

NATIONAL
ECONOMIC
DEVELOPMENT

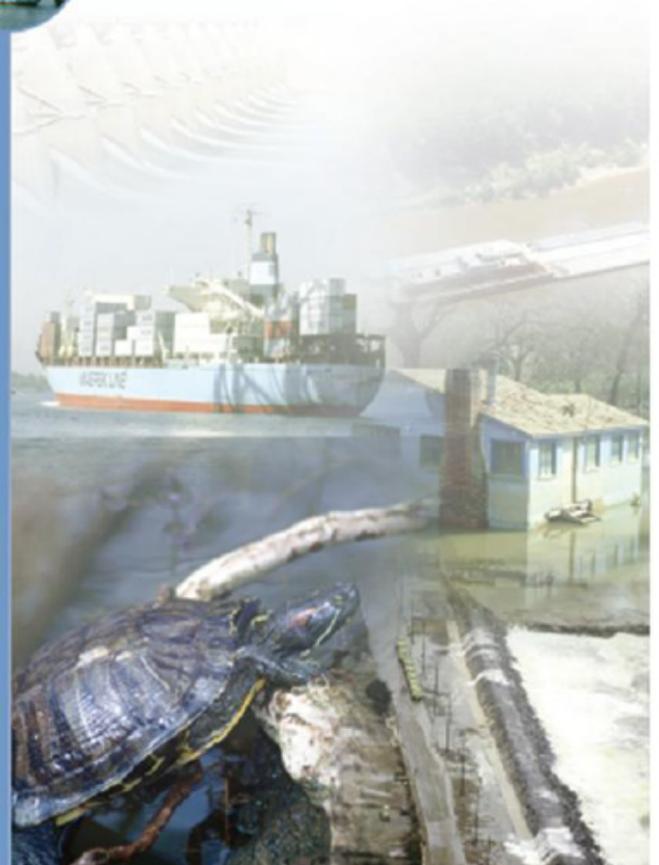


US Army Corps
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ECONOMICS PRIMER

IWR Report 09-R-3
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U.S. Army Institute for Water Resources

The Institute for Water Resources (IWR) is a Corps of Engineers Field Operating Activity located within the Washington DC National Capital Region (NCR), in Alexandria, Virginia and with satellite centers in New Orleans, LA and Davis, CA. IWR was created in 1969 to analyze and anticipate changing water resources management conditions, and to develop planning methods and analytical tools to address economic, social, institutional, and environmental needs in water resources planning and policy. Since its inception, IWR has been a leader in the development of strategies and tools for planning and executing the Corps water resources planning and water management programs.

IWR strives to improve the performance of the Corps water resources program by examining water resources problems and offering practical solutions through a wide variety of technology transfer mechanisms. In addition to hosting and leading Corps participation in national forums, these include the production of white papers, reports, workshops, training courses, guidance and manuals of practice; the development of new planning, socio-economic, and risk-based decision-support methodologies, improved hydrologic engineering methods and software tools; and the management of national waterborne commerce statistics and other Civil Works information systems. IWR serves as the Corps expertise center for integrated water resources planning and management; hydrologic engineering; collaborative planning and environmental conflict resolution; and waterborne commerce data and marine transportation systems.

The Institute's Hydrologic Engineering Center (HEC), located in Davis, CA specializes in the development, documentation, training, and application of hydrologic engineering and hydrologic models. IWR's Navigation Data Center (NDC) and its Waterborne Commerce Statistical Center (WCSC) in New Orleans, LA, is the Corps data collection organization for waterborne commerce, vessel characteristics, port facilities, dredging information, and information on navigation locks.

Other enterprise centers at the Institute's NCR office include the International Center for Integrated Water Resources Management (ICIWaRM), which is a distributed, intergovernmental center, established in partnership with various Universities and non-Government organizations; and a Collaborative Planning Center which includes a focus on both the processes associated with conflict resolution, and the integration of public participation techniques with decision support and technical modeling – Computer Assisted Dispute Resolution (CADRe). The Institute plays a prominent role within a number of the Corps technical Communities of Practice (CoP), including the Economics CoP. The Corps Chief Economist is resident at the Institute, along with a critical mass of economists, sociologists and geographers specializing in water and natural resources investment decision support analysis and multi-criteria tradeoff techniques.

For further information on the Institute's activities associated with the Corps Economics Community of Practice (CoP) please contact Chief Economist, Dr. David Moser, at 703-428-6289, or via-mail at: david.a.moser@usace.army.mil. The IWR contact for the Corps Planning CoP activities is Ms. Lillian Almodovar at 703-428-6021, or: lillian.almodovar@usace.army.mil.

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ECONOMICS PRIMER

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Foreword

The Corps of Engineers Planning Excellence Program is designed to build planning capability now and for the future. Economics is a vital component of the planning process and updating the National Economic Development manual series is a key element of the Planning Excellence Program.

I appreciate the efforts of the interdisciplinary team across the Corps, local sponsors and others who contributed to this manual. I am pleased to endorse its use as a tool for the Planning Community of Practice to reach out to all who are interested in our work.

Harry E. Kitch, Planning Community of Practice
Deputy, Planning Civil Works

Welcome

As the Corps of Engineers strives to improve its planning and decision making, economic analysis is one of its most reliable and important tools. A critical element of successful economic analysis is communication with others—in gathering data, making assumptions, developing models and presenting results.

This Economics Primer presents the rudiments of the science of economics and its use in the Corps of Engineers. We hope it will be enlightening and useful to a wide audience.

Dr. David Moser
Chief Economist
U. S. Army Corps of Engineers

Acknowledgements

The Economics Primer is one of a series of National Economic Development (NED) Manuals. The NED Manuals are important resource documents for performing economic analysis within the Corps of Engineer's planning framework. The Manuals are part of the Planning Guidance Improvement Program. Ms. Lillian Almodovar of the Institute for Water Resources (IWR) has provided critical support to this effort. Ms. Susan Durden of IWR was the project manager for the update of the NED manual series. Mr. Ken Orth of Corps' Headquarters (retired) helped set the vision for this document and Mr. Darrell Nolton of IWR has been effective and generous in serving as the Program Manager for the Planning Guidance Improvement Program. Mr. Bill Hansen contributed to the early draft of this document. Editorial and production assistance was provided by Arlene Nurthen, Brenda Murphy and Monica Franklin of IWR.

Valuable review comments were provided by Scott Miner of the Corps' Sacramento District; Lyle Maciejewski of the Corps' Savannah District; John Phillips of the Georgia Department of Transportation; John Sawyer of the City of Savannah; personnel from NOAA and Fish and Wildlife Service and Carol Sanders (retired) of the Corps' Headquarters. Thank you to the many others, not mentioned by name, who showed interest, offered ideas and encouraged development of this primer.

Table of Contents

Foreword	iii
Welcome	iii
Acknowledgements	v
Table of Contents	vii
Chapter I - Economics, Past and Present	1
Economic Analyses in the Corps of Engineers	1
History	1
NED, National Economic Development	2
Economic Analysis in Other Federal Agencies	4
National and Regional Economics	4
Regional Economic Development (RED)	5
Corps' Activities	6
Look Back, Look Ahead	7
Chapter II - Economics Fundamentals	9
Economics—The Science of Choice.....	9
Opportunity Costs	10
Marginal Analysis.....	10
Scarcity	10
Supply and Demand	11
Making Choices	12
What Do We Compare? Without- and With-Project Conditions	12
How Do We Compare Over Time?	13
Look Back, Look Ahead	14
Chapter III - Economists and Economic Techniques	15
What Do Economists Do?.....	15
Why Do Economic Analysis?	16
Benefit-Cost Analysis.....	17
Cost Effectiveness and Incremental Cost Analysis.....	18
What is Risk Analysis?.....	19
Are There Other Factors?	20
Summary	21
Look Back, Look Ahead	21
Chapter IV - If You Want to Know More	23
Headquarters, U.S. Army Corps of Engineers	23
Institute for Water Resources	23
Other Sources of Information.....	23
Appendix A: Accounting for the Timing of NED Effects	25

CHAPTER I - ECONOMICS, PAST AND PRESENT

“Economists must look at the future in the light of the present while remembering the lessons of the past.” John Maynard Keynes

Economic Analyses in the Corps of Engineers

It is the Corps of Engineers, after all. Why do economics? Because the Corps is a steward of taxpayer money and must determine which projects are good investments for the nation. Engineering science alone is not enough. The Corps, along with other water resource development agencies, must follow a path of economic efficiency to reach engineering remedies.

History

The primary basis for economic analyses within the Corps of Engineers dates back to a classic piece of legislation, the **Flood Control Act of 1936, Public Law 74-738**. This Act established flood control, now characterized as flood risk management, as a nationwide mission for the Corps of Engineers. This Act was important in terms of economics, because the Congress specified within it that the Federal Government should participate in such flood control projects “. . . if the benefits to whomsoever they may accrue are in excess of the estimated costs, and if the lives and social security of people are otherwise adversely affected.” This law established the criterion of economic benefits exceeding economic costs and the need to consider social (and subsequently other) impacts in the decision making process.

The Corps has been performing benefit-cost analysis for many years. See Chapter II for more detail on benefit-cost analysis.

Over the years, the general principle of benefits exceeding costs was extended not only to Corps water projects but also to the projects of other water resource development agencies, including the Bureau of Reclamation, the Natural Resources and Conservation Service and the Tennessee Valley Authority. This principle and the subsequent development of the practice of benefit-cost analysis was therefore advanced by the requirement of economic evaluations by water resource development agencies. Most other federal agencies, though concerned with efficiency and effectiveness, are not necessarily required to conduct detailed benefit-cost analysis for individual project justification.

Although the 1936 Flood Control Act required that project benefits exceed costs, it was not until the 1950's that a specific set of standards and procedures

was developed for evaluating economic benefits and costs. Some of the key efforts related to these standards and procedures included:

- *Proposed Practices for Economic Analysis of River Basin Projects:*
This was a report by the Federal Inter-Agency River Basin Committee. Often referenced as the *Green Book* because of the color of its cover, this was the first interagency effort to develop guidance for benefit-cost analysis and for what has become known as the national economic development perspective. First issued in 1950, a revised edition was promulgated in May 1958, the *Green Book* states that the objective of economic analysis is: "...to provide a guide for effective use of the required economic resources..." and the general objective of project formulation is "...to maximize net economic returns and human satisfactions from the economic resources used in the project." This expresses the basic principles and concepts included in today's NED analysis.

NED, National Economic Development:

- *Policies, Standards and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources*
Known as *Senate Document 97*, these procedures were approved by President John Kennedy in May 1962. This document states that the basic objective of plan formulation is to provide for the best use of resources. *Senate Document 97* is generally believed to include the first use of the term "national economic development." It also states that in pursuit of this objective full consideration is to be given to the objectives of "Development, Preservation (proper stewardship of the nation's bounty) and the Well-Being of People."
- *Principles and Standards for Planning Water and Related Land Resources (P&S)*
The Water Resources Planning Act of 1965 (P.L. 89-90) required the newly created Water Resources Council to establish principles, standards and procedures for Federal water resources planning. In September 1973, the P&S were the result of their effort. For the first time, National Economic Development was mentioned explicitly as one of the two overall purposes of water resources planning—the other being environmental quality. The P&S required that the beneficial and adverse effects for both of these purposes be displayed in separate accounts along with other accounts for regional development and social well-being.
- *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*

Known as *Principles and Guidelines* or P&G, this document was approved by President Ronald Reagan in February 1983. P&G states that “The Federal Objective of water and related land resources project planning is to contribute to national economic development consistent with protecting the Nation’s environment...” In addition, “...four accounts are established to facilitate evaluation and display of effects of alternative plans.” These four accounts are:

- The **National Economic Development (NED) Account** displays changes in the economic value of the national output of goods and services.
 - The **Environmental Quality (EQ) Account** displays effects on significant natural and cultural resources.
 - The **Regional Economic Development (RED) Account** displays the regional and localized economic impacts that result from each alternative plan. Evaluations of regional effects are to be carried out using nationally consistent projections of income, employment, output and population.
 -
 - The **Other Social Effects (OSE) Account** registers plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts.
- *Water Resources Development Act 2007(WRDA)*
WRDA 2007 directed the Secretary of the Army (CW) to rewrite the 1983 Principles and Guidelines (P&G) to accommodate new national water resources objectives and other considerations. The 1983 P&G included the following sections: Principles, Standards and Procedures. Implementing this directive will result in a broadened P&G that will include new objectives and new project selection criteria. On September 12, 2007 a draft Principles was published in the Federal Register. As expected, these Principles specified new objectives and new decision criteria. The final outcome may not be decided until the next administration, but it is clear that National Economic Development (NED) will be a vital part of any new document

The interrelationship of the NED and RED accounts is discussed in the following sections.

Economic Analysis in Other Federal Agencies

All federal agencies conduct economic analyses. The Corps, the Bureau of Reclamation, the Tennessee Valley Authority, and the National Resource Conservation Service follow the same P&G for conducting economic analyses. (The Water Resources Development Act of 2007 instructs the Corps of Engineers to review the P&G and its application in the Corps.) The agency mission determines the types of analyses and the way in which economic analyses are incorporated into decision processes. The Corps works closely with economists in many other agencies to share techniques, develop models, explore policy implications and forecast future conditions. Data collected by other agencies, such as the U.S. Census Bureau, is often critical to the Corps' economic analyses.

To explore the use of economics in some other agencies, access these web sites:

www.fs.fed.us

www.noaa.gov

www.epa.gov

www.fws.gov

National and Regional Economics

Individuals or groups may look at the same problem with different perspectives and come to different conclusions regarding the desirability of a particular alternative or course of action. A simple example may help to illustrate this point. You paint your house and can sell it for \$3,000 more than you could before it was painted. You paint your house and your neighbor can sell his house for \$5,000 more now that his house is no longer next to a house badly in need of paint. The paint produces \$8,000 in benefits. How much of those benefits are relevant to you when making the decision to paint or not? Obviously, you are concerned only with the \$3,000 benefit that accrues to you. It's a matter of **perspective**.

The **National Economic Development (NED) objective** is a policy that guides federal water resource planners in their choice of solutions to problems. Choice is the fundamental business of economics. Economics is the science of allocating resources based on rational choices. The objective of NED is to maximize increases in the net value of the **national output** of goods and services. Within the Corps, this is done by comparing the difference in the value (benefits) produced by the project to the value of the resources (costs) required to produce those goods and services or construct the project.

Benefits are increases in the net value of national outputs (goods and services) and vary by type of water resource project. The **costs** (opportunity

costs) are the costs of the resources required or displaced to achieve the plan, such as concrete and steel for building a floodwall. The NED objective is maximizing the difference between monetized benefits and costs. How comparisons between costs and benefits are made is explained in Chapter III.

What Are NED Benefits?	
<u>Water Resource Projects</u>	<u>Types of Benefits</u>
Flood Control	Reduced property damages, emergency costs, avoiding losses
Navigation	Reduced costs for commodity transport

What Are NED Costs?
Materials, labor, other direct construction costs
Operation and maintenance costs over a project life
Environmental mitigation costs
Real estate needed for the project, other improvements to realize benefits

The NED principle describes a very specific perspective, the **federal perspective**, to be used in valuing project outputs, or benefits, and project inputs, or costs. Federal funds are to be invested to achieve the greatest **national benefits**. What is considered a NED benefit is defined in law and policy. It represents the current state of a continuously evolving federal policy on water resource projects as discussed above. NED is a matter of law, policy and interpretation rather than one of economic fact, although it is a policy firmly rooted in economic theory.

Regional Economic Development (RED)

The biggest difference in perspectives between a federal water resource agency and the non-federal partner is often in respect to the NED objective. The goal of the NED or federal perspective is to identify *“the alternative plan with the greatest net national economic benefit consistent with protecting the nation’s environment (the NED plan).”*

Major infrastructure projects, such as water resource developments, will often also result in **economic impacts** that are not national (NED) impacts. These are called **Regional Economic Development** benefits and include benefits such as employment shifts from one region to another. RED benefits impact a region, not the nation as a whole. For example, during construction, expenditures by construction workers will increase the economic activity of the

community which also causes increases in sales taxes collected in the area. After completion of a flood control project, businesses may relocate from other communities because of increased flood protection or shipping lines may divert ships to a newly deepened port. Both actions result in increased economic activity in a region but are not increases from a national perspective. These regional benefits are generally transfers from other parts of the country—construction workers spending money in Illinois rather than Wyoming.

There should be no doubt that the increases in regional economic activities are real. To the non-federal partner they may be very important in determining whether or not they should participate in cost sharing a project. From the federal NED perspective, the Corps is required to follow the P&G decision process which is interested in contributions to national economic development, not benefits that result from transfers between regions. Economists have an important role in distinguishing between NED and RED benefits.

From the federal perspective transfers are a zero sum game. That does not mean that RED benefits are not significant or important to the non-federal partner. The distinction between RED and NED is a matter of perspective and policy, not economics.

RED, environmental and social benefits are considered in the selection of the plan which is recommended to Congress. This decision includes factors beyond the scope of the economic analysis.

Corps' Activities

When people think about the use of economics within the Corps, many think about the evaluation of flood risk management and navigation projects within the water resources development program. The Corps is involved in many activities in which economic principles are applied.

These include:

- Water Resources Development
 - Navigation—Deep Draft and Inland
 - Flood and Storm Damage Reduction
 - Hurricane and Coastal Storm Damage Reduction
 - Ecosystem Restoration
 - Hydropower
 - Municipal and Industrial Water Supply
 - Irrigation
 - Recreation
 - Fish and Wildlife

- Watershed Planning
- Planning Assistance to State
- Operation and Maintenance
 - Major Rehabilitation
 - Maintenance Dredging
 - Dredged Material Management Plans
 - Reservoir Re-regulation
 - Master Plans
 - Review of Completed Projects
- Regulatory Permits
 - Special Area Management Plans
 - Mitigation Banking
- Environmental Infrastructure Planning
- Drought Preparedness Planning
- Military Activities
 - Master Plans
 - Military Construction
 - Logistics
 - Mobilization Plans
- Restoration Planning
 - Formerly Used Defense Sites
 - Installation Restoration Programs
- Support for Others
- Strategic Planning
- Research and Development

Look Back, Look Ahead

Chapter I has explained

- the history of economics in the Corps of Engineers.
- the NED and RED principles.
- types of activities which use economic analysis.

Chapter II describes

- basic concepts in the science of economics.

Chapter II - Economics Fundamentals

Economics: *n. (used with a singular verb): The science that deals with the production, distribution, and consumption of commodities.*
(The American Heritage Dictionary)

Economic Discipline: *Studies how scarce resources are allocated among various [uses and] users.*
(Introduction to Economics web site – www.eco.nm.ru)

Economics—The Science of Choice

Economics is the **science of allocating resources**. We all apply economic principles every day.

All individuals, businesses, organizations and governments make decisions daily as to the trade off of resources. Our resources are commonly money or time. Do we buy a generic product or pay more for a name brand? Do we want to invest \$500 for a radio advertising spot for our new product? Is it worth \$10 million of taxpayers' money to construct a reservoir? Some of these decisions are based primarily on personal preferences, e.g., color, taste, size, or brand loyalty, while others are based on expectations, e.g., which car is the most reliable? Dollars are often used to express and compare economic values, but they are not the key to economics.

We all make choices everyday. How to spend our time. To spend or save our money. Economics is about making choices.

Economics is about how we make choices as individuals and as a nation. We apply basic economic principles and concepts when we decide what is most valuable to us: do we take a second job or spend more time with our family? These are relative values, not necessarily measured in dollars.

As the good or service we are considering becomes larger and more complex, the decision process becomes more difficult. For example, a large multiple-purpose water resource development project, such as a reservoir, requires a team of not only economists and engineers, but also other disciplines (biologists, ecologists, landscape architects, archeologists, social scientists, public information specialists) to help develop and design alternatives and to identify and describe the potential impacts on individuals, businesses, organizations, and government entities. Sorting through the enormity and myriad types of data to pick the best plan is a very difficult task.

Economists can bring to this team several concepts to help with analysis and decision-making. **Marginal analysis** and **opportunity costs** are two of the more important notions used by economists to help make decisions. This chapter discusses these and other important economic concepts. Although these concepts and their usefulness are well understood by economists, they may be unfamiliar or misunderstood by others.

Opportunity Costs

Because economists are concerned primarily with the efficient allocation of resources, economists define costs as opportunity costs. Opportunity costs are the cost of foregoing an alternative in favor of pursuing a different alternative. To an economist, cost is not necessarily the amount of money you spend to buy something. An example will help make this clear. Say you have a sponsor who donates land for an ecosystem restoration project. To a bystander the land would appear to have no cost. However, the economist values the land at \$10,000 an acre, its opportunity cost. The next best use of the land in this example is residential homes where acreage is valued at \$10,000 an acre. By using the land for ecosystem restoration, the chance to use it for homes is foregone. Opportunity costs allow the economist to accurately evaluate trade-offs in the use of resources.

Marginal Analysis

Economists focus on changes at the margin. Optimal choices are made using this information. NED benefits are maximized where marginal benefits are equal to marginal costs. Marginal costs are the change in total costs that result from increasing the output by one more unit. Marginal benefits are the change in total benefits that result from increasing the output by one more unit. When the economist evaluates the proper scale of a project, he looks to determine through marginal analysis whether the costs for additional channel depth exceed the benefits for this additional depth. When the marginal benefits of channel depth are equal to the marginal costs, NED benefits are maximized.

Scarcity

The economic discipline is a study of how resources are allocated among alternative uses and how outputs are distributed among competing demands. This is an issue of choice. Economics is the science of making rational decisions, and the fundamental problem is one of resource **scarcity**. To most of us, scarcity means “rare”. We do not have enough money to buy all that we want. While a resource such as wood is not rare, as a society there is not enough wood to satisfy all the uses we wish to make of it. This is the economic concept of scarcity—there are not enough resources to fulfill all wants. One of the most important resources affecting all our lives is time. Are we going to sleep, eat, attend a sports event, read a book, or watch TV? We have many

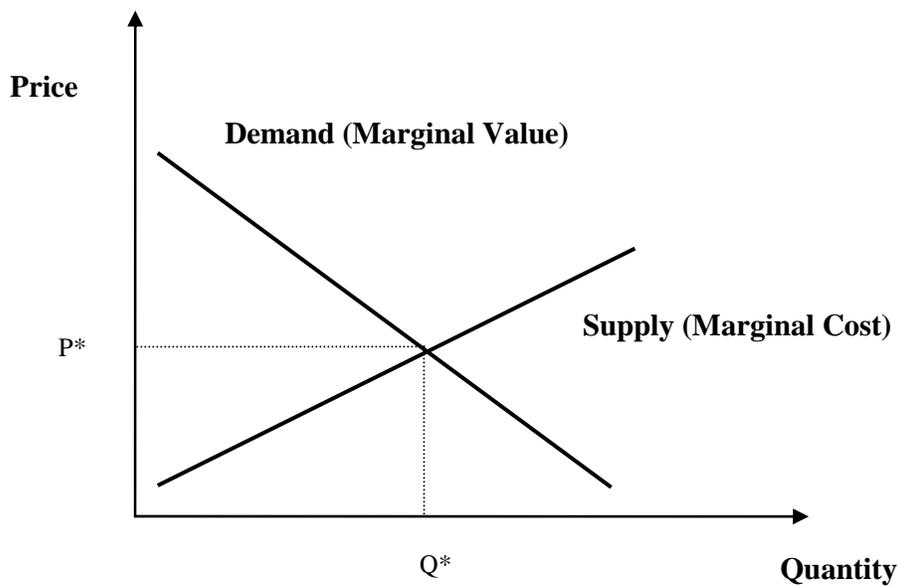
different options of how to spend our time, but the amount of time available is limited and we cannot do everything we would like to do.

The Rational Person
Economics assumes that people act rationally. They will seek to be as “well off” as possible. Individuals act in their own self-interest.

Supply and Demand

As with scarcity, supply and demand are basic concepts that we live with every day. Most of us know the “Law of Demand” well although we may not be familiar with that title. The “Law of Demand” states that, all other things being equal, if the price of a good goes up, the quantity purchased will go down and vice versa. This can be measured for specific goods and the relationship of price and quantity purchased shown graphically. This concept is intuitively obvious—if the price of Jaguar automobiles were reduced the demand for Jaguar’s would increase.

The demand curve is also referred to as the willingness to pay curve. It measures how much people are willing to pay for each additional unit of a good or service.



The supply curve is the other part of the demand and supply equation. It states that, all other things being equal, if the price of a good goes up, the quantity produced will go up and vice versa. Thus, if the price of Jaguars fell dramatically, the manufacturer would be willing to produce fewer of them. When supply and demand are in equilibrium, the price is at a point that what people are willing to buy and what producers are willing to sell are the same. Those buying and those selling the product value it equally.

Making Choices

We must make choices, or **trade-offs** every day. Choose doing more of one thing and we must simultaneously do less of something else. Every choice costs us something in terms of the resources used. At a minimum it costs us the opportunity to do the next best thing with those resources, which is known as the opportunity cost--that is what we did not do.

For example, the concrete and steel that might be used in constructing a floodwall could be used in many other ways. Using these resources in a floodwall means they will not be available for use elsewhere, for example in an office building. Thus, the floodwall costs us an opportunity to do something else with the resources. Some people might be inclined to argue that concrete and steel are not "scarce" in the common usage of the word. All resources are scarce--that is limited. Their prices are an indication of their relative scarcity. Thus concrete and steel, though easily obtained, are not unlimited.

What Do We Compare? Without- and With-Project Conditions

Another key concept in evaluating the allocation of resources for water resource developments is **without- and with-project conditions**. The period of analysis for such projects frequently extends fifty years into the future. Evaluation of a project is, therefore, not dependent on existing conditions, but what is most likely to occur in the future, either with or without the project.

In defining our without-project condition we begin with projections of economic activity, including population growth, jobs, and income. These projections are translated into development, trade, and transportation demand, in the study area. Fifty years from now there may be more people and thus more demand for inland navigation.

When we buy a house we evaluate future conditions: how many other houses will be built in surrounding areas? What will traffic be like in 20 years? Are new roads being built? Is the airport expanding? If we plan to live in a house for many years, these factors are part of our decision.

But Corps economists are not just concerned with development. Corps economists are also concerned with other actions that may be undertaken in the absence of the alternatives being considered in our study. Will restrictions be enacted, in terms of location or type of construction so there is less damage from a flood? Or will some other entity undertake an action that might affect the flood risk for all or part of the study area, such as providing a small levee that would reduce flood damages to a portion of the study area? Such actions change the without-project conditions as compared to existing conditions. Correctly describing the without- and with-project conditions is important so that we can accurately predict the benefits that a project produces.

Change will always occur in the absence of the alternatives that Corps planners are considering in a study. This is the without-project condition. To correctly evaluate the benefits and costs of the alternatives we are considering, we must compare the *changes* between the future *without*-project conditions and the future *with* a particular alternative (with project condition). The Corps cannot consider only the existing condition as a static basis.

***No action** is the default choice. A project should be implemented only if it is better for society than doing nothing. The project must be convincingly shown to be preferred over no action, i.e., no project.*

How Do We Compare Over Time?

Time and comparisons over periods of time are important in evaluating projects. Project costs are incurred primarily at the time of construction. Benefits accrue in varying amounts over the project life. When benefits and costs are measured in monetary terms, dollars spent on construction today cannot be directly compared to the dollars in benefits that will be realized years from now. One million dollars in costs today is not the same as one million dollars in benefits received 20 years from now. All other things being equal, a rational person (someone who is maximizing their current resources) prefers one dollar now to one dollar in the future, even when inflation is not a concern.

Discounting is the process of equating monetary values over time. It defines future sums of money in an equivalent value today. Discounting requires the use of a **discount rate**. The discount rate is society's opportunity cost of current consumption. That is, it is the rate society would use to equate amounts of money at different points in time. Using the discount rate, values can be expressed in current dollars and spread over the life of the project producing an "annual average" value for costs and for benefits. This provides a common base of reference for a variety of projects. What that discount rate should be is a matter of debate even among economists. Congress has resolved the dilemma for water resource agencies; the discount rate used in evaluating water resource

projects is set annually, by law (Section 80 of PL 93-251), based on the cost of government borrowing.

Look Back, Look Ahead

Chapter II discusses

- the basic principles that underlie economic analysis
- how these principles are incorporated in the economic analysis performed by the Corps of Engineers

Chapter III will discuss

- what economists do.
- benefit cost analysis.
- cost effectiveness analysis.
- Incremental cost analysis.

CHAPTER III - ECONOMISTS AND ECONOMIC TECHNIQUES

“In my opinion, economists and sociologists are the people to whom we ought to turn more than we do for instruction in the grounds and foundations of all rational decisions.”

Oliver Wendall Holmes

What Do Economists Do?

Economists are often quoted in newspapers and interviewed on radio and television. These economists are usually concerned with the impact of government policies, analyzing specific industries, evaluating international trade or explaining their political party's economic policies.

Economists in the Corps of Engineers are concerned with these topics because they are pertinent to the economist's role of evaluating water resources projects. Justice Holmes encapsulates the economist's role well—economists provide information in a consistent, structured framework to assist decision makers in making the best possible decisions. Economists strive to have the best available data and science. They specialize in clarifying and documenting assumptions so all concerned are aware of the base upon which an analysis is built.

The economist is a key member of the project delivery team and a primary integrator of information from hydrologists, cost engineers, design engineers, environmental specialists, real estate personnel, archaeologists and program analysts. The economist also collects and analyzes data measuring the benefits of a proposed project. In order to perform their wide range of duties, the economist usually has professional education in economic theory and application. Good writing and communication skills are also essential. Economists often serve the Corps as project managers, supervisors, financial specialists, strategic planners, Congressional liaisons and in other roles because their skill-set is useful to various needs and positions within the agency.

Types of tasks and analyses often performed by Corps' economists:

Identify problems and opportunities; define without-project conditions; quantify and value project outputs; identify project costs; optimize net benefits; allocate costs to project purposes; evaluate risk and uncertainty; define regional and social impacts; assess the non-Federal sponsor's financial capability.

Why Do Economic Analysis?

There are many reasons why individuals or a government agency may want to do economic analysis, but two of the most important are to minimize the resources used to produce a result and to maximize the satisfaction from the result achieved. Some might want to say instead, to minimize dollar costs and to maximize dollar benefits, but economic analyses do not always require measurement in dollar terms. The primary reason for economic analysis by the Corps is to inform decision makers of the value of alternative solutions to water resources problems.

Resources do not have to be money. Time is the most valuable resource to many of us.

Your child, Daisy, receives an allowance of \$10 each week. From her allowance she must provide herself with lunch on schooldays. She can buy lunch at school for \$1 a day or pack a lunch for \$.50 a day. Daisy must decide how to maximize her satisfaction (have a lunch so she isn't hungry) and use her resources (determine whether it is worth the extra time to pack a lunch versus having more money left to buy other items).

Daisy's basic resources are time and money. Her measures of satisfaction are having lunch each day and spending her money on other items, such as movies or clothes. Daisy's choices are familiar to us.

To an economist, when she decides how to spend her money and time, she has made an "*allocation of scarce resources.*"

The above example is not unusual. You can probably quickly think of a similar one in your life. Often individuals are making choices between a relatively small number of alternatives, involving a limited number of resources. However, as the number of alternatives and combinations of resources increases, the decision process becomes more complex and difficult. While the principles of making choices are simple, performing economic analyses can be complex and requires advanced training. Economic evaluation techniques, such as benefit-cost analysis, cost effectiveness analysis, and incremental cost analysis, can help decision makers minimize costs (resources used) to taxpayers while maximizing benefits (satisfaction to society).

Benefit-Cost Analysis

Benefit-cost analysis is a technique to evaluate in monetary terms what is achieved (benefits) in comparison to what is invested (costs). It is used to ensure that the value of the benefits exceeds the value of the costs, or, in other words, resources are allocated in the most efficient manner possible. When both benefits and costs can be measured in monetary terms, then **benefit-cost analysis** can help decision makers select the best solution.

Benefit-cost analysis involves two mathematical comparisons:

- **Net benefits** are calculated by subtracting total economic costs from total economic benefits.
- A **benefit-cost ratio** is calculated by dividing total economic benefits by total economic costs.

Why two ways to look at benefits and costs? What do they mean? How do we use them?

- Net benefits represent the amount of total benefits less the total costs. This analysis is used to select and scale a recommended course of action from an array of alternatives.
- A benefit-cost ratio tells us which alternative produces the most benefits for every dollar of cost (total benefits/total costs). The benefit-cost ratio is useful for comparing or ranking different projects. Once the optimal scale of the alternative is identified by measuring net benefits the benefit-cost ratio can be used to rank among competing investments.

The following example illustrates the relationship between net benefits and the benefit-cost ratio.

	Alternative A	Alternative B	Alternative C
Benefits	\$500,000	\$750,000	\$1,000,000
Costs	\$125,000	\$500,000	\$500,000
Net Benefits	\$375,000	\$250,000	\$500,000
BCR	4.0	1.5	2.0

Alternative C produces the most net benefits although its benefit-to-cost ratio is lower than that of Alternative A. Alternative C is identified as the best plan based on maximum net benefits produced.

A benefit-cost ratio of 1.0 indicates that the total benefits equal the total costs. In other words for every dollar of cost, a dollar of benefits is produced. If the benefit-cost ratio is less than 1.0, the total costs are greater than total benefits which is not a good economic investment.

So what is the benefit-cost ratio used for? In the Federal appropriation process, different projects at different locations across the Nation for different purposes, such as flood risk management and navigation, are compared and prioritized. The benefit-cost ratio shows which projects provide the most benefits per dollar of cost (benefits/costs). Projects with high benefit-cost ratios produce benefits the most efficiently per dollar invested. The benefit-cost ratio is one factor in determining which projects will be funded, given that Federal funds are limited, i.e., scarce.

A benefit-cost ratio allows dissimilar projects to be compared. It shows which investments give “the most bang (benefits) for the buck”.

Cost Effectiveness and Incremental Cost Analysis

Benefit-cost analysis is the primary analysis framework used by the Corps in evaluating water resources development projects. In the 1990’s when the Corps began undertaking ecosystem restoration projects—projects with outputs that are often not measured in monetary terms—other evaluation techniques were needed.

Historically, environmental outputs have been expressed as changes in physical items, such as acres of wetlands, or changes in populations, such as number of ducks or fish. No matter what the unit, if it is not converted to a monetary measure, then benefit-cost analysis cannot be used. However, there are other techniques, such as cost effectiveness and incremental cost analysis, which employ the concepts and theories of economics and can help the decision maker allocate scarce resources without dollar values.

The primary objective of cost effectiveness analysis is to identify a set of **efficient** alternatives for further evaluation. Inefficient alternatives are eliminated from further consideration. Alternatives are inefficient and not cost effective if:

- the same level of output (benefit) can be produced by another alternative for less cost or
- another alternative can provide more output (benefit) for the same or less cost.

Cost effectiveness analysis, by itself, will not tell you which of the alternatives is the *best solution*, but it can reduce the number of alternatives from which the best solution should be chosen.

After the inefficient alternatives have been eliminated using cost effectiveness analysis, **incremental cost analysis** can provide additional information about the best solution for a particular situation. Total cost and total output information for each alternative are used for cost effectiveness analysis, incremental cost analysis uses data showing the *difference* in cost (incremental cost) and the *difference* in output (incremental output) between each efficient alternative and the next larger alternative. Incremental cost analysis illustrates the additional cost for each additional unit of output.

Cost effectiveness and incremental cost analyses will not identify an objective “best” solution from the alternatives available, as is the case with benefit-cost analysis. However, they do provide useful information for decision makers. Selection of the preferred alternative may be guided by output “targets” (legislative requirements or regulatory standards, for example), maximum cost thresholds or other factors.

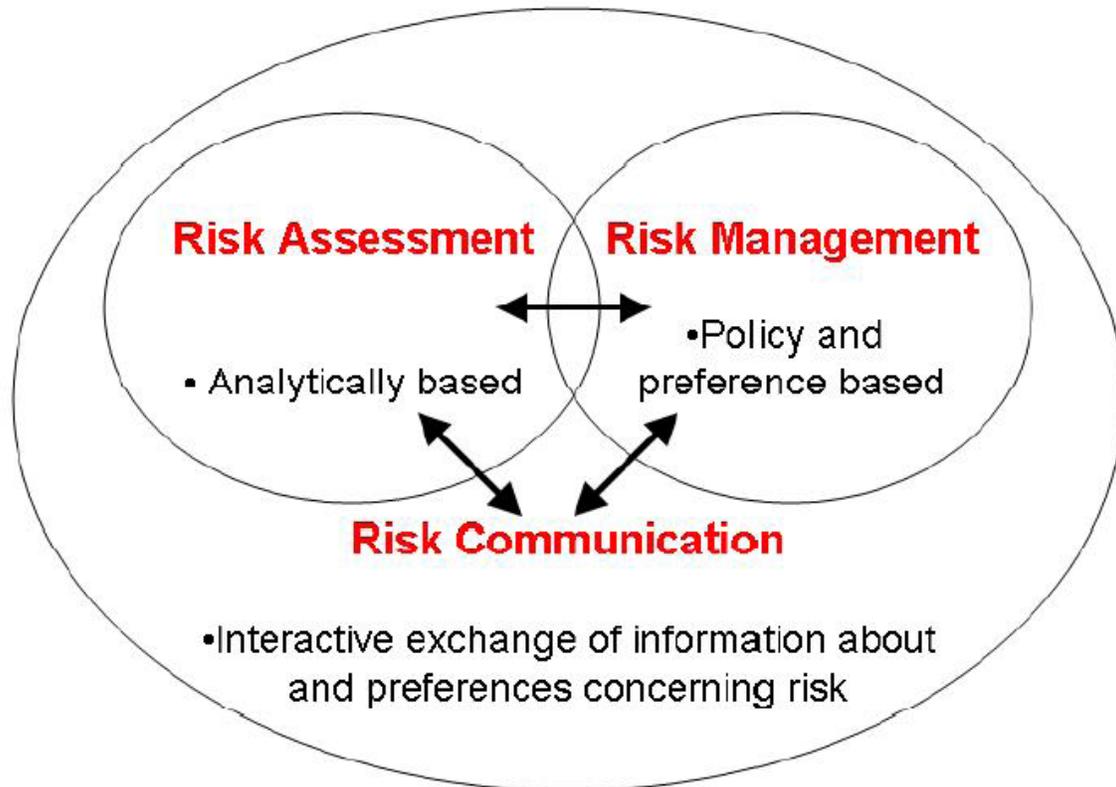
What is Risk Analysis?¹

The Corps is transforming to a risk-based management organization. Risk is a measure of the probability of undesirable consequences. Risk analysis is a decision-making framework that explicitly evaluates the level of risk if no action is taken and recognizes the monetary and non-monetary costs and benefits of reducing risks when making decisions. Risk analysis comprises three tasks: risk assessment, risk management, and risk communication. Risk analysis organizations pursue their missions by managing risks. Risk analysis is being adopted by a growing number of organizations nationally and globally including the Corps of Engineers.

The figure² on the following page shows the interrelatedness of the three parts of risk analysis and the notion that risk communication is a vital and joining activity that must take place for the analysis to be an effective decision framework. Note that the technical scientific work takes place in the risk assessment while risk management is more concerned with applying social values and policy to sort through options and tradeoffs revealed in the risk assessment.

¹ Moser, Dave, et. al. “White Paper: Transforming the Corps into a Risk-Management Organization.” U.S. Army Corps of Engineers. 2007

² This figure is from the World Health Organization, www.who.int/foodsafety/micro/riskanalysis/en/. 2008



Are There Other Factors?

Benefit-cost analysis, cost effectiveness and incremental cost analyses are economic techniques that can help to inform decisions about the efficient and effective (achieves the project goal) allocation of resources. However, as noted earlier, different study participants may have different perspectives (for example national versus regional) regarding the importance of specific benefits and costs.

In the Corps' Civil Works Program, the Federal *Principles and Guidelines* require that the plan that reasonably maximizes net national economic benefits consistent with protecting the nation's environment, the National Economic Development Plan or the NED Plan, be selected unless an exception is granted. Common factors that influence the selection of a plan other the NED Plan include regional, environmental, and other social effects considerations. For example a flood risk management project that does not provide positive NED benefits may still be worthwhile if it provides for adequate flood protection for a disadvantaged community. Projects that are not formulated to maximize net benefits are the exception, not the rule.

Summary

The Corps uses economic analysis to inform investment decisions in water resource development management. Techniques like benefit-cost analysis and incremental and cost effectiveness analysis provide valuable information in the evaluation of these investment decisions. Central to these evaluations are fundamental economic concepts that allow the economist to compare incremental resource tradeoffs over time. These methods and concepts allow the Corps to inform stakeholders, Congress and the nation about water resources investments.

Look Back, Look Ahead

In chapter III we have learned

- what economists do
- some techniques economists use to perform economic analyses

Chapter IV provides

- sources of additional information on economics as a discipline
- discussion of the application of economics in the Corps.

CHAPTER IV - IF YOU WANT TO KNOW MORE

“Let there be light.”

(As quoted by the super computer in an Isaac Asimov short story)

Headquarters, U.S. Army Corps of Engineers

Extensive information about the Corps and its economic policies and economic analyses can be accessed via its home page at www.usace.army.mil.

Institute for Water Resources

In support of the Headquarters of the Corps of Engineers, the Corps' Institute for Water Resources (IWR) conducts research, special studies and field support to more fully develop and implement planning and economic techniques and policy. Products including manuals, policy reports and software are listed on the IWR web site www.iwr.usace.army.mil.

IWR has developed a series of *National Economic Development Manuals* to help field offices in applying benefit-cost analysis to water resources development projects consistently across the nation. A multi-year effort is currently underway at IWR, in conjunction with Headquarters, to update the National Economic Development Manual series. This Primer is a part of that effort. The updated manuals will be posted on the IWR website.

Other Sources of Information

The Corps has research laboratories and centers of expertise as well as its Division and District offices that have numerous research studies, manuals, or projects reports that provide information on economic analyses. The locations of these organizations can be found on the Headquarters home page, www.usace.army.mil, by clicking on *Where We Are*.

The web sites of many Federal and State agencies contain a wealth of information on how economics is used in specific programs. Universities, libraries and even popular literature can provide general to extremely specific information on economic theory, policy and techniques.

We use economics everyday—learn more about it!

Appendix A: Accounting for the Timing of NED Effects

The estimated NED costs and benefits for some project plan typically would be realized in different time periods, and often in varying amounts, throughout the project time horizon. For example, construction costs for some plan might be realized in several (constant or varying) increments over the initial years following commencement of the project, while plan operation and maintenance costs and plan benefits might not begin until project construction was completed, at which point they might be realized as (constant or varying) annual flows throughout the project useful life. When plan benefits and costs are separated in time from each other, it would be incorrect for the calculation of plan net NED benefits to simply sum all of the estimated NED benefits and costs without taking account of when they are expected to occur. In order to accurately calculate plan net NED benefits, the annual time streams of estimated benefits and costs must be translated into total values at a common point in time.

The reason that the annual time streams of estimated plan NED benefits and costs must be translated into total values at a common point in time is the recognition that people value a given level of consumption today more highly than they value the same amount of consumption at some future point in time. The procedure by which plan NED benefits and costs that occur in future time periods are translated into comparable total values is called “discounting.” In essence, discounting is an added valuation procedure that measures the “time value” of plan benefits and costs that occur in future time periods.

The discounting procedure employs a formula that includes an interest rate (discount rate) reflecting the rate at which people are assumed to be willing to trade-off future consumption for current consumption. The interest rate used for civil works studies is calculated annually by the U.S. Treasury using a prescribed formula, and is published each year by Corps Headquarters as an Economic Guidance Memorandum.

Corps guidance requires that the period of analysis for converting NED benefits and costs into comparable values should be the same for each alternative plan, and include the time required for plan implementation plus the time period over which any alternative would have significant beneficial or adverse effects. In studies for which alternative plans have different implementation periods, Corps guidance says that a common “base year” should be established for calculating total NED benefits and costs, reflecting the year when the project is expected to be “operational.” The estimated annual streams of NED benefits and costs expected to occur in time periods following the base year are to be discounted back to the base year using the prescribed interest rate. And since the implementation period for some plan may begin prior to the base year, any estimated NED benefits and costs for that plan expected to be realized before the base year are to be “compounded” forward to the base year. That is, for plan benefits or often known as “benefits during construction” and

costs expected to be realized before the base year, the discounting procedure is applied in reverse, so that the interest rate serves to compound rather than discount those effects to the base year. The same prescribed interest rate is to be used for both compounding benefit and cost streams that occur prior to the base year, and for discounting benefit and costs streams that occur after the base year.