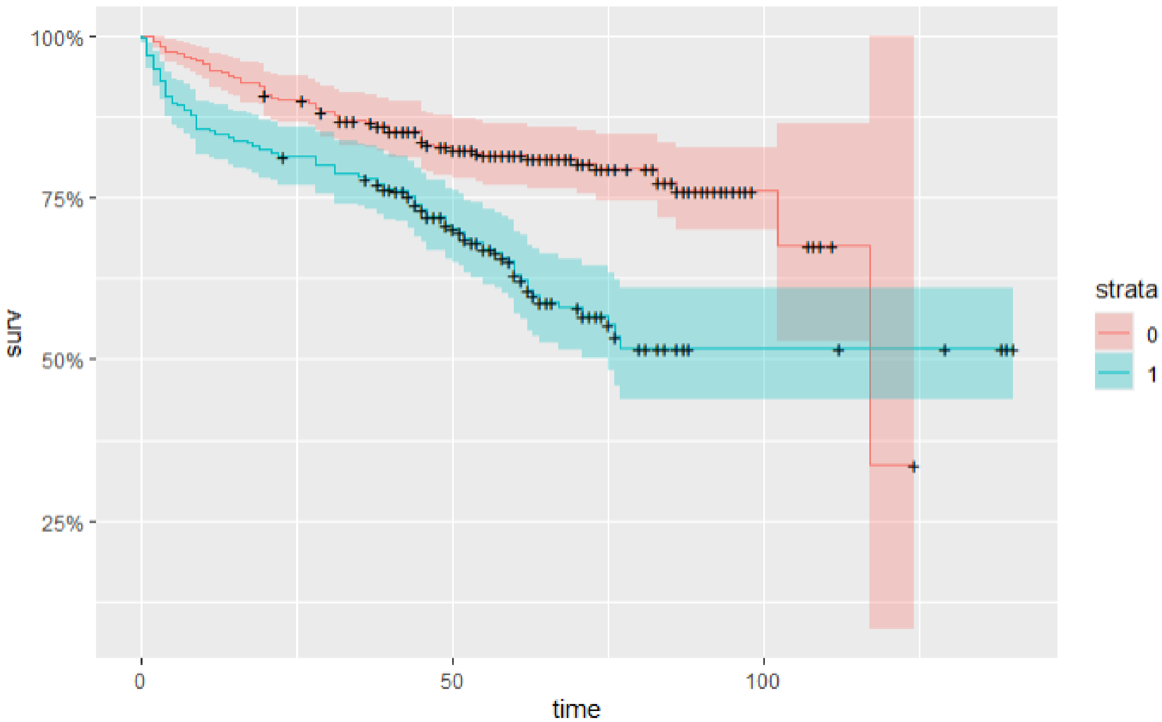

Table 1.
Regression Results for Poisson Regression where dependent variable is count of cases

Cases Poisson Model

	Dependent variable:
	Count of cases
Operating_Purposes	0.345***
	(0.046)
FloodControl	-1.015***
	(0.161)
SouthAtlantic	-1.623***
	(0.272)
NorthAtlantic	-2.064***
	(0.589)
Mississippi	-1.703***
	(0.221)
SouthPacific	-0.856***
	(0.275)
GLOR	-2.031***
	(0.222)
SouthWestern	-0.635***
	(0.167)
NorthWestern	-1.073***
	(0.222)
Observations	537
Log Likelihood	-423.254
Akaike Inf. Crit.	864.508
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 2.
Regression Results for Negative Binomial Regression where dependent variable is binary = 1 if dam has experienced a case

Case Enactment Negative Binomial

	Dependent variable:
	Any Case Enactment = 1
Operating_Purposes	0.235***
	(0.056)
FloodControl	-0.897***
	(0.192)
SouthAtlantic	-1.634***
	(0.323)
NorthAtlantic	-1.969***
	(0.594)
Mississippi	-1.790***
	(0.252)
SouthPacific	-1.066***
	(0.330)
GLOR	-1.900***
	(0.243)
SouthWestern	-0.808***
	(0.199)
NorthWestern	-1.141***
	(0.266)
Observations	537
Log Likelihood	-327.724
theta	6,542.650 (39,083.480)
Akaike Inf. Crit.	673.449
Note:	*p<0.1; **p<0.05; ***p<0.01

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