Developing Causal Map Codebooks to Analyze Policy Recommendations: A preliminary content analysis of floodplain management recommendations following the 1993 Midwest Floods

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Abstract

In July 2008, a congressional hearing was held to better understand the damages incurred during the Midwest Floods of 2008. In March 2009, the Army Corps of Engineers responded to a request made by Senator Boxer, who asked the Corps to report back on the status of the 97 recommendations made in Sharing the Challenge (1994). The codebook for analyzing recommendations helps answer a fundamental question asked by scholars and practitioners in policy analysis: Which recommendations are most likely to be implemented?

Policy recommendations in public policy venues provide a course of action by framing issues in ways that lead decision-makers to preferred solutions. This paper presents a codebook for developing causal maps of policy recommendations. The codebook's strengths and weaknesses are discussed as it is applied to a set of recommendations that were made to improve floodplain management in the U.S. By developing codebooks that are reliable, consistent, and transparent, the internal validity of causal maps constructed from qualitative data will improve substantially.

Keywords: flood mitigation, policy recommendation, public policy, codebook, content analysis, floodplain management, causal maps, causal loop diagram, issue framing

1 Introduction

Floodplain management policy recommendations made in public policy venues take on several forms, such as congressional hearing testimonies after a major event or solicited advice in reports provided by a task force (e.g., Sharing the Challenge in 1994). Strong policy recommendations frame issues in ways that lead decision-makers towards a preferred set of solutions.

The Midwest Floods of 2008 was a potential focusing event that shows despite efforts to mitigate damages, the United States is still vulnerable to flooding. Many of the areas affected in the 2008 flood had experienced flood damages in the Great Flood of 1993. After the 1993 flood, a task force was commissioned to develop policy recommendations to improve the nation's floodplain management in the United States. The resulting document, *Sharing the Challenge,* contained eight themes and 97 recommendations to change many aspects of federal policies on floodplain management. The Midwest Floods of 2008 sparked Senator Boxer to ask the Army Corps of Engineers to report back on the status of those 97 recommendations. The Army Corps of Engineers think tank, the Institute of Water Resources, took the lead on this fact finding mission and in April 2009, a status report was sent to Congress.

This paper presents a codebook for analyzing arguments that identify floodplain management issues and support recommendations for floodplain management alternatives. In this paper, I use qualitative data from the text in *Sharing the Challenge* to develop causal maps of the recommendations made in that document. I believe the characteristics of the recommendations may be used to predict their likelihood of adoption or implementation. The causal map codebook developed for this research is used to identify the connection between issues and solutions in this policy domain. Hopefully, the way in which data are coded using this codebook will improve consistency, reliability, and transparency in research that relies on qualitative causal mapping. Strengths and weaknesses of the codebook will be reviewed, as well as discussions about the future directions of this research.

## 2   Literature Review and Research Questions

In this section of the paper, I will illustrate a "feedback perspective" of a section of the natural hazards literature which deals with the policymaking process. Natural hazards scholars who study the policy process often present arguments in ways that resemble the concepts found in system dynamics. While no one statement or thought provides the basis for a complete causal map, the best scholars in the field often present arguments with the features of a closed feedback loop. As I reviewed the literature, I noticed some strengths and weaknesses in my approach, which prompted me to think about more precise ways for developing causal maps from a document or text. This feedback perspective of the academic literature illustrates three objectives: (1) establish a theoretical foundation for the analysis of policy recommendations in the study; (2) show how policy scholars (who may have no background in system dynamics) make elegant arguments containing feedback loops and system dynamics concepts; and (3) reveal a weakness in my prior approach to causal mapping. Objective three is the main focus of this paper, as my shortcomings have provided me with an incentive to develop a coding tool for systematically constructing causal maps from qualitative data. This coding tool is presented in sections three and four of this paper.

There are many important factors in the policy process literature that help scholars and practitioners better understand why certain policies are selected and others are not. Three of those factors include: policy windows, focusing events, and policy entrepreneurs. Since natural hazards are often viewed as potential focusing events (see Birkland 1997), it is important to explore how and why policies change over time and how these policy changes affect the damages incurred during future events.

2.1   *Policy Windows*

Kingdon (1995) and Polsby (1984) examined patterns of policy adoption and innovation in government. Kingdon's (1995) streams metaphor of the policy process describes conditions for policy change when the politics, problem and policy streams converge at a window of opportunity.

Figure 2.1 Window of Opportunity
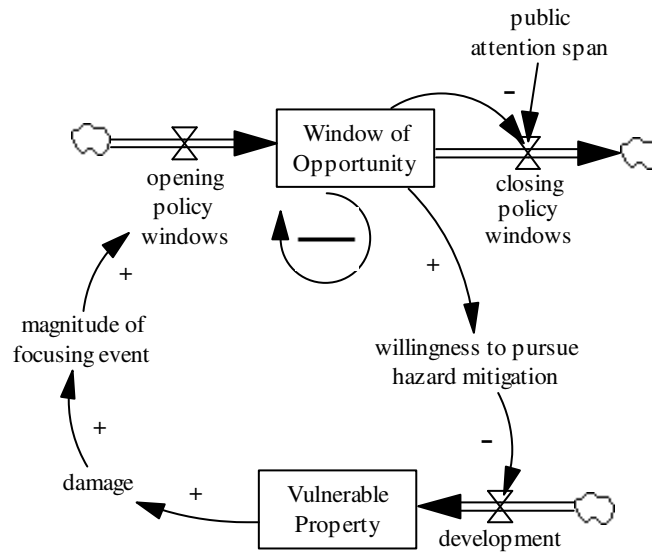
The author discusses how changing indicators and focusing events can be used to open the policy window. This theory has been applied by several researchers in a variety of policy contexts (see Rabe 1986; Birkland 1997). Mileti, Nathe et al. (2004) conclude that windows of opportunity can be used as an advocacy tool to increase hazard communication and public education. Very often the window of opportunity opens very briefly, which suggests that those who attempt to use the opportunity must be well prepared. Prater and Lindell (2000) suggest there should be well-developed policy alternatives and a clear strategy of action established even before the window opens.

2.2   *Focusing Events*

A major focusing event can open the window of opportunity for policy change (Kingdon 1995). In the case of hazard mitigation policy, this window usually occurs in the immediate aftermath of a disaster when the community is most receptive to policy changes. The window closes quickly, as the public's attention span is short and soon shifts to other issues. For example, Pennebaker and Harber (1993) reported that discussions about hazard mitigation following San Francisco's Loma Prieta earthquake virtually disappeared within three months of the event.

Figure 2.2 Disaster Knowledge
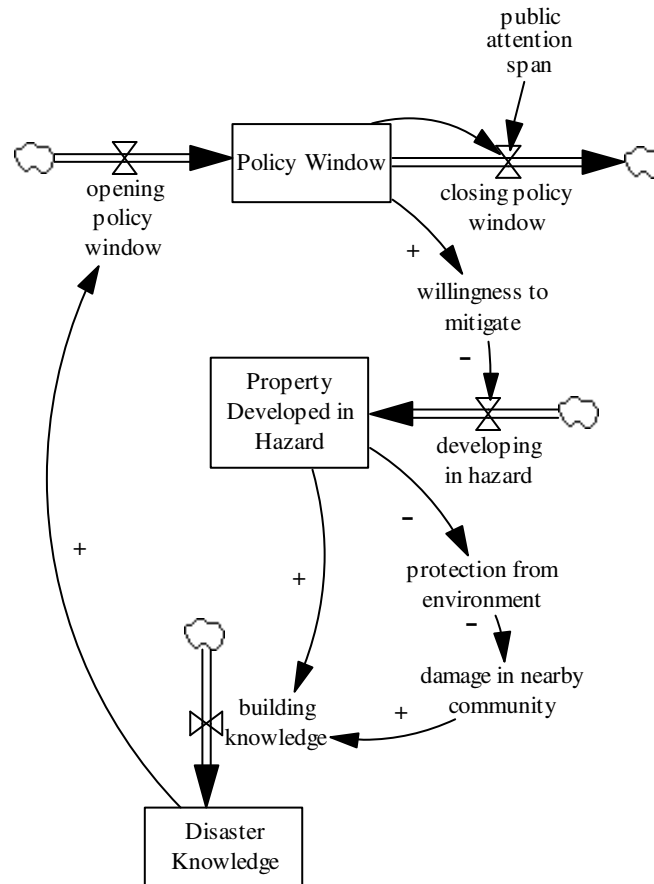
However, the recent experience of a disaster is a potential focusing event that can keep the issue on the agenda (Birkland 1998). An experienced disaster is a powerful way to start the policy process moving. Turner (1967) identifies circumstances where recent events influence decisions to take precautions and how organized support is most likely to take place. In a hazards context, the occurrence of an event (e.g., flood hazard) might be considered a focusing event if it can be used to increase advocacy for the adoption of policies to take precautions against future events (e.g., hazard mitigation policies). Prater and Lindell (2000) suggest that even a disaster that has occurred within a neighboring community, especially one that is perceived to be similar in its hazard vulnerability, can provide a very powerful agenda setting effect.

2.3 *Policy Entrepreneurs*

Not all potential focusing events become actual focusing events, nor do they guarantee policy change in all cases (Birkland 1997). The window of opportunity is facilitated by very important actors in system known as policy entrepreneurs. Policy entrepreneurs have expert knowledge in specific policy alternatives, as well as political expertise in the policy process (Kingdon 1995). They are able to use focusing events and changing indicators to maintain support on the agenda for their preferred policy alternatives.

Figure 2.3 Policy Entrepreneurs
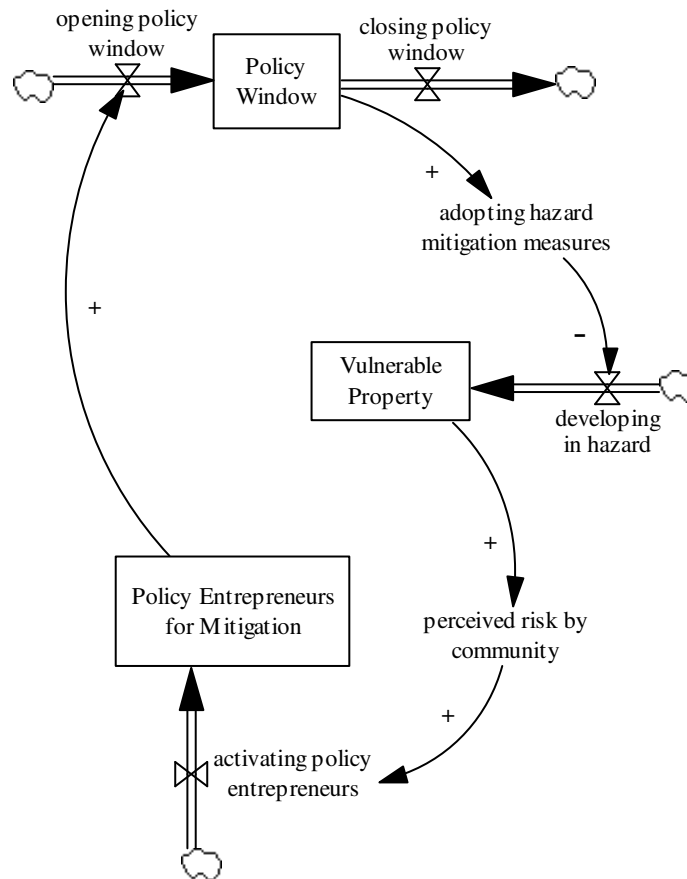
The adoption of hazard mitigation measures is associated with the presence of strong advocates who have access to policy makers and a high degree of legitimacy due to technical expertise, political power, or the prospects of longevity in office (Wyner 1984; Alesch and Petak 1986; May and Williams 1986; Berke and Wilhite 1989).

Policy entrepreneurs have been studied in a variety of settings. In the case of state coastal erosion policy, scholars have found that policy entrepreneurs who understood the technical research as well as the policy implications were able to change the direction of coastal management policy (Deyle 1994). For environmental programs, Borins (1998) found that environmental activists were valuable resources for policy entrepreneurs, as they explored market mechanisms for innovative policy changes to environmental programs. Meo Ziebro et al (2004) applied the Borins findings to their case study on Tulsa hazard mitigation policies. They found that successful outcomes were influenced by policy entrepreneurs who facilitated the interaction of political and nonpolitical actors.

The policy entrepreneur takes many forms and plays several roles in hazard mitigation policy design. They can be champions for safer communities, advocates who define the problem and maintain it on the institutional agenda, and people who mobilize support for preferred policies (Berke and Beatley 1992; Olson and Olson 1993). Roberts and King (1996) break policy entrepreneurs into five categories: policy intellectuals, political entrepreneurs, bureaucratic entrepreneurs, policy entrepreneurs, and executive entrepreneurs. Based on this description, the role of the public administrator comes into focus, as experts at government agencies have a long-

term interest in an issue and understands the efficacy of mitigation and prevention over strictly response and relief policies (Prater and Lindell 2000).

Policy entrepreneurs work on both sides of hazard mitigation policy design. Community planners and emergency managers with the necessary hazard knowledge could try to link mitigation policies to urban development and environmental issues that are of interest to neighborhood associations, particularly those who have become active in the aftermath of a disaster (Prater and Lindell 2000). In this way, technical specialists can exert upward influence upon policymakers my mobilizing a political constituency for more farsighted hazard policies (Lindell 1994). On the other side of the issue, there can be powerful interests who have policy entrepreneurs who promote solutions that do not include hazard mitigation. These entrepreneurs work to keep hazard mitigation off the agenda, defining the issue as a condition rather than a problem (Bachrach and Baratz 1962).

2.4   *Research Questions*

- Which issues and solutions are discussed by policy entrepreneurs when potential focusing events open a policy window?
- How are the connections between issues and solutions framed in floodplain management policy recommendations?
- What is the causal model (stated or implied) in the recommendation?

3   Developing the Codebook

The codebook developed for this research builds on existing system dynamics research, where qualitative data has been used to construct causal maps and system dynamics models (for examples see Luna-Reyes and Andersen 2003; Kim 2007). For my research, the task is somewhat straight-forward, as recommendations carry a logical structure which often identify causal relationships. A policy analysis report (e.g., Sharing the Challenge) presents the relevant issues and shows how solutions address each of the issues. In doing so, the analyst (explicitly or implicitly, by discussing indicators of the problem) identifies the causal map used in the analysis. In a public policy setting, the task is slightly more complex, but not impossible to achieve. Public forums allow advocacy groups to weigh-in on the discussion in venues such as: congressional testimony, court hearings, and administrative agency public comment periods. In the policy process literature, advocacy groups (and policy analysts to some extent) engage in issue framing, a strategy whereby a causal model (or issue frame) is identified by a proponent for a particular piece of the problem or solution. Issue frames can be viewed as pieces of a causal map. According to the person or group making the recommendation, they are, in fact, the most important pieces of the causal map. This research develops a codebook for constructing causal maps of policy recommendations. The method I suggest for this study is very similar to a content analysis, since there is a *source* who sends a *message* using a *channel* to a *recipient*.

3.1   Components of a content analysis

A content analysis contains four elements: a *source*, the person or group who produces a message; a *message* that contains distinct characteristics; a *channel* or venue in which the message appears; and a *receiver* or target of the message. The codebook developed for this research was used to analyze each recommendation as a message unit. Since there is only one document analyzed for this paper, the messages for the case study have only one source, the Interagency Floodplain Management Review Committee. The messages were made in a single

channel, the recommendation document, *Sharing the Challenge*. Technically, the receiver of every message was the Administration Floodplain Management Task Force, whose key members were the Associate Director of the Office of Management and Budget, the Director of the White House Office of Environmental Policy, and the Assistant Secretary of Agriculture for Natural Resources. However, upon further examination one sees that some recommendations were charged to the Executive Branch, some recommendations were charged to Congress, while other recommendations were charged to individual agencies.

- o Source = Interagency Floodplain Management Review Committee
- o Message / Channel = each of the 97 recommendations / the report, Sharing the Challenge
- o Receiver = Administration Floodplain Management Task Force

Those who study flood mitigation would agree that Sharing the Challenge was an influential document, whose recommendations were taken very seriously by the Administration Floodplain Management Task Force following the 1993 Midwest Floods. For this reason, I identified the Interagency Floodplain Management Review Committee's chairman, Gerry Galloway, as a policy entrepreneur in this policy domain. As the Corps put together its response to Senator Boxer, I developed a codebook to analyze the recommendations (i.e., messages) in Sharing the Challenge. It is my hope that the characteristics of the messages in this document can help us identify which recommendations are more likely to be adopted.

3.2 *Data Source, Unit of Analysis and Unit of Observation*

The data source for this study is *Sharing the Challenge*, a policy analysis report with 97 recommendations covering eight important floodplain management themes. The unit of analysis for this study is the recommendation. A recommendation is the argument in favor of a course of action, which identifies a connection between relevant issues and a proposed solution. The unit of observation for each recommendation is the *causal link* or *causal relationship*. There may be several causal links in a given recommendation. A causal link is an statement made by the source about the nature of a cause and effect relationship. At a minimum, a causal link will contain the cause variable, the effect variable, and the direction of the relationship between cause and effect. In addition, there may be information about the natural of the relationship, such as the linearity (or nonlinearity) between the cause and effect, as well as any delays between the cause and effect, both of which may result in important accumulations in the system.

3.3 *Coding Rules for Constructing Causal Maps of Recommendations*

The coding rules defined in this section of the paper include a series of steps for the coder to follow in sequence, as well as advice on how to address different types of language in the document. Ideally, it would be best to address each step in the codebook as a question, whose answer helps define the causal relationship. The coder should respond "not clear" in cases where a relationship is not clearly defined. Otherwise, observations should be coded and answers should be provided for each of the 10 rules in this codebook. There are two coding forms for this codebook. First, a hand drawn causal map should be kept for each observation (in this case, observation=recommendation). Second, a table, spreadsheet, or database should be maintained that transforms the causal map into its respective components.

The codebook designed for this research provides instructions for developing causal maps from documents and hearings with policy recommendations. The coding rules that follow

provide guidance in two ways: (1) instruction for coding causal relationships; and (2) instruction for identifying issues and solutions discussed in the recommendation. Here are the coding rules developed for this study.

<u>Coding Rules</u>

Section A: Causal Relationships

1. Read the recommendation carefully. Identify the recommended solution. Identify the arguments which support the recommendation. This step defines the boundary of the recommendation and provides evidence for the steps that follow.
   - **Directly quote the text whenever possible.**
   - Use brackets [ ] around any language that is not a direct quote from the source. Use these brackets sparingly – in a similar fashion as you would read a news article, use brackets to clarify a statement that makes reference to an earlier statement in the argument, when quoting out of context.
2. Divide the argument into segments for each cause and effect relationship.
   - Place a letter at the end of text which supports the causal relationship.
   - **Each argument segment provides evidence for a cause and effect relationship.**
3. Clearly identify the cause variable and effect variable. Variable names should be nouns, not verbs. **Variable names must be quantities could graphs over time.**
   - A causal relationship will be an explicit or implicit "if/then" statement.
   - The coder should be able to identify the units for the variable names. Soft variables, such as knowledge or willingness, are perfectly acceptable.
4. Identify the direction of the relationship (+ or -)
   - The direction of the relationship is positive if the statement explicitly or implicitly suggests an increase to X (cause) will increases Y (effect).
   - The direction of the relationship is negative if the statement explicitly or implicitly suggests an increase to X (cause) will decrease Y (effect).
5. Use the information in steps 1 through 4 to draw a causal map. Label the positive or negative relationship (i.e., the causal link) with the letter used to define the relationship in step 2.
   - *Provide evidence for the relationship by using direct quotes from the text.*
   - Highlight the text and mark the supporting quote with the same letter used to identify the causal relationship in step 2.

Steps 1 through 5 produce the causal map of the argument, as stated by the source. Save this causal map.

Section B: Defining the Argument - Issues and Solutions in the Causal Map

Review the extant literature on the policy domain, before the study. This will help understand how issues have been framed in the past and will support steps seven through ten.

6. Identify the causal links that make up the major issues discussed in the argument used to support the argument.
7. In the causal map, place a box around the major issues identified in the recommendation.
8. Identify a causal link between the solution proposed in the recommendation.

9. In the causal map, place a circle around each solution identified in the recommendation.
10. Under a new file name reproduce the causal map and close the feedback loops. The coder should use their existing knowledge of the literature to justify feedback loops.
    - Use dotted lines to link the cause and effect variables. Do NOT use capital letters to identify "new" causal links.
    - Use the literature to provide references for all links identified in step 10.

Table 1: Coding template for cause, effect, direction, and evidence of relationship

Causal link ID	Cause	Effect	Direction	Evidence
Observation 1A				
Observation 1B				
Observation 1C				

4   Discussion with a Coding Example

To illustrate how the text is coded using the codebook developed for this research, I have selected an example from *Sharing the Challenge*. Action 7.6 is a good example for a few reasons: (1) the argument to support the recommendation connects flooding with other policy domains; (2) there is excess information in the argument the coder must filter in order to identify the causal relationships; (3) with respect to the number of causal relationships used, the argument is not overly complex; and (4) the coder makes a couple of errors, which may help illustrate some challenges for any causal map codebook.

The following example will show how the codebook steps can be used to generate a causal map. The example selected appears in Chapter 7 of *Sharing the Challenge*, a chapter that focuses heavily on environmental impacts of flooding and flood policies. This example explains how the codebook steps are used and some challenges the coder may face during the coding process.

Step 1: Identify the recommended solution. In this document, the recommended solutions are clearly marked as sub-headers in each chapter. Thus, the task was rather straight-forward. However, in other documents the coder may have trouble defining the solution. The coder should look for language to describe a course of action that is intended to resolve an issue. As in Action 7.6, a solution provides direction on a course of action that should be taken to resolve an issue.

The coder would record step one as follows:

Action 7.6: Require agencies to Co-fund ecosystem management using Operations and Management funds

Step 2: Divide the argument into segments for each cause and effect relationship. There are three cause and effect relationships clearly identified in Action 7.6. The challenge for the coder in step two is determining how much information to include as supporting evidence for the causal relationship or merely to just identify those sentences. For this research, I decided to include supporting evidence, as this would help in another layer of analysis, coding causal links for themes. To be clear, the first or last sentence of the argument segment is not necessarily the

causal relationship. Thus, there will probably be some variation among coders on how segments of the argument are defined. Ultimately, the coder should define segments of the argument in a way that provides evidence to support a causal relationship.

The coder would record step two as follows[1]:

Construction of various federal navigation and flood control projects have impacted federal trust resources in many rivers of the upper Mississippi River Basin.3 Operation and maintenance of some of these projects continue to impact fish and wildlife resources and, in some cases, may accelerate those losses. **[A]**

In the 1970s and 1980s, concerns related to these impacts on the upper Mississippi River resulted in formation of cooperative interagency management efforts, such as the Great River Study,4 Upper Mississippi River Master Plan,5 and Upper Mississippi River Environmental Management Program.6 These programs, which address both development and natural resource needs, have resolved many interagency conflicts and problems. Across the upper Mississippi River Basin, though, federal agencies need to develop and implement ecosystem management plans. Especially on the Missouri River, such plans would help ensure protection of fragile ecosystems and address the needs of plant and animal species that are of inter-jurisdictional federal interest. Presently a funding mechanism to develop and implement ecosystem management plans does not exist. **[B]**

Action 7.6: Require agencies to co-fund ecosystem management using Operation and Maintenance funds.

Ecosystem management planning would document natural resource needs and identify actions that federal agencies can take to offset development impacts and enhance ecosystem sustainability. Funding for development and implementation of ecosystem management plans should be an annual standard component of each federal agency's operation/maintenance/construction budgets along with annual funding for development projects, which often impact the ecosystem. Funds should provide for participation of outside agencies and the states. Once costs of minimizing environmental impacts become a standard part of project costs, they can be reflected more closely in federal benefit-cost ratios. **[C]**

Step 3: Clearly identify the cause variable and the effect variable.
Step 4: Identify the direction of the relationship
Steps three and four will most likely be completed in close sequential order, as it is difficult for one to conceptual a causal relationship without thinking about the direction of that relationship. With that said, there will be circumstances when the direction of that relationship is unclear, weak, or nonlinear. Therefore, steps three and four are separate activities. In this example, the coder identified three argument segments in step two. In steps three and four, the coder's task is to clearly identify the causal relationship in each segment of the argument. Table 2 summarizes the three causal relationships in Action 7.6.

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[1] Appendix A1 provides the verbatim text of 7.6

As you can see in Table 2, the coder makes a few errors in step 3. First, a few of the variables are not expressed clearly as quantities. For example, the cause identified in causal link 7.6A, the cause is *operations and maintenance of federal navigation and flood control projects.* Phrased as such, the variable is at best a dummy variable and one could argue there is no possible graph over time for 7.6A. The cause identified in 7.6C, *using operations and maintenance of federal navigation and flood control projects,* is also poorly phrased. Can "using" be graphed over time? Perhaps yes, but another phrases, such as "level of", "number of" or "quality of" would be better suited in these circumstances.

Why did the coder make these mistakes? The mistakes were made because the coder was trying to maintain the "golden" rule in step 1, to use the source's words and directly quote the text whenever possible. In order to accurately represent the variable as a quantity, the coder runs the risk of making the variable less precise. The tension between precision and accuracy is an important issue and possible shortcoming in most codebooks. Should the coder change the wording of the text to transform a categorical variable into a quantity? I don't have the answer to this question, but I hope this paper generates some debate on the topic.

A summary of how the coder would record steps three and four (with "evidence" from step two) is provided in table 2:

Table 2: Causal Relationships for Action 7.6

Rec	Cause	+/-	Effect	Evidence
A7.6				
A	operations and maintenance of federal navigation and flood control projects	+	accelerated losses to fish and wildlife resources	Construction of various federal navigation and flood control projects have impacted federal trust resources in many rivers of the upper Mississippi River Basin.3 Operation and maintenance of some of these projects continue to impact fish and wildlife resources and, in some cases, may accelerate those losses.
B	upper miss river basin agencies developing and implementing ecosystem management plans	+	protection of fragile ecosystems and address the needs of plant and animal species that are of interjurisdictional federal interest	In the 1970s and 1980s, concerns related to these impacts on the upper Mississippi River resulted in formation of cooperative interagency management efforts, such as the Great River Study,4 Upper Mississippi River Master Plan,5 and Upper Mississippi River Environmental Management Program.6 These programs, which address both development and natural resource needs, have resolved many interagency conflicts and problems. Across the upper Mississippi River Basin, though, federal agencies need to develop and implement ecosystem management plans. Especially on the Missouri River, such plans would help ensure protection of fragile ecosystems and address the needs of plant and animal species that are of interjurisdictional federal interest. Presently a funding mechanism to develop and implement ecosystem management plans does not exist.

Rec	Cause	+/-	Effect	Evidence
C	using operation and management funds to co-fund ecosystem management	+	environmental impacts becoming a standard part of project costs so they can be reflected more closely in federal benefit-cost ratios.	Action 7.6: Require agencies to co-fund ecosystem management using Operation and Maintenance funds. Ecosystem management planning would document natural resource needs and identify actions that federal agencies can take to offset development impacts and enhance ecosystem sustainability. Funding for development and implementation of ecosystem management plans should be an annual standard component of each federal agency's operation/maintenance/construction budgets along with annual funding for development projects, which often impact the ecosystem. Funds should provide for participation of outside agencies and the states. Once costs of minimizing environmental impacts become a standard part of project costs, they can be reflected more closely in federal benefit-cost ratios.

Step 5: Use the information in steps 1 through 4 to draw a causal map.
Step 6: Identify the causal links that make up the major issues discussed in the argument used to support the argument.
Step 7: In the causal map, place a box around the major issues identified in the recommendation.
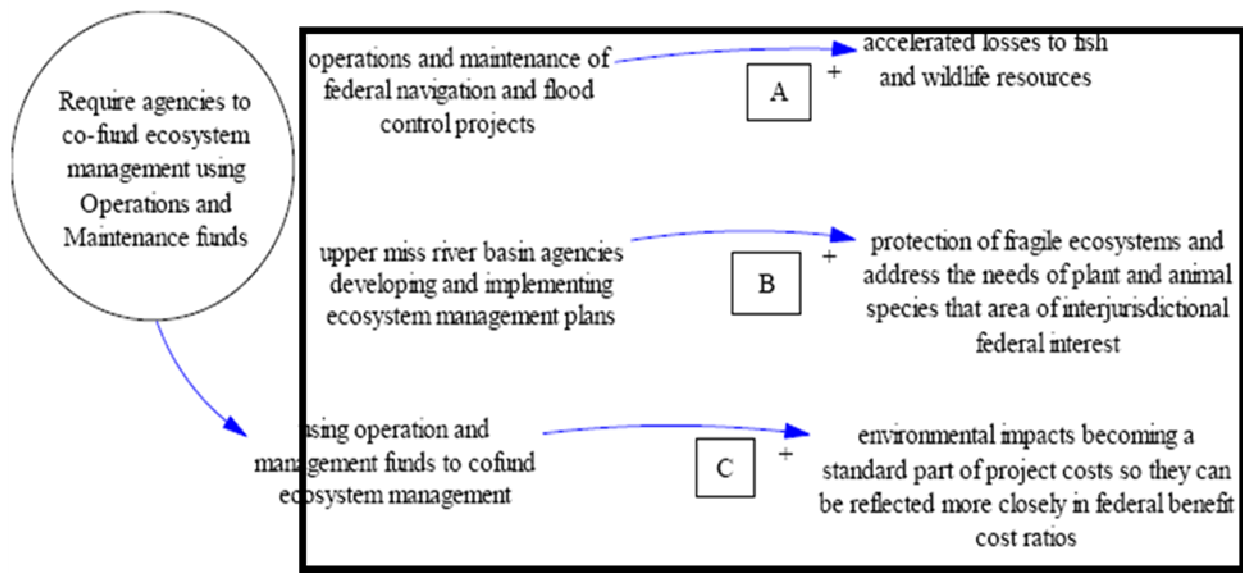Step 8: Identify a causal link between the solution proposed in the recommendation.
Step 9: In the causal map, place a circle around each solution identified in the recommendation.

After the arguments have been summarized in some format, such as the one shown in table 2, the coder maps the arguments either by hand or preferably with system dynamics software, such as Vensim. For Action 7.6, there are three causal links identified in the text and one recommended solution. The process is relatively straight-forward from here, as most of the work has been done in steps one through four. By constructing a causal map, we see the logic used by the source to "frame" the issue. I strongly believe the visual representation of this data provides a more elegant way of defining issue frames in public policy recommendations.

Figure 4.1 shows how the coder would use the information in steps one through four to record steps five through nine[2].

Figure 4.1: The Causal Map for Action 7.6

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[2] Step 10 is discussed briefly in the final section of this paper. Rules for closing the feedback loops will be the subject of the next paper.

Figure showing causal map with nodes A, B, C:

- "operations and maintenance of federal navigation and flood control projects" → (+) "accelerated losses to fish and wildlife resources" [A]
- "upper miss river basin agencies developing and implementing ecosystem management plans" → (+) "protection of fragile ecosystems and address the needs of plant and animal species that area of interjurisdictional federal interest" [B]
- "...sing operation and management funds to cofund ecosystem management" → (+) "environmental impacts becoming a standard part of project costs so they can be reflected more closely in federal benefit cost ratios" [C]
- Circle: "Require agencies to co-fund ecosystem management using Operations and Maintenance funds"

5 Conclusions

In my early research, I developed a conceptual model based on major themes in the public policy literature, such as Policy Windows, Focusing Events, and Policy Entrepreneurs. Arguments use elements of these and other important themes. However, very little empirical work has been done to show how arguments for recommendations can be analyzed to connect themes and arguments using elements of systems thinking, causal mapping and content analysis. This paper takes a small step in that direction by presenting a codebook, whose final product can be empirically verified and whose process is transparent.

As mentioned earlier, *Sharing the Challenge* contains eight major themes and 97 recommendations. Examples of coded data for each of the eight major themes in the document have been provided in the appendix. The reader can examine those examples to get a sense of the issues and challenges the author experienced as he developed the codebook for this study. A codebook needs to be precise, flexible, and accurate. I believe that a balance has been achieved for the purpose of the study identified in this paper.

6 Next Steps and Future Research

This paper argues in favor of using system dynamics concepts to construct causal maps from reports and hearings that contain policy recommendations. The codebook presented in this paper contributes to the system dynamics literature which uses qualitative data to build causal maps. The coding rules presented here provide a way to analyze and deconstruct the arguments made by experts and advocates. In addition, the coding rules provide a way to compare the reliability between coders to minimize the amount one must "read between the line" in order to produce causal maps. Hopefully, this paper will continue the discussion that leads modelers towards measures of inter-coder reliability.

With that said, there is much work to be done in the future. The next versions of the codebook will need to address other types of policy problems and types of data. The codebook

presented in this paper was designed to address a specific set of research questions. For this research, it was not essential to close all feedback loops, as the task was focused on how issues and solutions were framed. In the current version of the coding scheme, causal links with weak or no supporting evidence were allowed on the diagram as a dotted-line. This approach needs to be revisited. In future research the author needs to be more explicit about ways for closing loops when evidence is not clearly stated in the text.

Additional Coding: From causal map to system dynamics model & Coding Major Themes
1. Identify variables that appear frequently in the arguments. Then, determine which of these variables should be considered stocks in the model
2. Identify the strength of the relationship.
   - Record "not clear" if strength is not explicitly stated.
3. If one exists, identify nonlinearities in the causal relationship.
4. If one exists, identify delays in the causal relationship.
5. Coding for major themes: After all of the recommendations have been coded in one document, review the themes identified in the literature review. Code the issues and solutions for the relevant themes in the literature.

Table: Coding for strength of relationship, nonlinear relationships and delays

Causal link ID	Strength	Nonlinearity	Delays
Observation 1, A			
Observation 1, B			
Observation 1, C			

Table: Example with Recommendation 4.1

Causal link ID	Strength	Nonlinearity	Delays
4.1 A	Moderate	NA	NA
4.1 B	stronger when federal monies are limited	NA	over time federal monies have been limited
4.1 C	strength is relative to size of structural project	NA	NA

**Table: Themes in the Literature – Recommendation 4.1**

Recommendation	Causal Links	Issue or Solution	Literature Theme
4.1	A, B, C	Issue	urban centers at risk
4.1	D	Solution	defining vulnerability: standard project flood instead of the 1% flood

Next Steps: Example of Complexity
In Step 10, the coder creates a duplicate version of the causal map and uses their knowledge of the extant literature to close the feedback loops. The diagram below shows two

ways to represent the same argument made to support recommendation 4.1, which says "reduce vulnerability of population centers to damages from the standard project flood discharge and move from a 1 percent flood design standard to an SPF design standard." The diagram on the left is an exogenous view of the problem, where cause and effect variables are neatly separated from each other. The diagram on the right is an endogenous view (**step 10 in the codebook**) of the same argument.

Complexity in the Argument: Causal Map 4.1
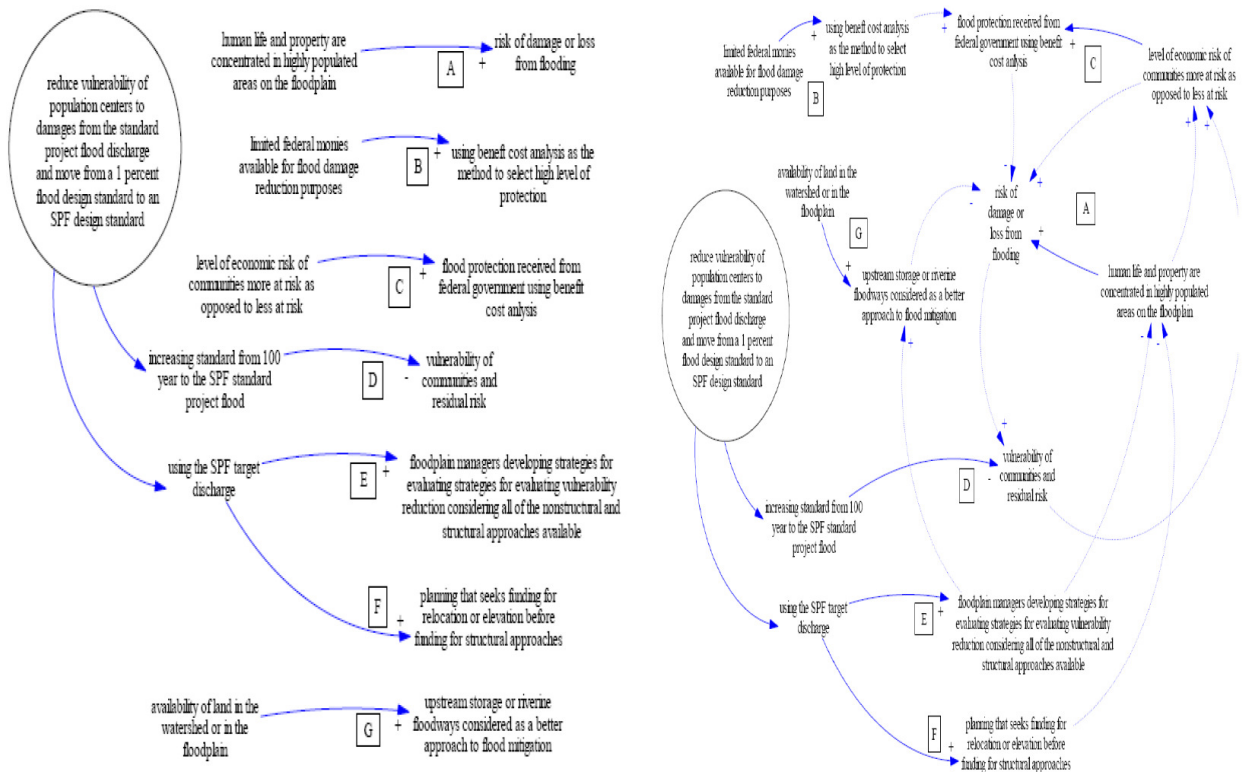
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Appendix A1: Direct Quotes from the Text to Support the Causal Map in Action 7.6

Require agencies to co-fund ecosystem management using Operation and Maintenance funds.

Before Rec:

USING O&M FUNDS TO MANAGE ECOSYSTEMS
Construction of various federal navigation and flood control projects have impacted federal trust resources in many rivers of the upper Mississippi River Basin.3 Operation and maintenance of some of these projects continue to impact fish and wildlife resources and, in some cases, may accelerate those losses. In the 1970s and 1980s, concerns related to these impacts on the upper Mississippi River resulted in formation of cooperative interagency management efforts, such as the Great River Study,4 Upper Mississippi River Master Plan,5 and Upper Mississippi River Environmental Management Program.6 These programs, which address both development and natural resource needs, have resolved many interagency conflicts and problems.

Comment [T11]: A

Across the upper Mississippi River Basin, though, federal agencies need to develop and implement ecosystem management plans. Especially on the Missouri River, such plans would help ensure protection of fragile ecosystems and address the needs of plant and animal species that are of interjurisdictional federal interest. Presently a funding mechanism to develop and implement ecosystem management plans does not exist.

Comment [T12]: B

As a matter of practice, agencies responsible for operating and maintaining major development projects should procure funding for representation and participation of other federal agencies in their major study and implementation efforts. The USACE-FWS Memorandum of Agreement for fund transfers related to Fish and Wildlife Coordination Act compliance makes such participation possible during the planning process, but no authority exists to transfer funds for support of post-construction ecosystem planning. Similarly no funding mechanisms exist for state or local participation in either the planning or post-construction phases of federal water resources development.

Action 7.6: Require agencies to co-fund ecosystem management using Operation and Maintenance funds.

Ecosystem management planning would document natural resource needs and identify actions that federal agencies

can take to offset development impacts and enhance ecosystem sustainability. Funding for development and implementation of ecosystem management plans should be an annual standard component of each federal agency's operation/maintenance/construction budgets along with annual funding for development projects, which often impact the ecosystem. Funds should provide for participation of outside agencies and the states. Once costs of minimizing environmental impacts become a standard part of project costs, they can be reflected more closely in federal benefit-cost ratios.

Comment [T13]: C