Evaluating U.S. Army Corps of Engineers water projects: aiding decisions with cost-benefit analysis

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Presented by: Tyler Davis and Julie Vano

Supervised by: Dr. Richard O. Zerbe, Jr. and Dr. Joseph Cook

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Water Center Seminar, Seattle, W.A.

Who are we?

- University of Washington, Evans School of Public Affairs
- Congressional Research Service collaboration, working with Betsy Cody and Nicole Carter
- Graduate course on benefit-cost analysis, transitioned into class focused on this CRS project

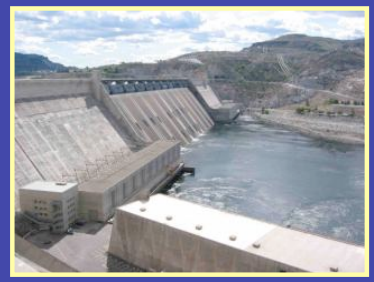
Why Now?

- Timely investigation, requests for revisions WRDA 2007
- Agencies that follow the Principles and Guidelines: U.S. Army Corps of Engineers, Bureau of Reclamation, Tennessee Valley Authority, Natural Resource Conservation Services
- Water managed for multiple purposes with limited federal funds

Municipal & Industrial Use

Irrigated Agriculture

Flood Control



Hydropower & Navigation

Ecosystems / Instream Flows

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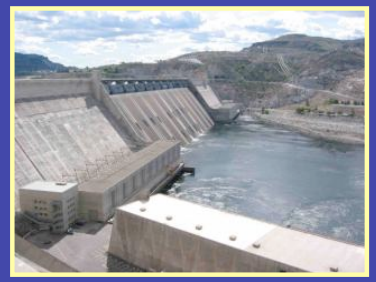

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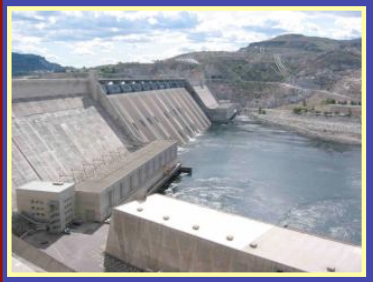


Hydropower & Navigation

Ecosystems / Instream Flows

Scope of Analysis

- Planning in the U.S. Army Corps of Engineers
- Criticisms and Revisions to the Principles and Guidelines
- Upper Mississippi Case Study

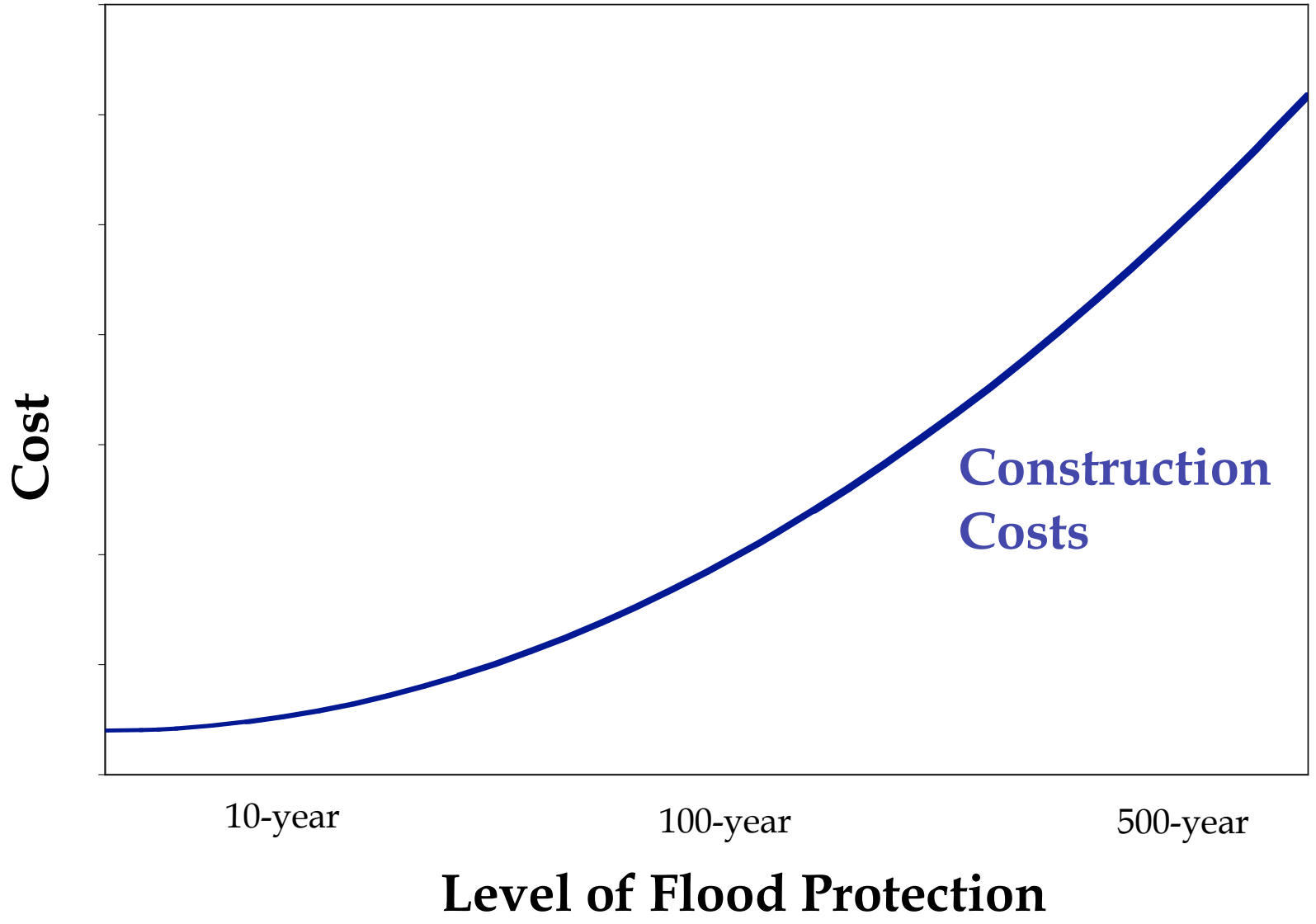
Photo courtesy of UMRCP final report.

Overview

1. What is benefit-cost analysis in water resource planning?
2. Why is benefit-cost analysis of federal water projects important?
3. How benefit-cost analysis relates to practices in the Corps?
4. How might benefit-cost analysis be improved in Principles and Guidelines?
5. What are special considerations for flood projects?
6. How were Principles and Guidelines applied to the Upper Mississippi Comprehensive Plan?

1. What is benefit-cost analysis in water resource planning?

Benefit-Costs Analysis in Water Resource Planning



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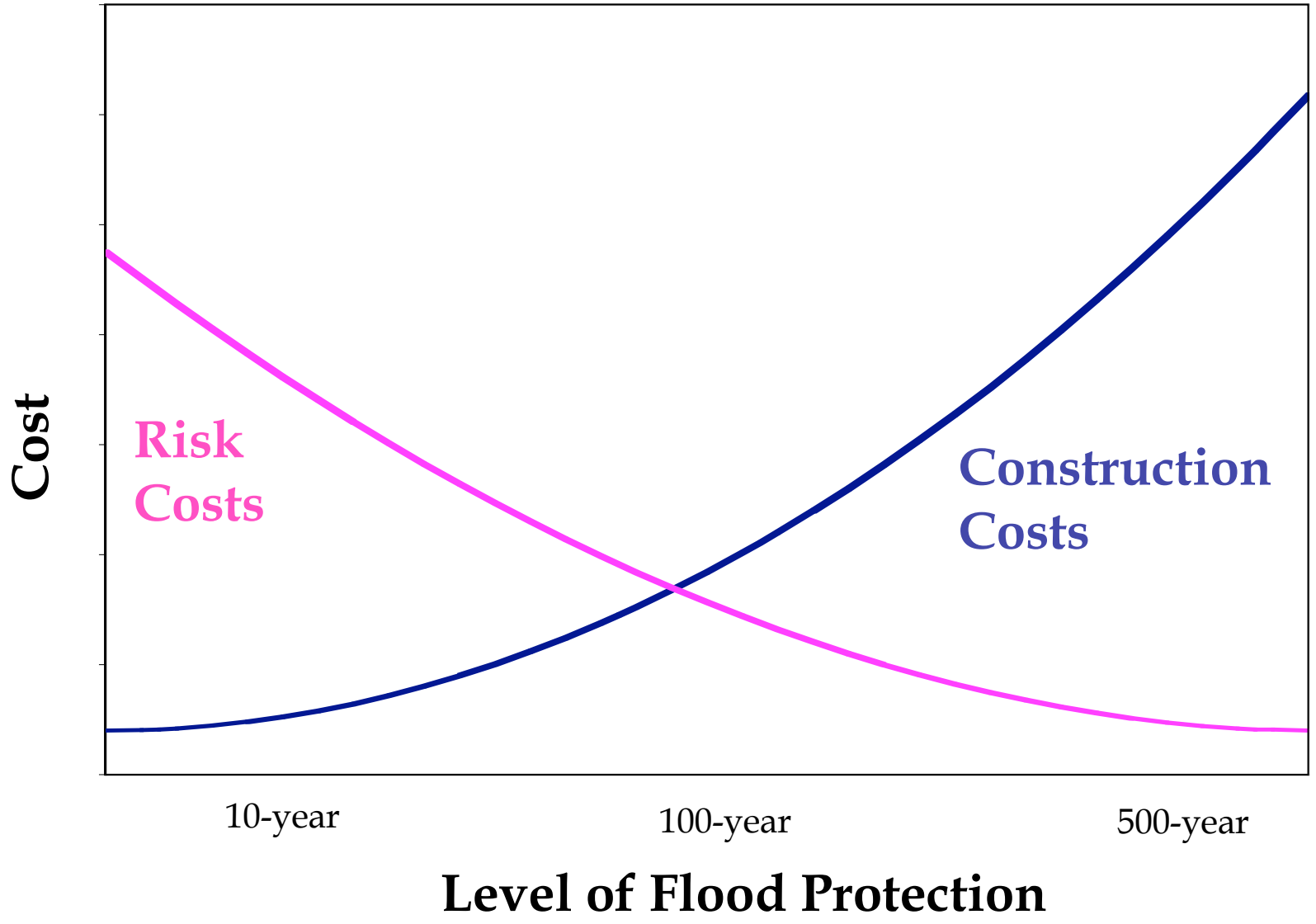

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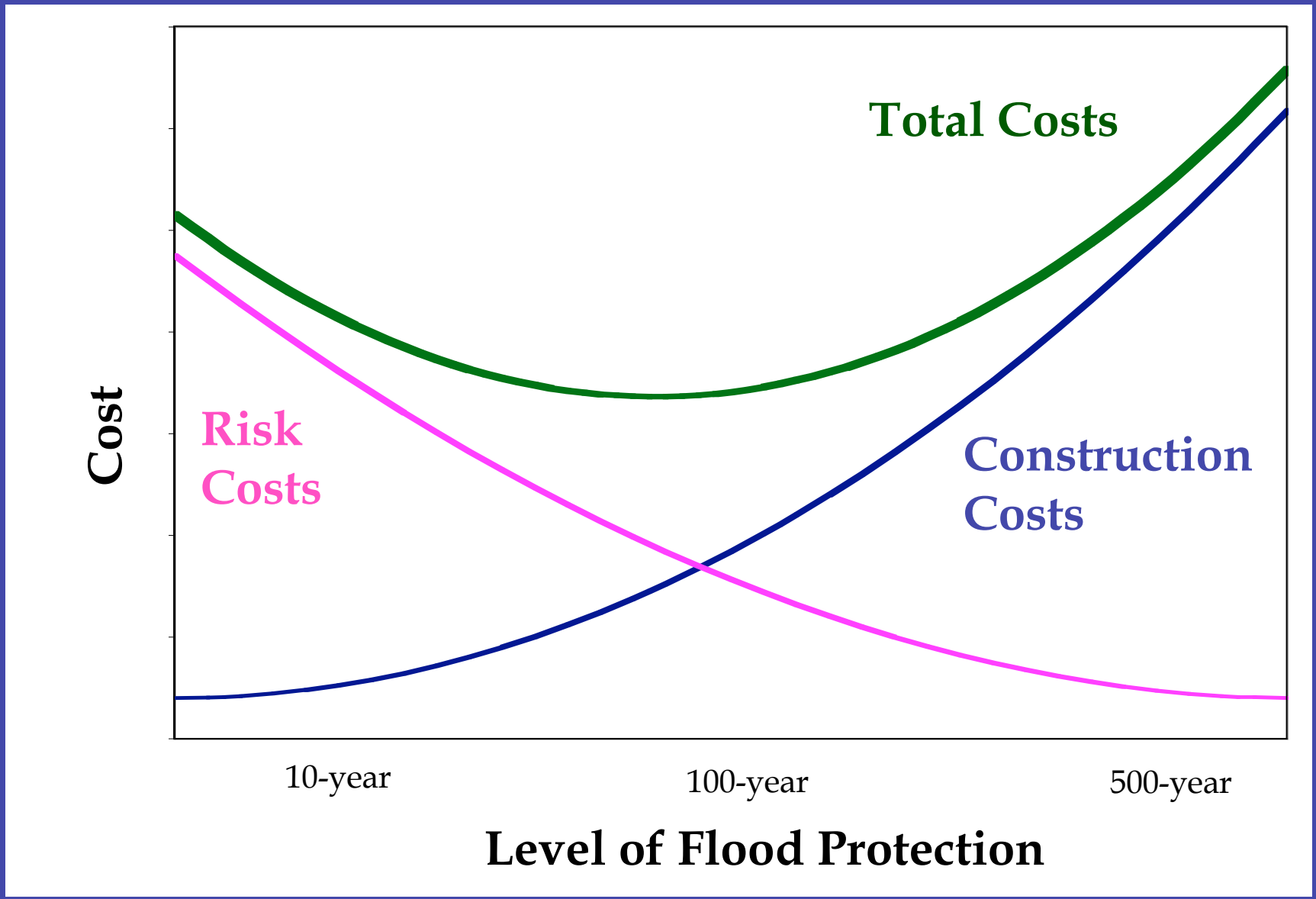

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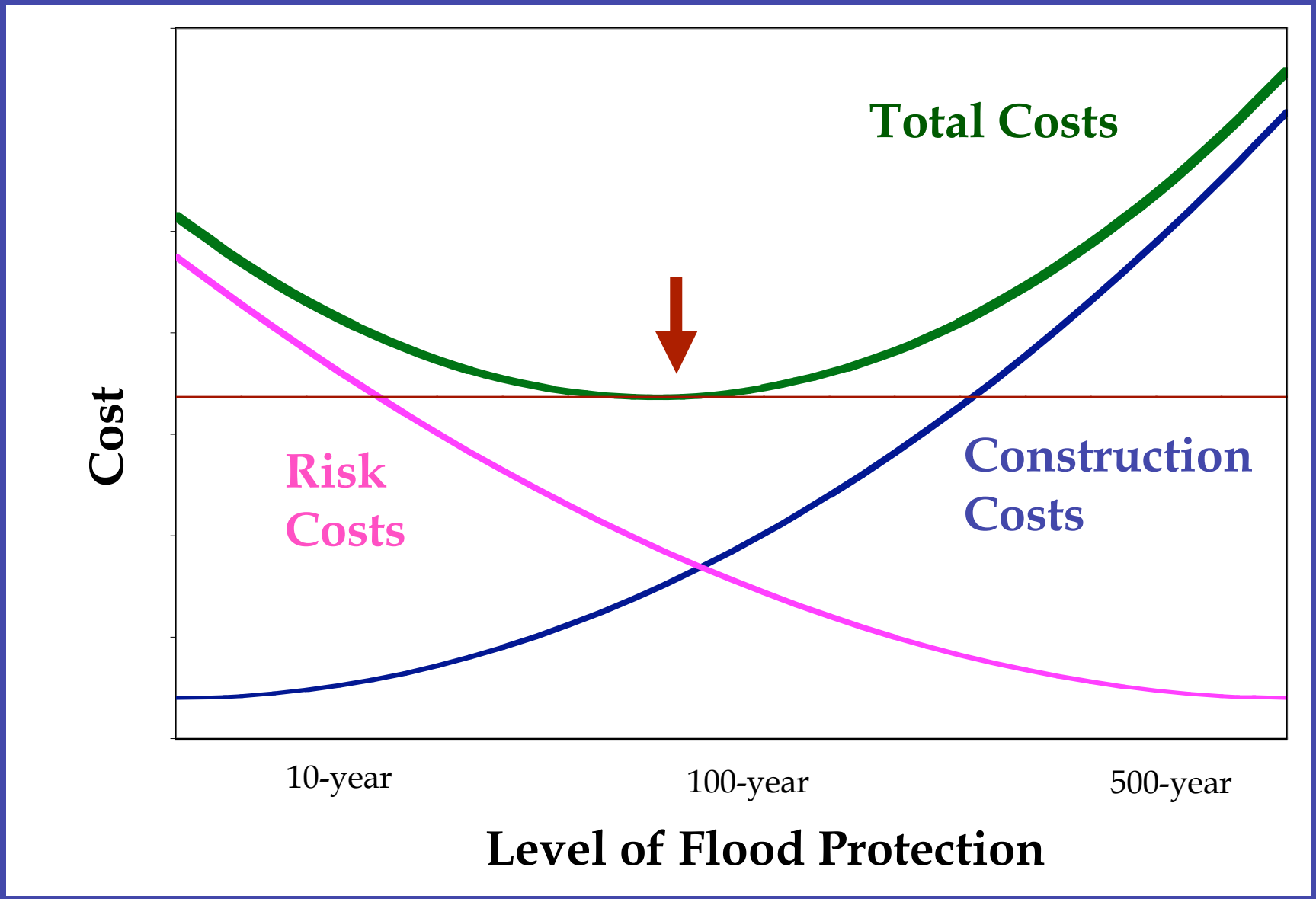

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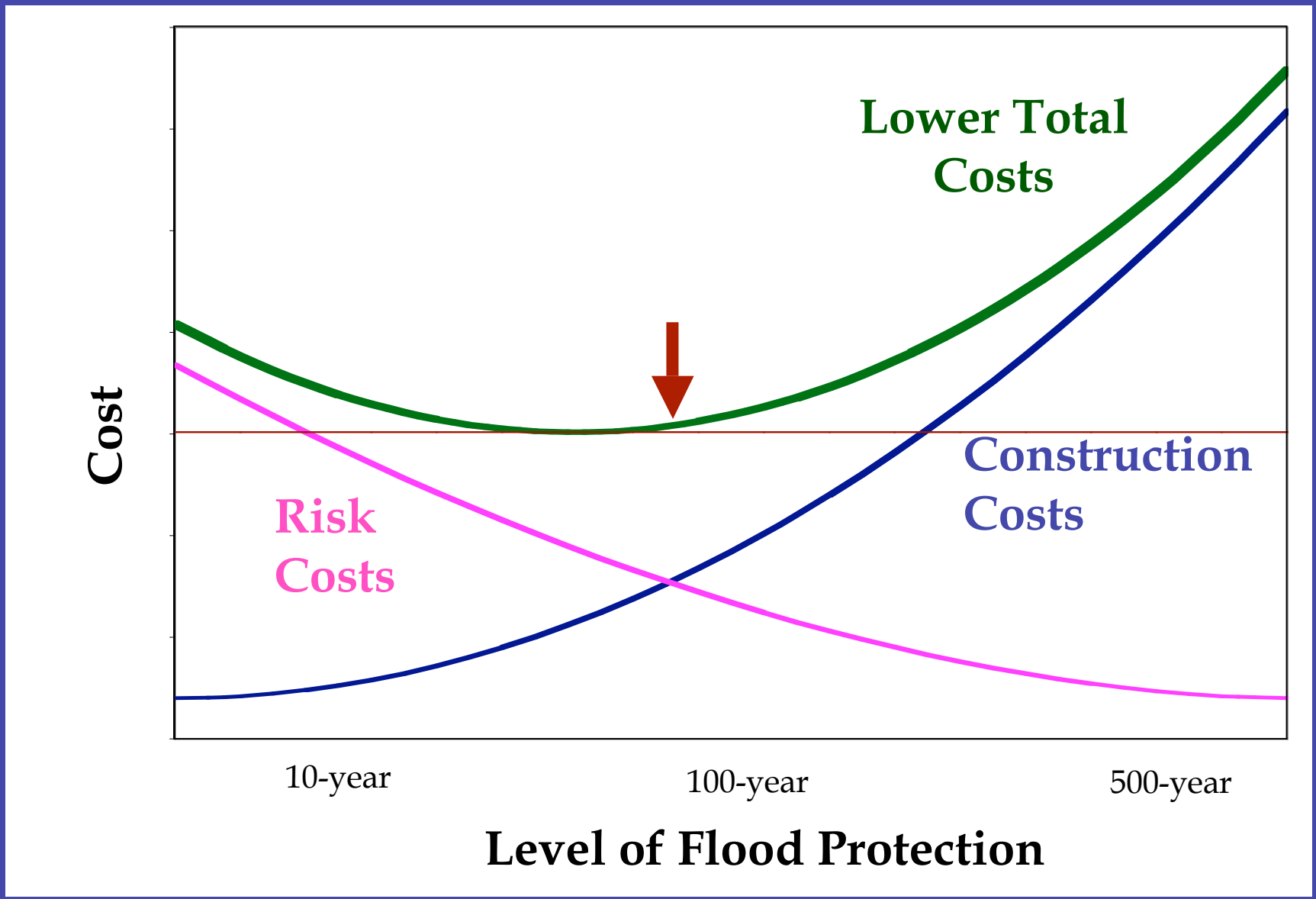

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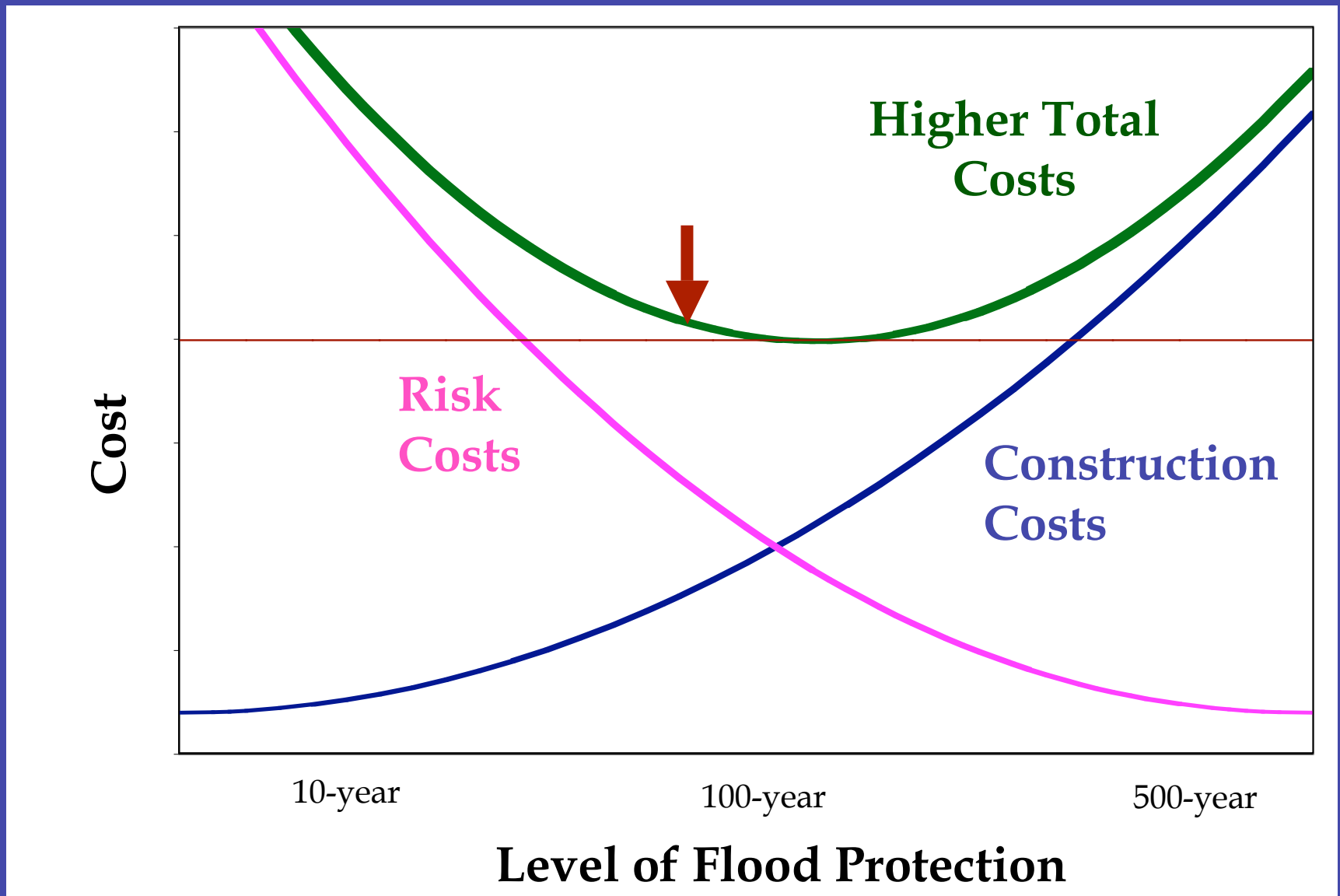

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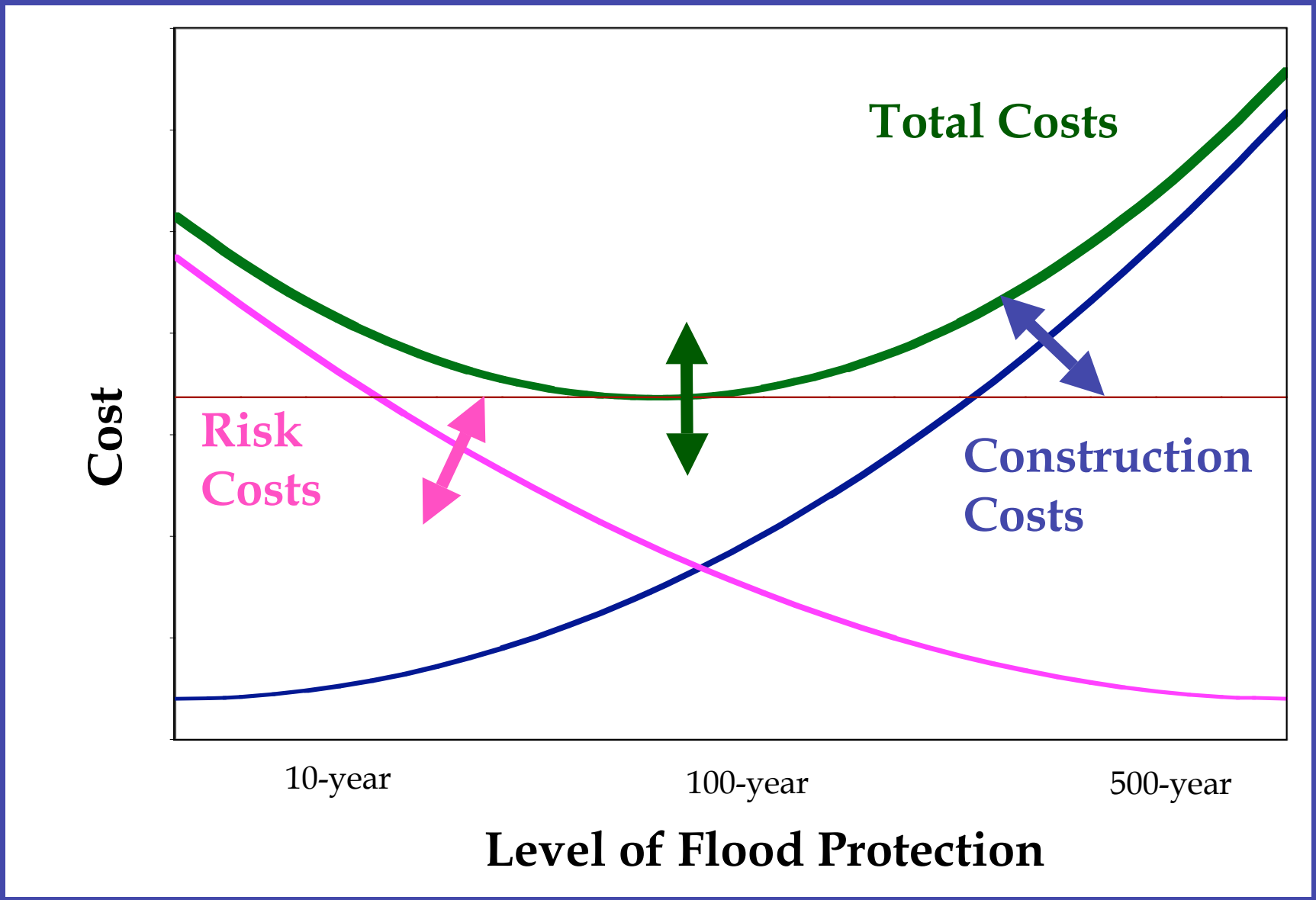


Benefit-Cost Ratio

$$\frac{\text{\$ project benefits}}{\text{\$ project costs}} = \text{benefit-cost ratio}$$

If greater than 1, project has net benefit and project moves forward. Corps new criteria is greater than 1.5.

2. Why is benefit-cost analysis of federal water projects important?

SHELLEY MATCHETT / AP

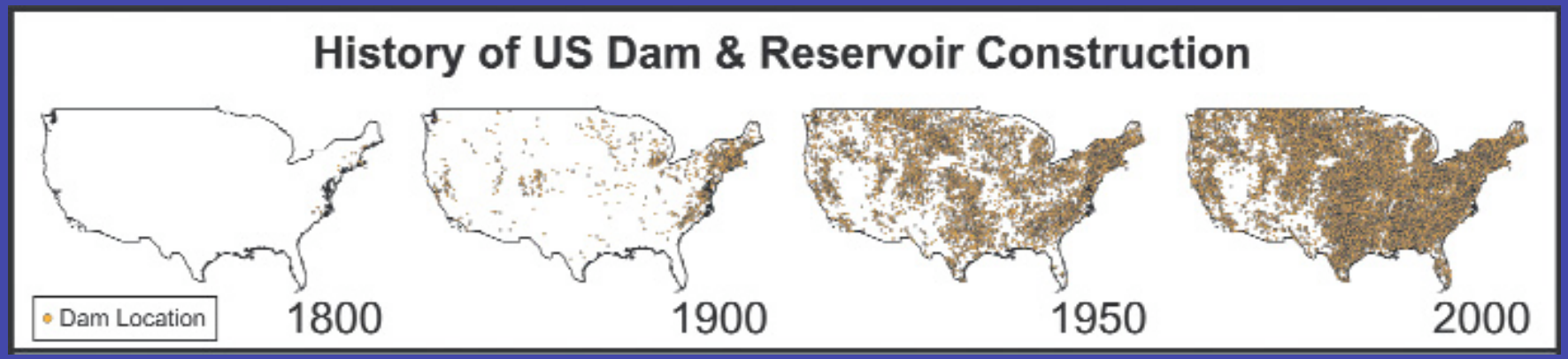
In this photo released by the Lewis County Sheriff's Office, a house floats down the Cowlitz River near Packwood, WA.

Flood Damages

- 2008 floods caused more than $6 billion in damages and 13 deaths in the Mississippi River Valley
- 2005 floods from Hurricane Katrina caused ~$125 billion in damages
- 1993 Mississippi River floods caused $20 billion in damages

Trends in Infrastructure and Floods

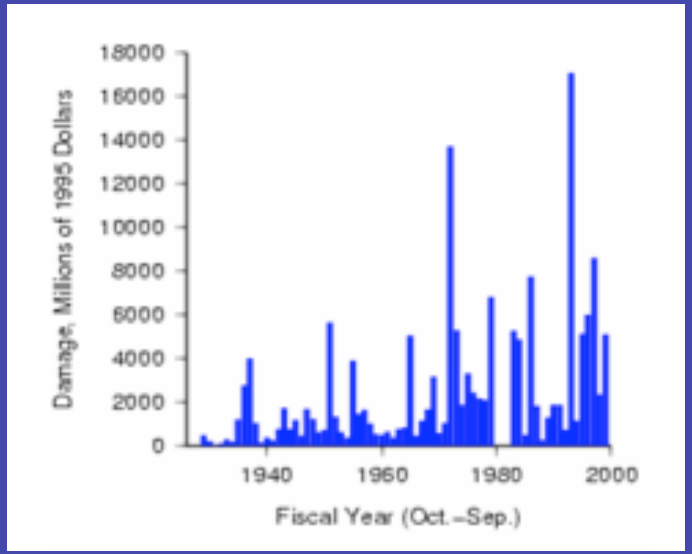
Increased Infrastructure



Figures from Vorosmarty et al., 2004 and Pielke et al., 2002.

Trends in Infrastructure and Floods

Flood Damage Costs



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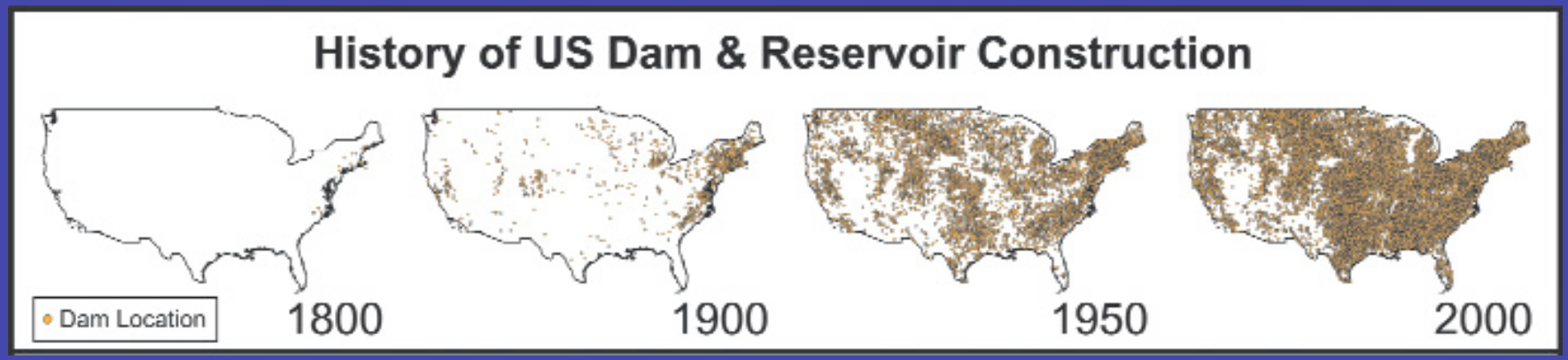


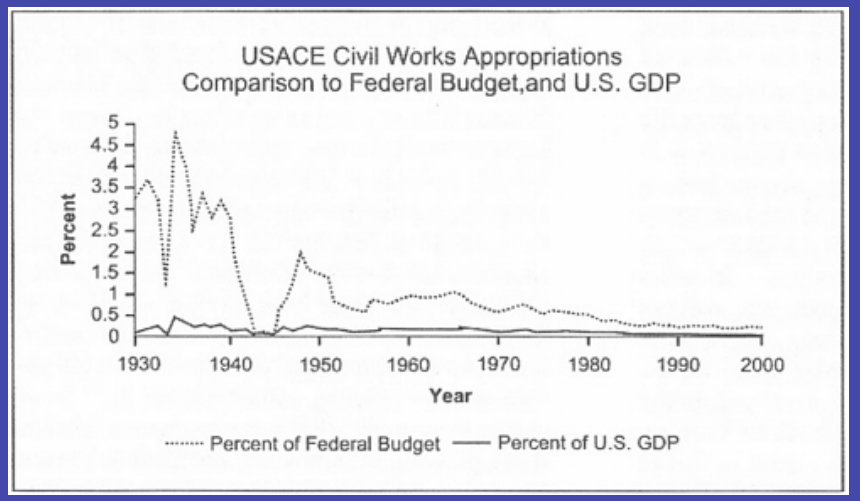
Figures from Vorosmarty et al., 2004 and Pielke et al., 2002.

3. How does benefit-cost analysis relate to Corps practices?

U.S. Army Corps of Engineers

Public engineering to build dams, levees, and channels that control the flow of the nation's rivers and maintain navigable depths for its ports and harbors

Created in 1775 to improve navigation, since mission has evolved to include hydropower, flood control, and aquatic ecosystem restoration



Appropriations as percentages of federal budget and of U.S. GDP, SOURCE: USACE (2001)

Corps Planning Guidance

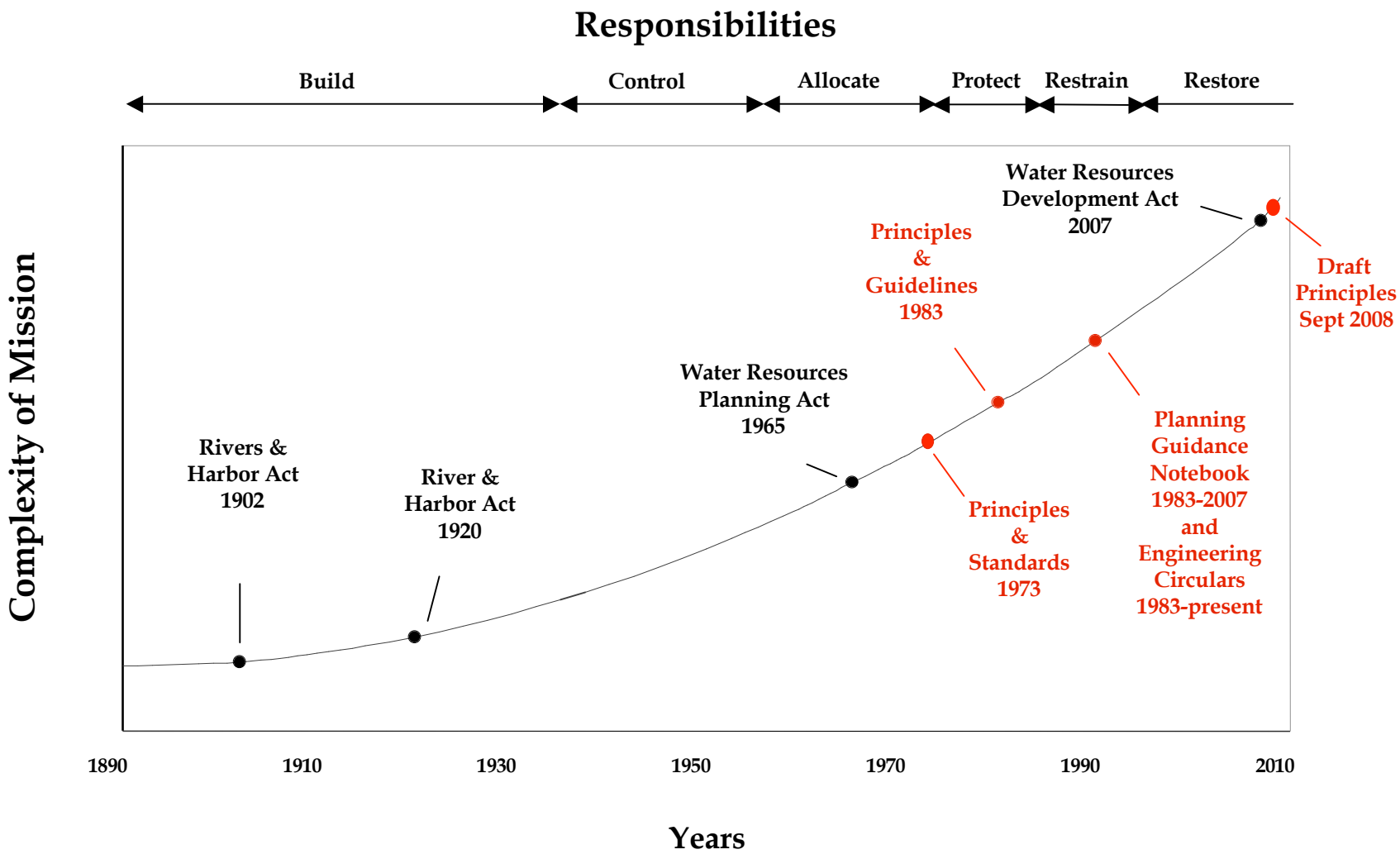
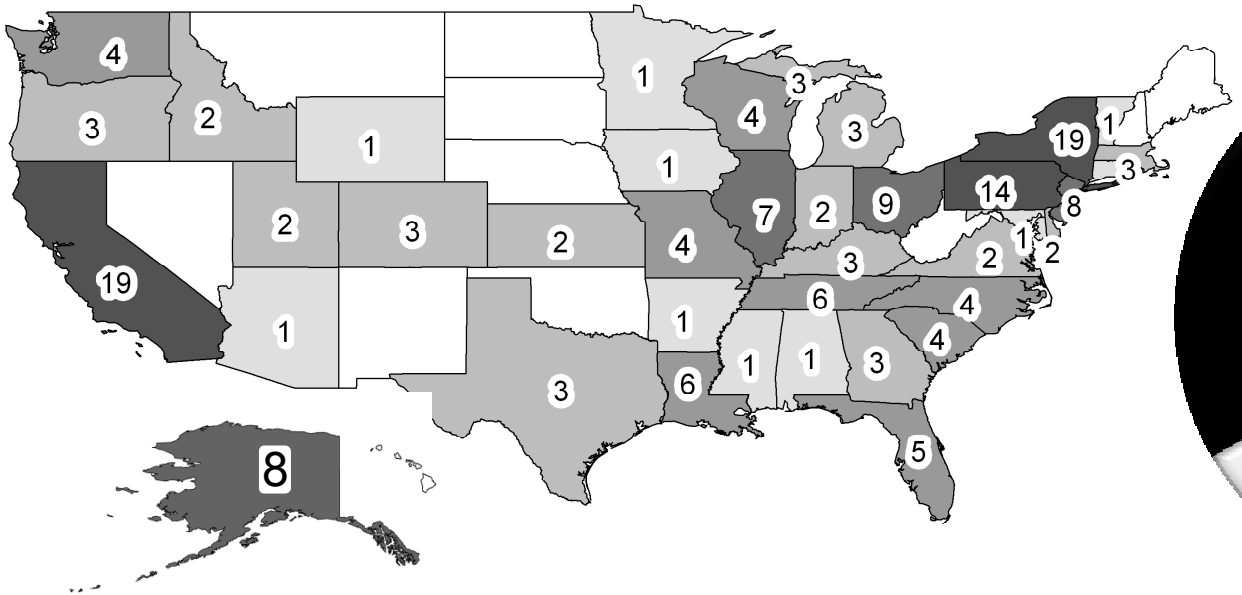
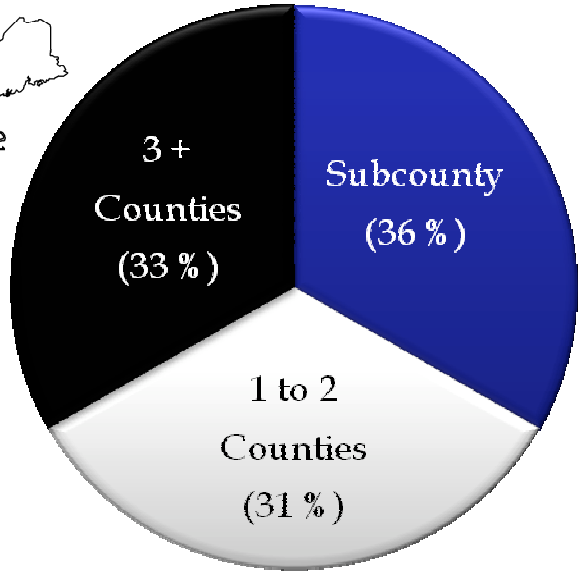


Figure revised from Water Resource Trends report by NRC 1999.

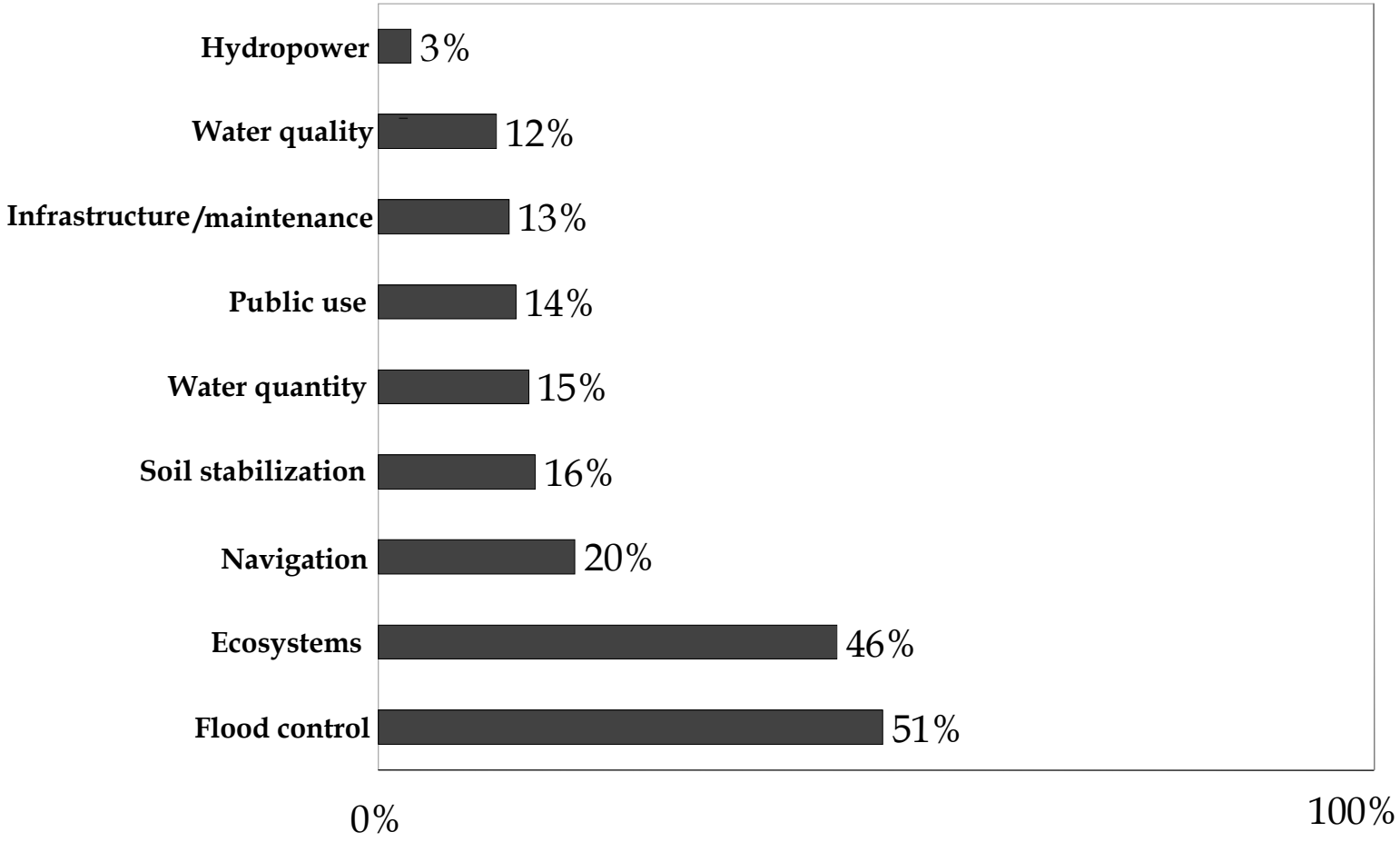
Proposed Projects





- 154 projects: House (51), Senate (3) and WRDA 2007 (100)
- 88% one state, 6% two states, 3% three states
- Five regional projects: John Glen Great Lakes Basin, Southwest, Lake Erie Region, Northeast, New England States

Proposed Project Goals



- Half projects, single goal in legislation
- Half projects, average three goals, maximum of six goals

P&G Accounts

Account	P&G (1983)	Metric
National Economic Development	**Required** Economic value of the national output of goods and services	Monetary
Environmental Quality	Ecological, cultural, and aesthetic effects on natural and cultural resources	Non-monetary units
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Required for Decision Criteria

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4. How might benefit-cost analysis be improved in the Principles and Guidelines?

Criticisms and Revisions to the P&G

- Major criticisms from:
  - -National Research Council
  - -EPA
  - -The Corps
- Revisions from:
  - -Agency regulation
  - -Federal legislation
- The Corps is reviewing P&G

Principle Criticisms

- National vs. Regional Accounting
- Planning Areas
- Environmental Quality (monetary vs. non-monetary)
- Public Safety
- Uncertainty and Risk

National vs. Regional Accounts

Major Criticisms:

- NED is heavily weighted relative to other accounts
- Who should pay?
- Other Social Effects (OSE) not considered in NED

Options:

- Cost sharing
- Require other accounts (RED, EQ, OSE) in reporting
- Use BCA methods to account for distributional effects in NED

Planning Area

How the planning area is defined and managed by planners affects the benefit-cost analysis of alternative plans.

Major Criticisms:

- **Project area versus affected area**
- **Local vs. regional definitions of affected area differ**

Options:

- **Upstream-downstream analysis**

Environmental Quality

Environmental effects and ecosystem services are difficult to quantify or value in benefit-cost analysis.

Major Criticisms:

- No strong guidance on how to quantify and monetize environmental effects
- Difficult to make comparisons between accounts and within EQ account

Options:

- Use newer methods for quantifying and monetizing environmental effects
- Require EQ analysis

Public Safety

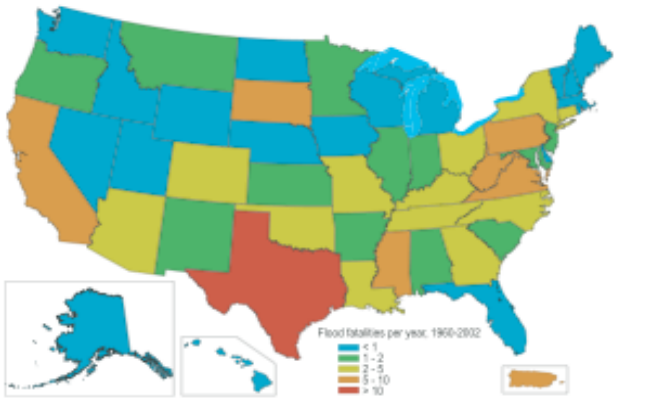


Figure 6. Average annual flood related fatalities for the United States and Puerto Rico for 1960–2002. State averages calculated from a 1960–1996 summary from the National Climatic Data Center (available at www.ncdc.noaa.gov/oa/climate/sd/annsum96.pdf) and 1997–2002 data from the National Weather Service (available at http://www.nws.noaa.gov/om/severe_weather/).

8 of 11

Major Criticisms:

- **Health and safety reporting is currently not required in the Principles and Guidelines**

Options:

- **Include non-monetized health and safety effects in required accounts**
- **Use methods of BCA (i.e.Value of a Statistical Life) to monetize health and safety risks**

Figure from O'Conner and Costa (2004)

Uncertainty and Risk

Analysis can provide benefit-cost information as probabilities and better account for risk.

Major Criticisms:

- **Analysis focuses on point estimates**

Options:

- **Use probability distributions (i.e. Monte Carlo)**
- **Consider output pricing**
- **Use distributions of risk**

5. What are special considerations for flood projects?

Define and Include Risk

"Let no one believe that because you are behind a levee, you are safe"
--Brig. Gen. Gerald Galloway

Risk: potential outcomes that can be described in reasonably well-known probability distribution.

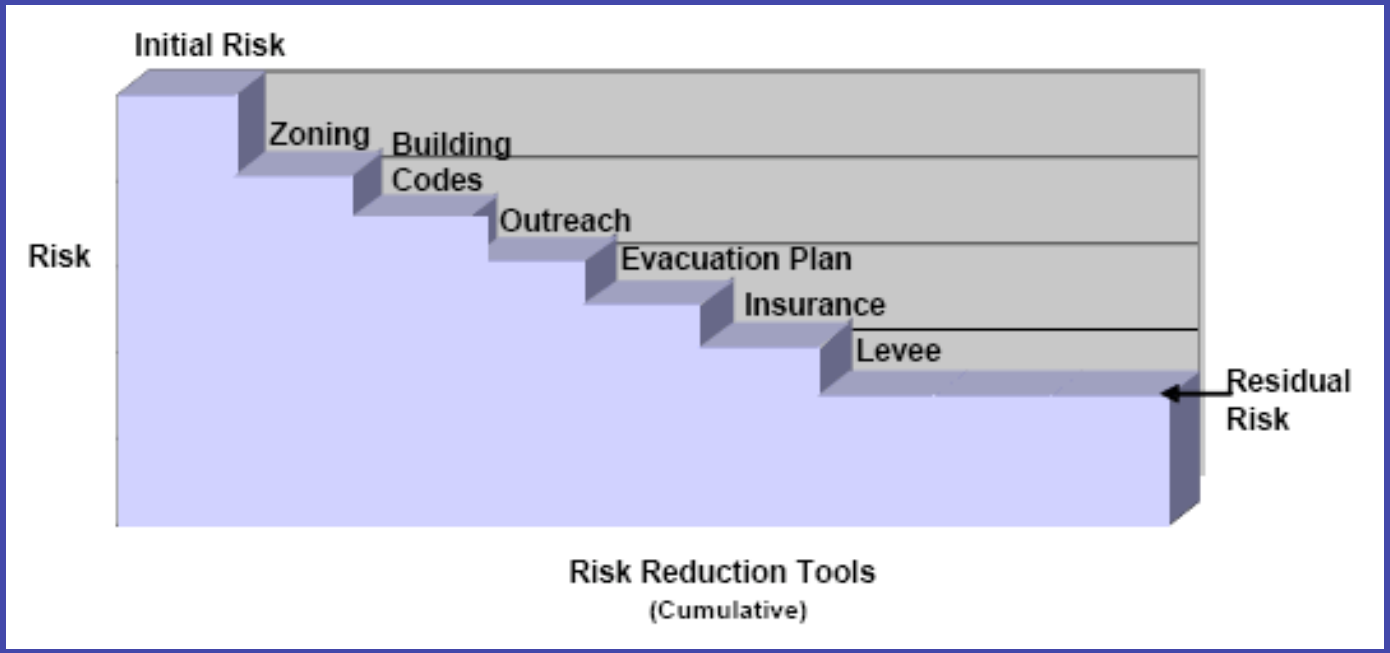


Figure from Corps at http://www.asce.org/files/pdf/erp.pdf

Nonstructural Alternatives

The Corps will include "a plan which primarily employs nonstructural alternatives" in all future planning according to the 2008 draft principles.

Examples:

- **Flood forecasting**
- **Awareness raising**
- **Recovery plans**
- **Zoning and relocation**

Development Behind Levees

Remove subsidized incentives to build in risky areas.

6. How were the P&G applied to the Upper Mississippi River Comprehensive Plan?

Case Study: Upper Mississippi

- Upper Mississippi River Comprehensive Plan (UMRCP)
- WRDA of 1999 authorized UMRCP
- Fourteen alternative plans that include: no action, non-structural, structural alternatives, and low benefit-cost ratio (0.03 – 0.07)
- Reconnaissance study

Planning Area

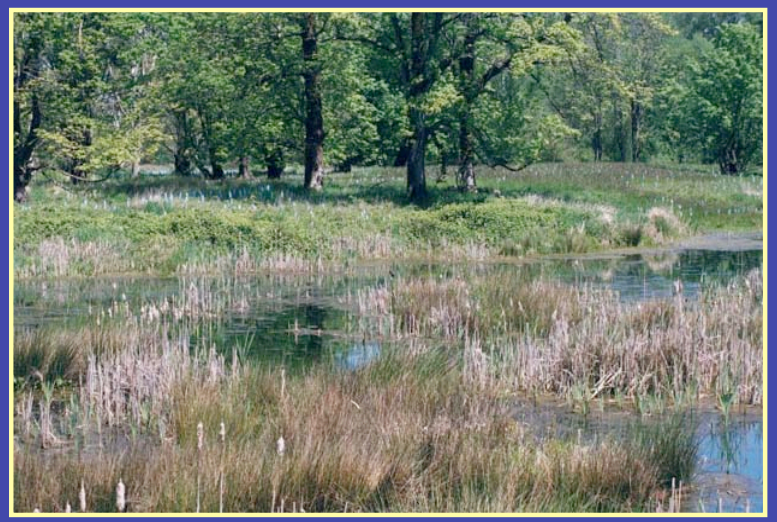
In the Upper Mississippi Case Study

- Upstream and downstream effects in individual plans
- Plan A, D and G – Impacts on Lower Mississippi
- Formulation of Plan M after public hearings – typical example of upstream – downstream conflict

Environmental Quality

In the Upper Mississippi Case Study

- The EQ account is not required. The Corps only conduced a preliminary assessment.
- Mix of monetized and non-monetized values in account but nothing indicating if and how they were compared or combined.



- Monetized values not moved to the NED account as required by the P&G.
- Other environmental impacts discussed but not quantified or included in EQ account.

Flood-Specific Considerations

In the Upper Mississippi Case Study

- Risk Analysis with the Risk Informed Decision Framework (RIDF)
- Nonstructural alternatives in UMRCP alternative plans:
  - Relocations
  - Buyouts
  - Urban floodplain development restrictions

Project Scope Revisited

1. What is the current benefit-cost analysis practice within the Corps?

2. What criticisms and suggestions exist to modify current benefit-cost analysis practices?

2. How was benefit-cost analysis used in the case study of the Upper Mississippi Comprehensive Plan?

Findings

General considerations:

Findings

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National vs. Regional Accounting

Include costs and benefits in proper accounts

Findings

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Include ecosystem services and other non-monetary benefits appropriately

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Planning Areas

Select appropriate spatial bounds

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Public Safety

Account for public safety

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Findings

General considerations:

National vs. Regional Accounting

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Account for public safety

Environmental Quality

Include ecosystem services and other non-monetary benefits appropriately

Uncertainty and Risk

Communicate the range in risks

Findings

Flood specific considerations:

Findings

Flood specific considerations:

Non-structural Alternatives

Give full consideration to all potential solutions (structural and nonstructural)

Findings

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Treatment of Risk

Incorporate risk into the decision-making framework

Findings

Flood specific considerations:

Non-structural Alternatives

Give full consideration to all potential solutions (structural and nonstructural)

Treatment of Risk

Incorporate risk into the decision-making framework

Development Behind Levees

Discourage development in places that are risky

Highlights

- Great opportunity to update science and economics of BCA
- Upper Mississippi provides examples for innovative methods
- Future research questions:
  - -How should BCA process be evaluated?
  - -How should climate change be included?
  - -When is BCA the appropriate tool?

Thank you!

Questions?

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Tyler Davis: tbdavis@u.washington.edu

http://www.usace.army.mil/CECW/Pages/pgr.aspx

Additional items (possible references for questions & answer)

P&S and P&G Accounts

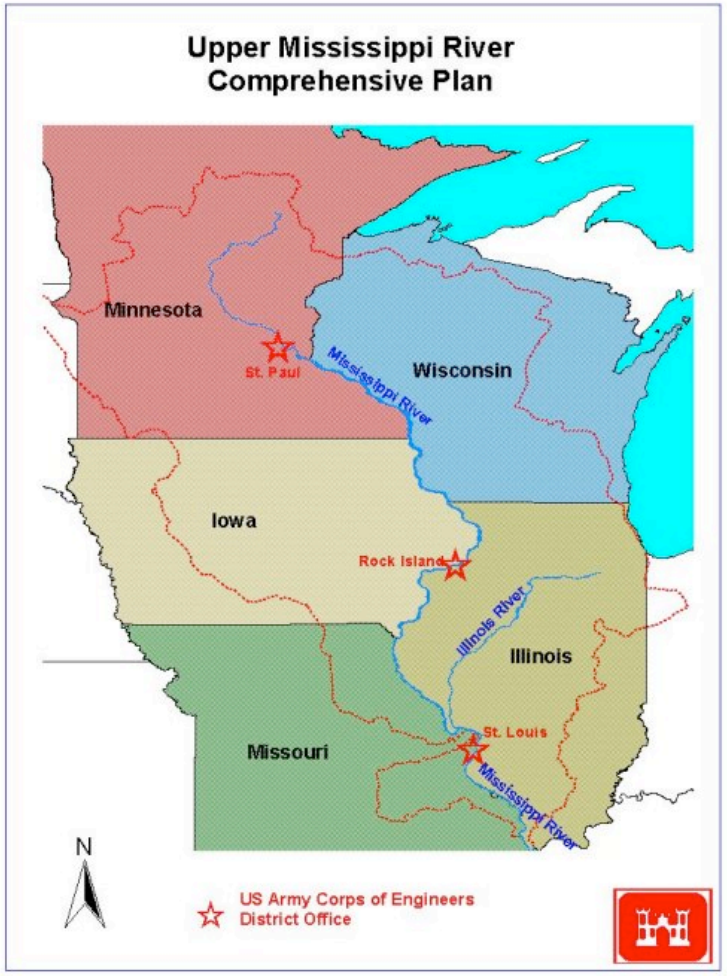
Account	P&S (1974)	Metric	P&G (1983)	Metric
National Economic Development	**Required** Economic value of the national output of goods and services	Monetary	**Required** Economic value of the national output of goods and services	Monetary
Environmental Quality	**Required** Natural and historical resources, ecological systems, and irreversible commitments to future uses	Monetary and/or Non-monetary units	Ecological, cultural, and aesthetic effects on natural and cultural resources	Non-monetary units
Regional Economic Development	Regional employment, population distribution, economic stability, and environment	Monetary	Regional economic activity, income transfers, and employment effects	Monetary
Other Social Effects/ Social Well-being	Real income distribution, life, health, safety, education, culture, recreation, and emergency preparedness	Monetary and/or Non-monetary units	Urban and community impacts, effects on life, health and safety, and relevant effects not reflected in other accounts	Monetary and/or Non-monetary units

National vs. Regional Accounts

NED and RED can be of different signs and different magnitudes for the same project. Four possible combinations of circumstances of Regional Economic Efficiency and National Economic Efficiency:

Possible Combination of Regional and National Economic Capacity				
Regional Economy	Below Capacity	Below Capacity	Near Capacity	Near Capacity
National Economy	Below Capacity	Near Capacity	Below Capacity	Near Capacity
Treatment of RED vs. NED	Conducting a Corps project in the region may preclude conducting a project in some other region of the nation that results in higher returns. Therefore a Corps project may have positive RED and negative NED effects. It is possible that the RED would be positive and the NED would be positive but smaller.	Unlikely by definition	Conducting a Corps project will draw economic resources from other regions to meet the increased demand in the region with the Corps project. Therefore, in an extreme case the RED may be 0 and the NED positive.	Conducting a Corps project will draw resources from within the region and possibly from surrounding regions. RED may be either positive, while NED is either negative or smaller than RED.

UMRCP



Time Line

Aug 2002 – Collaboration Team formed to work with Corps Product Development Team (PDT)

Sep 2002 & Jun 2006 – four public meetings hosted by Rock Island and St. Louis Districts

2004 – Evaluation of RED benefits completed

Early 2005 – UMRCP draft report issued to public

Aug-Sep 2005 – Hurricanes Katrina and Rita

Fall 2006-Spring 2008 – public input led the PDT to develop Plan M

Figure from UMRCP website: http://www2.mvr.usace.army.mil/UMRCP/

Project Evaluation

The Corps is not required to evaluate the impacts of projects. The information from these projects would improve future planning processes.