An Economic Evaluation of Proposed Flood Protection Plans on the Upper Mississippi River and Illinois Waterway

Prepared for

The Rock Island District

U.S. Army Corps of Engineers

By

The Tennessee Valley Authority

October 14, 2004

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Definitions Of Economic Impact Measures

In this document, four economic measures are used to gauge the regional impacts of flood protection. These measures are as follows:

Gross Regional Product. For each state, the gross regional product is an estimate of that state's share of the nation's gross domestic product, which is the total value of the goods and services produced by labor and property in the United States.

Employment. For each state, employment is defined by the Bureau of Economic Analysis as the sum of total full and part time jobs held by workers. Employment is based on the place of work and includes proprietors employment.

Output. Output is defined as the amount of production in dollars, including all intermediate goods purchased as well as value-added (compensation and profit). Output can also be thought of as sales.

Real Personal Income. Personal income is a Bureau of Economics concept based on place of residence. It is the sum of wage and salary disbursements, other labor income, proprietors' income, rental income, personal dividend income, personal interest income, and transfer payments, less personal contributions for social insurance.

Note on Flood Insurance

Two assumptions are made in this study due the paucity of flood insurance premium data in the region. In one case, it is assumed that half of the average annual damages avoided (AADA) in the study regions is compensated with federal and state disaster relief money. This means as much as one half of the AAD would be an increase in regional expenditures in the with-project condition. For the second case, it is assumed that 75 percent of the AADA are supplied from outside to the region. This implies that 25 percent of the AAD would be an increase in regional expenditures. A range of impacts is thus provided.

In the tables where total impacts are presented, data generated in the first case (50 percent) are presented. Additional results for simulations where case 2 holds have been provided to the Rock Island District of the U. S. Army Corps of Engineers.

Executive Summary

This study examines the economic impacts of three flood protection plans: (1) confined 500 year, (2) unconfined 500 year, and (3) unconfined 500 year with a maximum 99 year agricultural protection plan. The 500 year protection plan (termed plan C1) would achieve flood damage reduction (FDR) benefits using a purely structural approach. The major feature would be raising existing levees and floodwalls to the 500-year protection level, with no restrictions regarding induced river stages. At such a high level of protection, levees and floodwalls could be certified for future development. With escalating land values for development (due to this extremely high level of protection), a habitat incentives/conservation easements program would not likely be a competitive alternative land use.

The unconfined 500 year plan (termed U1) would achieve FDR benefits using levees and floodwalls in all floodplain areas except for agricultural unprotected areas. All existing urban protected, urban unprotected, and agricultural protected areas would be protected to the 500-year level. Unlike Plan C1, Plan U1 attempts to (1) limit the induced water surface rise imposed by new levee construction to below one foot for the 100-yr event, and (2) minimize impacts to the Lower Mississippi Valley Mississippi River and Tributaries (MR&T) projects. Like Plan C1, this plan would not likely compete well for future habitat development.

The unconfined 500 year plan with the associated 99 year agricultural plan (termed U3) is identical to Plan U1, except that its flood protection level in the agricultural protected areas has been lowered to less than 100 year. Since the protected agricultural areas in the U3 plan would not be eligible for certification, they could serve as a viable candidate for habitat restoration incentives and easements.

In the study five potential economic impact paths were evaluated: construction, economic development, land value enhancement, farm income gains, and flood

damages averted. Since Plans C1 and U1 provide flood protection for at least the 100 year flood for urban and agricultural areas, the five state benefits provided should be similar, exclusive of the impacts of the construction itself. The costs for plan C1 are higher than for U1 since more construction would be required to provide the greater level of flood protection, and thus the regional benefits due to construction should be higher in Plan C1.

The regional benefits for Plan U3 should be lower than found in Plans C1 and U1 due to levee improvements in the agricultural areas only being upgraded to protect (at the maximum) against a 99 year flood event. Costs should also be lower in Plan U3, and thus the regional benefits due to construction should be lower than in C1. Table E1 shows the project cost of the three plans as present values discounted at 5.625 percent. Plan C1 costs $5.803 billion as compared to costs for U1 and U3, respectively of $3.6 billion and $2.7 billion.

Table E1: Project Cost Present Values for Alternatives C1, U1, and U3
(Billions of $03)

	C1	U1	U3
5 State Area	$5.803	$3.632	$2.671

In the study, TVA estimates the flood control economic impacts with an economic model constructed by Regional Economic Models Inc. (REMI) of Amherst, Massachusetts. REMI models are econometric models with highly detailed input-output industry categories. REMI translates the direct impacts into total impacts reflecting multiplier relationships between some change in an economy (a direct impact) and the succeeding economic activity that occurs as a result of that change (the indirect and induced impacts of the project or action). The direct impacts from improved flood protection of the project proposals occur in five areas: construction, economic development, land value enhancement, farm income gains, and damages averted.

Table E2 shows the REMI-estimated total regional benefits of the flood control projects in the five state study area, as measured by present value GRP, are

$30.381 billion in C1, $27.091 billion in U1 and $22.029 billion in U3. Benefits are dominated by economic development and construction, together accounting for 95 percent of total benefits ($29.086 billion) in alternative C1. This is not to argue that other impacts are not significant because damages averted are estimated to be $179 million, and farm income is $1.045 billion. The economic development impact of the increase in property is $72 million.

Table E2: Five State Area Present Value GRP Impacts By Type of Impact For Alternatives C1, U1, And U3 (Billions of $03)

Impact	C1	U1	U3
Construction	$8.559	$5.268	$3.803
Economic Development	$20.527	$20.527	$18.079
Damages Averted	$0.179	$0.179	$0.099
Land Values	$0.072	$0.072	$0.006
Farm Income	$1.045	$1.045	$0.042
Total	$30.381	$27.091	$22.029

Table E3 shows the distribution by state of total economic impacts, as measured by GRP, for each of the three plans. Benefits cluster in Illinois, which accounts for 79 percent of total benefits in all three cases, Iowa and Missouri make up most of the remainder. For the C1 alternative, the Illinois GRP impacts is $24 billion. Also for C1, Iowa, at $2.7 billion, and Missouri at $2.2 billion, together account for 16.5 percent; Wisconsin, at $819 million, and Minnesota, at $548 million, make up the remaining 4.5 percent.

Table E3: Present Value GRP Impacts For Alternatives C1, U1 And U3 (Billions of $03)

Region	C1	U1	U3
Illinois	$23.999	$21.459	$17.518
Iowa	$2.768	$2.687	$2.411
Minnesota	$0.548	$0.498	$0.423
Missouri	$2.248	$1.804	$1.230
Wisconsin	$0.819	$0.642	$0.477
Total	$30.381	$27.091	$22.029

Impacts for two other monetary measures captured in this study are closely proportional to GRP impacts across regions and across sources of impacts. Total impacts for these two measures are shown in Table E4.

Table E4: Additional Present Value Measures Of Total Impacts For Alternatives C1, U1, And U3 (Billions of $03)

Measure	C1	U1	U3
Real Personal Income	$25.295	$22.730	$17.719
Output	$51.518	$45.618	$36.985

Table E5 shows the distribution by state of total economic impacts, as measured by average annual employment, for each of the three plans.

Table E5: Average Annual Employment Impacts By State For Alternatives C1, U1 and U3

Region	C1	U1	U3
Illinois	20,724	19,039	15,431
Iowa	2,430	2,397	2,192
Minnesota	291	275	237
Missouri	1,800	1,353	855
Wisconsin	445	364	252
Total	25,690	23,428	18,966

Table E6 details the costs and economic impact findings for alternative C1[1, 2]: Similar tables for Plan U1 and Plan U3 are furnished with the report.

Table E6: Project Costs And Detailed Impacts for Alternative C1 (present values for monetary items and average annual for employment)

Project Costs ($03B)

	Construction
Illinois	$3.493
Iowa	$0.247
Minnesota	$0.253
Missouri	$1.597
Wisconsin	$0.231
Total	**$5.803**

[1] The Southern region is defined as Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Tennessee, and Texas.

[2] TVA used Census population and construction worker commuting patterns recorded at large TVA construction projects to allocate construction expenditures among states. Additionally, trade flow data built into the REMI databases allocates certain purchases, and thus employment and earnings, across state borders.

Project Impacts

GRP ($03B)	Construc-tion	Economic Dev.	Damages Averted	Land Values	Farm Income	Total
	Type Of Impact					
Illinois	$5.091	$18.135	$0.099	$0.038	$0.637	$23.999
Iowa	$0.443	$2.218	$0.012	$0.006	$0.089	$2.768
Minnesota	$0.493	$0.000	$0.012	$0.003	$0.039	$0.548
Missouri	$1.835	$0.174	$0.031	$0.020	$0.187	$2.248
Wisconsin	$0.696	$0.000	$0.024	$0.005	$0.093	$0.819
5-States	**$8.559**	**$20.527**	**$0.179**	**$0.072**	**$1.045**	**$30.381**
Southern Region	$0.629	$0.000	$0.027	$0.010	$0.162	$0.827

Real Pers. Inc. ($03B)	Construc-tion	Economic Dev.	Damages Averted	Land Values	Farm Income	Total
Illinois	$4.399	$15.640	$0.060	$0.064	$1.253	$21.415
Iowa	$0.207	$1.167	$0.004	$0.008	$0.121	$1.508
Minnesota	$0.272	$0.000	$0.002	$0.001	$0.013	$0.287
Missouri	$1.169	$0.120	$0.015	$0.037	$0.305	$1.647
Wisconsin	$0.384	$0.000	$0.014	$0.002	$0.038	$0.438
5-States	**$6.431**	**$16.927**	**$0.096**	**$0.112**	**$1.729**	**$25.295**
Southern Region	-$0.068	$0.000	$0.009	-$0.001	$0.000	-$0.060

Output ($03B)	Construc-tion	Economic Dev.	Damages Averted	Land Values	Farm Income	Total
Illinois	$9.073	$29.962	$0.159	$0.062	$1.055	$40.312
Iowa	$0.807	$3.711	$0.021	$0.009	$0.151	$4.699
Minnesota	$0.903	$0.000	$0.021	$0.006	$0.072	$1.002
Missouri	$3.332	$0.279	$0.050	$0.033	$0.310	$4.003
Wisconsin	$1.279	$0.000	$0.041	$0.008	$0.173	$1.502
5-States	**$15.395**	**$33.952**	**$0.291**	**$0.118**	**$1.762**	**$51.518**
Southern Region	$1.384	$0.000	$0.053	$0.018	$0.320	$1.775

Employment	Construc-tion	Economic Dev.	Damages Averted	Land Values	Farm Income	Total
Illinois	3,275	16,765	86	29	569	20,724
Iowa	259	2,076	10	5	81	2,430
Minnesota	256	0	9	2	23	291
Missouri	1,388	182	30	17	184	1,800
Wisconsin	362	0	19	3	62	445
5-States	**5,539**	**19,023**	**154**	**56**	**918**	**25,690**
Southern Region	144	0	17	5	87	253

Introduction

> *…uncontrolled runoff is detrimental to human health and welfare, is certainly detrimental to economic development, disrupts various recreational pursuits and in many cases has been deemed detrimental to managed ecosystem refugee developments.*[3]

This study estimates the economic impacts of three flood protection plans: (1) confined 500 year, (2) unconfined 500 year, and (3) unconfined 500 year with a maximum 99 year agricultural plan. The 500 year confined protection plan (termed plan C1) would achieve flood damage reduction (FDR) benefits using a purely structural approach. The major feature would be raising existing levees and floodwalls to the 500-year protection level, with no restrictions regarding induced river stages. At such a high level of protection, levees and floodwalls could be certified for future development. With escalating land values for development (due to this extremely high level of protection), a habitat incentives/conservation easements program would not likely be a competitive alternative land use.

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The unconfined 500 year plan with the associated 99 year agricultural plan (termed U3) is identical to Plan U1, except that its flood protection level in the agricultural protected areas has been lowered to less than 100 year. Since the

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[3] McMurray, Dave. River Currents, UMIMRA, Volume MMIV, Issue 2, page 1.

protected agricultural areas in the U3 plan would not be eligible for certification, they could serve as a viable candidate for habitat restoration incentives and easements.

Overview

In the study, TVA estimates total economic impacts resulting from flood control with an economic model constructed by Regional Economic Models Inc. (REMI) of Amherst, Massachusetts. REMI models are econometric models with highly detailed input-output industry categories. The direct impacts of the project proposals, which are inputs to the REMI Model, result from evaluations of five potential impact sources: construction, economic development, land value enhancement, farm income gains, and flood damages averted,.

Direct construction activity results in indirect impacts in the local economy as money spent on construction labor and the purchases of materials and equipment generate additional income and employment in a multiplier fashion. In a large construction project, impacts can range well distant from the local or regional construction area as purchases are made over long distances, as construction workers migrate to the construction site and leave their families at home where the construction earnings are partially spent, and as certain of the construction work is done by private companies at remote locations.

As flood risks are reduced in the floodplains, the likelihood of economic activity may increase due to reduced costs of operation, since flood insurance could become unnecessary or available at reduced rates due to having flood protection that exceeds the 100 year flood level. Portions of land previously zoned to prohibit development could become usable. Infrastructure development (highways, railroads, and utilities) might be more feasibly upgraded with levees in place, which may also spur development.

With better flood protection, flood damages would be averted over time. Most flood insurance is actuarially based[4], and thus most that purchase flood insurance should enjoy reduced premiums. Those not insured can be considered to be self insured. Thus, for the majority, those residences and commercial establishments without flood insurance, better flood protection lowers the implicit premium for their self-insurance, making available increased dollars for consumption expenditures.

Better flood protection also raises the value of floodplain land. The result is a wealth increase for floodplain owners. This increased wealth is expected to be converted over time to landowners' annual income streams.

Lastly, there will be gains in farm income as the floodplain farms become more productive with less flooding.

In the study, the extraordinarily voluminous amounts of data generated in the various simulations are converted from annual estimates to present values. This is done by using the federally mandated discount rate of 5.875 percent. The impacts are measured by four economic quantities: gross regional product (GRP), real personal income (RPI), output (OUTP), and employment (EMP). Detailed annual values are presented for all four variables on an accompanying compact disk, while discounted and summarized data are presented in this report.

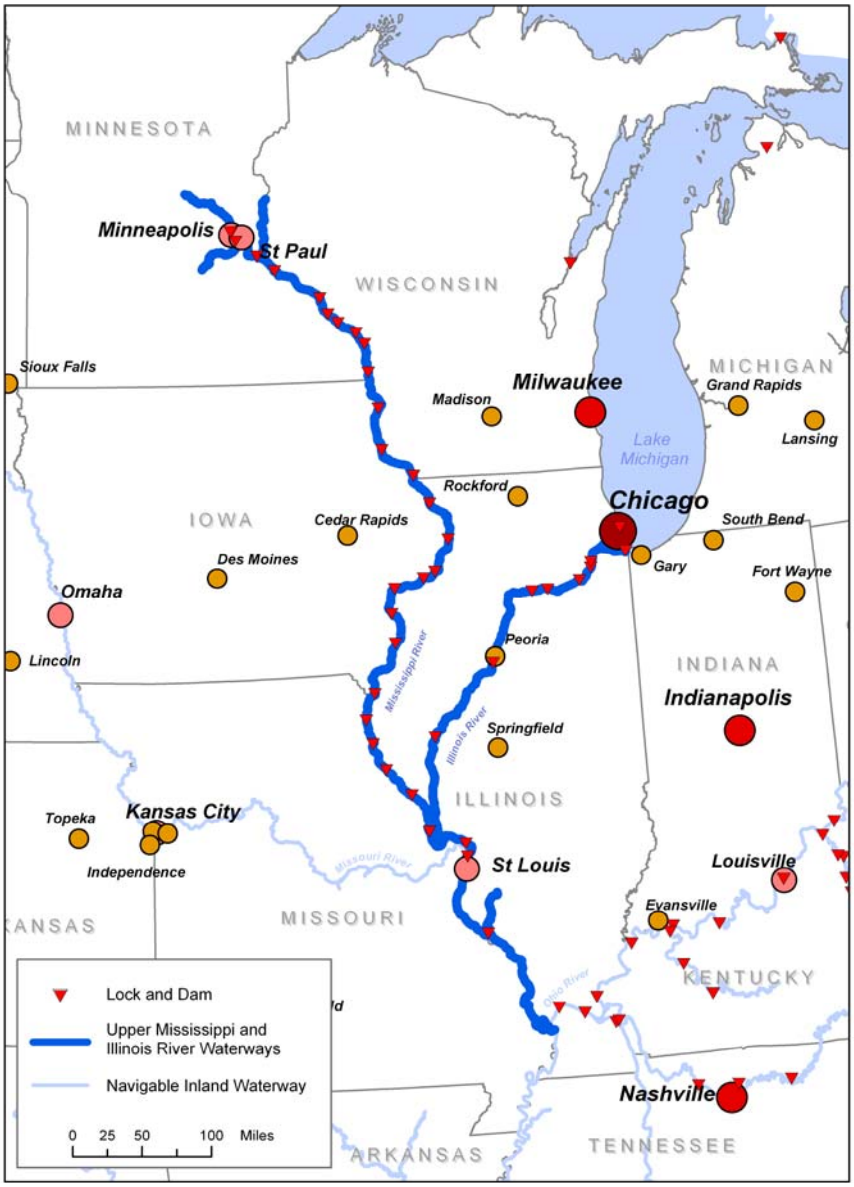
Regional Description

The study area of the upper Mississippi River-Illinois Waterway is shown in Figure 1. The study area comprises an entire navigation system and a portion of another—the Illinois Waterway and the Mississippi River, respectively. The study area is defined precisely as the Illinois Waterway from the confluence with the Mississippi River at Grafton, Illinois, River Mile 0.0, to T. J. O'Brien Lock in

[4] The exception is highly subsidized pre-FIRM rates (about 19% of all coverage).

Chicago, Illinois, River Mile 327.0, and the segment of the Mississippi River from the confluence with the Ohio River, River Mile 0.0, to Upper St. Anthony Falls Lock in Minneapolis-St. Paul, Minnesota, River Mile 854.0. Its combined area includes approximately 1,200 miles of navigable waterway.

Figure 1: Penetration of the upper Mississippi River Traffic



As shown in Table 1, the primary impact area of improvements to the Upper Mississippi River and Illinois Waterway includes five states: Illinois, Iowa, Minnesota, Missouri, and Wisconsin. Together, these states contain more than 11% of the nation's population, with total population in 2000 of about 31.2 million (Table 1). The states range in size from Illinois with a population of about 12.4 million to Iowa with a population of over 2.9 million. With the exception of Illinois, these states are more rural than the nation as a whole. Iowa is the most rural, with almost 39% of its population living in rural areas, followed by Wisconsin with almost 32% of its population in rural areas.

All of the states in the primary impact area have been growing more slowly than the national average over the past several years. From 1980 to 2000, Iowa had a very small increase in population, about four-tenths of one percent, reversing a decline since the 1980s. The other four states experienced larger population increases, ranging from 20.7% in Minnesota to 8.7% in Illinois.

Average income levels in this area are slightly higher than the national average, with per capita personal income in 2001 at $30,959, compared to the national average of $30,413. The income range among the states is from $27,225 in Iowa, 89.5% of the national average, to $33,059 in Minnesota, 108.7% of the national average.

All of the area states are more dependent on manufacturing earnings than the nation as a whole, especially Wisconsin which, in 2001, derived 23.2% of earnings from manufacturing. On the other hand, both Illinois and Missouri are only slightly more dependent on manufacturing, 13.8% and 13.6% of the total, respectively. With the exception of Iowa, the states derive about the same or less of their total earnings from agriculture. In 2001, Iowa derived 2.8% of its earnings from agriculture compared to the national average of 0.9%.

Table 1: Population, Income, and Employment Data for the Five Study State Area

	Illinois	Iowa	Minnesota	Missouri	Wisconsin
Population, 2000	12,419,293	2,926,324	4,919,479	5,595,211	5,363,675
Percent Rural, 2000	12.2	38.9	29.1	30.6	31.7
Population Increase, 1980-2000 (%)	8.7	0.4	20.7	13.8	14.0
Per Capita Personal Income, 2001	$32,990	$27,225	$33,059	$28,221	$29,196
Earnings by industry (%):					
Agriculture	0.4	2.8	0.8	0.7	0.7
Manufacturing	13.8	18.7	15.2	13.6	23.2
Trade	12.3	13.5	13.1	12.4	12.4
Services	37.6	28.6	36.3	38.8	31.0
Government	13.5	16.5	13.4	15.5	14.8
Other	22.3	19.9	21.1	19.0	17.8

Source: U. S. Bureau of the Census; U. S. Bureau of Economic Analysis

This area is an important producer of the nation's major agricultural crops: in 2002, over half (54.6 percent) of the total value of soybean production was in this area, primarily in Illinois and Iowa, and almost half (48.7 percent) of the corn was in this area, also primarily in Illinois and Iowa. In addition, over half (51.7 percent) of the value of hog production was in the area, concentrated primarily in Iowa with 27.6 percent. Dairy products, primarily in Wisconsin, were important, contributing 23.1% of the nation's milk production by value and 39.3% of the volume of cheese produced in 2001.

In the mining sector, Minnesota is the source of most of the iron ore produced in this country, with production of 33.8 million metric tons in 2001, about 73% of the nation's production.

Indirect Impacts

Direct construction activity results in indirect impacts in the local economy such that money spent on construction activity, labor and the purchase of materials and equipment, generates additional income and employment in a multiplier

fashion. In a large construction project, impacts can range well distant from the local or regional construction area as purchases are made over long distances, as construction workers migrate to the construction site and leave their families at home where the construction earnings are partially spent, and as certain of the construction work is done by private companies at remote locations.

In the study, TVA used an economic model constructed by Regional Economic Models Inc. (REMI) of Amherst, Massachusetts. REMI models are econometric models with highly detailed input-output industry categories. The specific model constructed for this project is a multiregional model, the regions being each of the five states in the Upper Mississippi area (Illinois, Iowa, Minnesota, Missouri, and Wisconsin) plus a Lower Mississippi region that is an aggregation of seven states (Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Tennessee, and Texas), for a total of 6 regions. The model is discussed further in the discussion of methodology below.

Methodology

Economic Impact Analysis

The purpose of an economic impact analysis is to study and estimate the full economic consequences to local, regional, or national economies that can be expected to ultimately result from a project's direct expenditures and deployment of resources within that economy. The most common focus of such studies, as is the case with the current study, is on impacts to the output of goods and services and to employment, income, and population. However, almost any economic variable can be a focus if the necessary data are available. Some studies, for example, include impacts on local tax revenues or impacts on housing.

Various techniques have been developed for estimating economic impacts. However, all of these techniques directly or indirectly involve the concept of multipliers. A multiplier quantifies the relationship between some change in an economy (a direct impact) and the succeeding economic activity that occurs as a result of that change (the indirect and induced impacts of the project or action).

The jobs created by the project itself, such as the construction jobs created to build a structure or to operate a facility after it is constructed, and the income earned by these new workers are direct impacts, as is the purchase of materials used in construction. The purchase of materials will lead to additional spending by the suppliers of these materials; this additional spending is referred to as indirect impacts. The new income of the workers will lead to new spending for goods and services; this additional spending is referred to as induced impacts. The sum of the direct, indirect, and induced impacts is the total impact.

Various types of economic models can be used to estimate the total impacts of a project or other change on a given geographic area. One commonly used approach is input/output (I/O) models. These models trace the linkages of purchases and sales among industries within a given region, state, or country. The basic data used to develop an I/O model describes the technological relationships among industries. These technological relationships are modified to reflect trade patterns within the area for which the analysis is being conducted (state, multicounty area, etc.).

While I/O models can be used to estimate the impacts of changes, they are static in nature, reflecting the relationships at some point in time. By themselves, they do not capture dynamic impacts over time, including changes in the technological and trade relationships. Other items that would not be covered include dynamic impacts on wage levels, property values, prices and costs of other inputs and outputs, labor and capital productivity, and population or migration patterns.

Alternative approaches include dynamic econometric and general equilibrium models that estimate the effects over time of changing conditions in a given area. These models vary greatly, however, with regard to their industry detail and the degree to which they capture interindustry relationships. The model used in this study, a REMI model, is, in part, a dynamic econometric model.

The REMI economic simulation and forecasting model was leased from *Regional Economic Models, Inc.* (REMI) for this study. In addition to its simulation and forecasting equations, it also contains a detailed input-output structure, so that it

combines the features of typical of both static I/O and dynamic models and is also multiregional. The version of REMI used for this study is described below.

The REMI Model

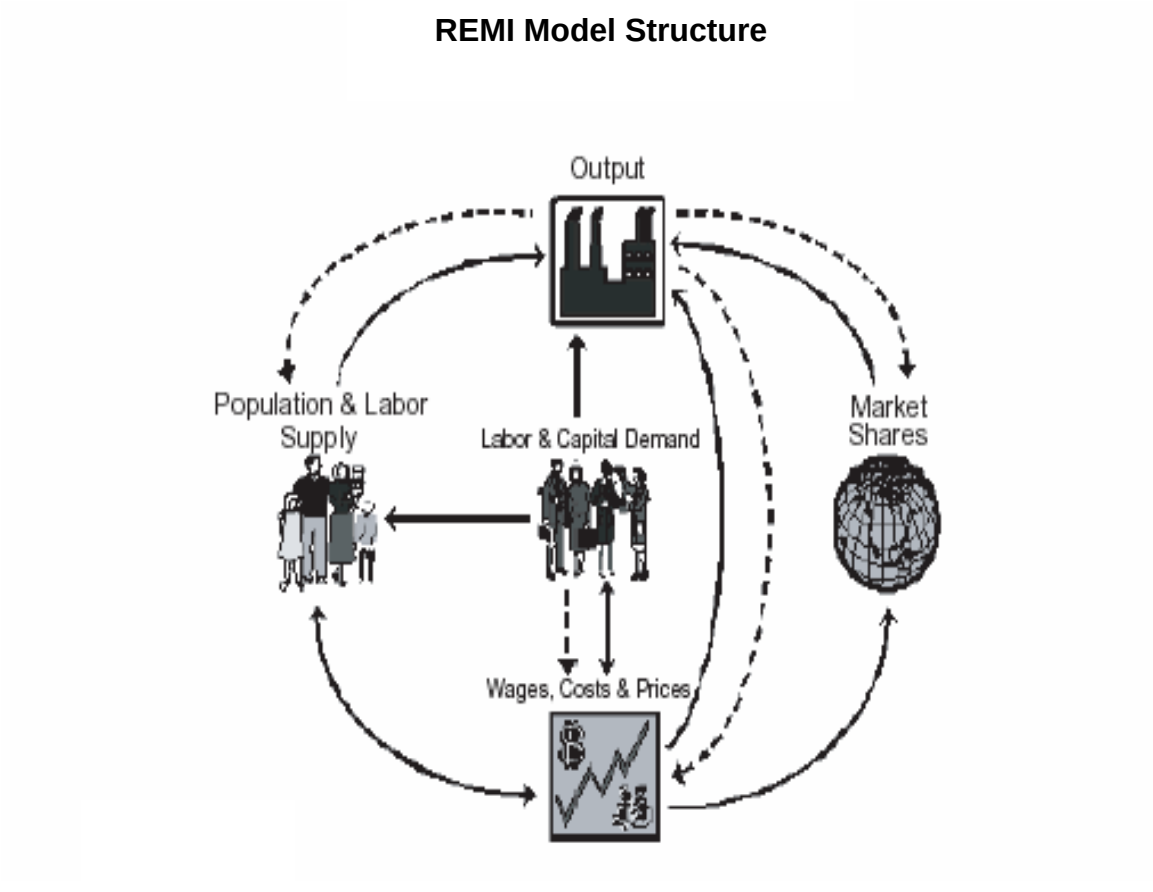
This REMI model was built especially for the Upper Mississippi River region for the purpose of better understanding the economic and demographic effects that policy initiatives or external events may impose on the Upper Mississippi River area economy. REMI's model-building system uses hundreds of programs developed over the past two decades to build customized models using data from the *Bureau of Economic Analysis*, the *Bureau of Labor Statistics*, the *Department of Energy*, the *Census Bureau* and other public sources.

REMI Policy Insight, the newest version of REMI's software, combines years of economic experience with a user-friendly software interface. A major feature of REMI is that it is a dynamic model, which forecasts how changes in the economy and adjustments to those changes will occur on a year-by-year basis. The model is sensitive to a very wide range of policy and project alternatives, and to interactions between the regional and national economies.

The REMI model is a structural model, meaning that the REMI Upper Mississippi Model (UMM) includes cause-and-effect relationships. Figure 2 below depicts the basic model structure. Estimated changes to the five direct drivers are model inputs. These are the endogenous linkages in the REMI model: output; population and labor supply; labor and capital demand; market shares; and wages prices and profit.

The model builds on two key underlying assumptions that guide economic theory: households maximize utility and producers maximize profits. Interested lay people as well as trained economists can understand the basic model because these assumptions make sense.

Figure 2: REMI Model Structure



In the model, businesses produce goods to sell to other firms, consumers, investors, governments and purchasers outside the region. The output is produced using labor, capital, fuel and intermediate inputs. The demand for labor, capital and fuel per unit of output depends on their relative costs; an increase in the price of any of these inputs leads to substitution away from that input to other inputs.

The supply of labor in the model depends on the number of people in the population and the proportion of those people who participate in the labor force. Economic migration affects the population size. More people will be enticed to migrate into an area if the real after-tax wage rates, the likelihood of being employed, and the access to consumer goods increase in a region. They will also increasingly move into an area if the attractiveness of the area improves due to changes in its amenities.

Supply and demand for labor in the model determines the wage rates. These wage rates, along with other prices and productivity, determine the cost of doing business for every industry in the model. An increase in the cost of doing business causes an increase in production costs and the price of the goods or service, which would decrease the share of the domestic and foreign markets supplied by local firms. This market share, combined with the demand described above, determines the amount of local output.

The model has many other feedbacks. For example changes in wages and employment affect income and consumption, while economic expansion changes investment and population growth affects government spending.

The Output block shows a factory that sells to all the sectors of final demand as well as to other industries. The Labor and Capital Demand block shows how labor and capital requirements depend both on output and their relative costs Population and Labor Supply are shown as contributing to demand and to wage determination in the product and labor market. The feedback from this market shows that economic migrants respond to labor market conditions. Demand and supply interact in the Wage, Costs, & Prices block. Once costs and prices are established, they determine market shares, which along with components of demand determine output.

Linkages indicated by the dashed arrows account for the effects of agglomeration in both the labor and product markets. These effects are crucial to accurately capture the key to why certain areas with a concentration of similar businesses can prosper despite high wages and real estate costs. By having a choice of suppliers and workers, each firm can obtain specialized labor and inputs that best fulfill their needs. This increases productivity and efficiency.

The dashed arrow from the Output block to the Cost block shows that more suppliers will increase the efficiency of inputs, which will then reduce production costs and competitiveness. The dashed arrow from the Labor block shows that more labor will increase the productivity of labor, thus reducing labor costs and thereby making the area more competitive. The arrow from Output to the

Population block shows that the greater output provides more variety of choices and enhances consumer satisfaction, and thus inward migration. The arrow from the Output to the Shares block shows that the areas with concentration can offer more to purchasers, thus having an effect on market share in addition to the price advantages through the Cost & Price block.

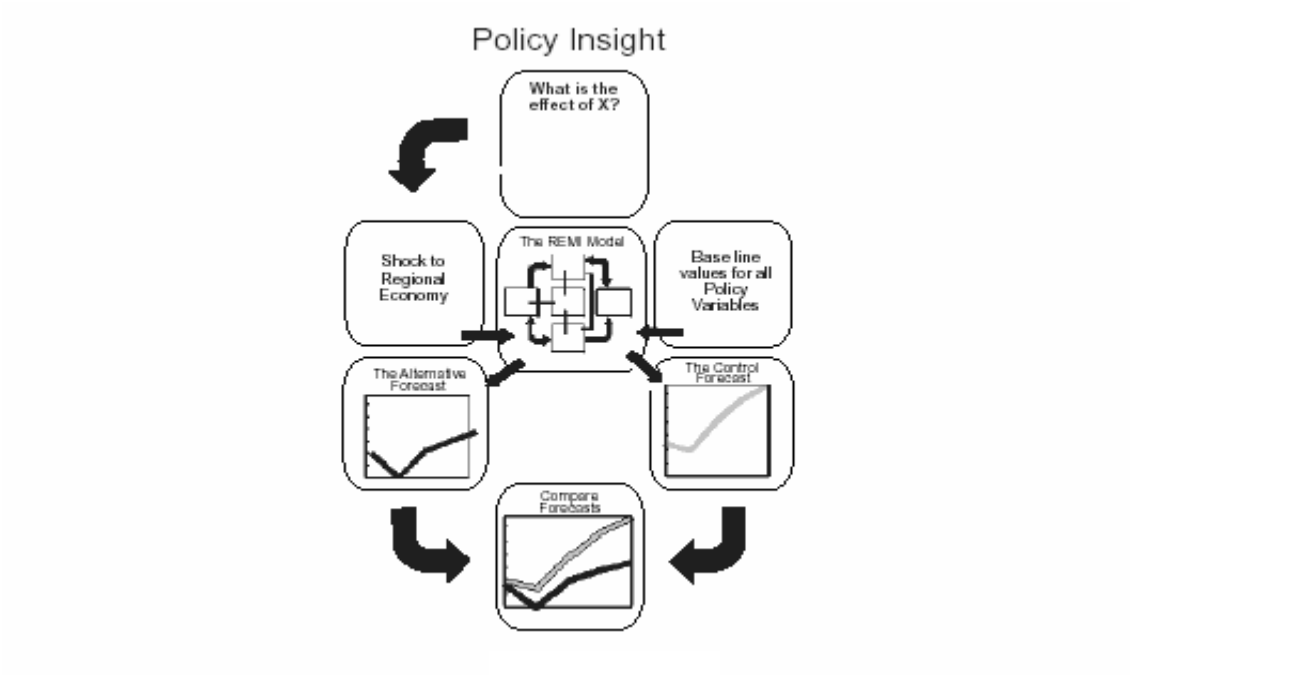
The REMI model has strong dynamic properties, which means that it forecasts what will happen and when it will happen. The model brings together all of the above elements to determine the value of each of the variables in the model for each year in the baseline forecast. Inter-industry relationships contained in typical input-output models are captured in the REMI Output block; but REMI goes well beyond typical input-output models by including the relationships among all of the other blocks shown in Figure 3.

The REMI model for the Upper Mississippi Region is designed to examine the effects of policy changes, or direct economic changes, to the Upper Mississippi regional economy arising from the five economic drivers. The baseline forecast uses a base set of data and assumptions about the national and regional economic variables. Alternative forecasts are generated, using appropriate input variable values for the five drivers, that reflect the full economic effects on the regional economy from project expenditures or other direct project impacts brought about by the implementation of the project.

The REMI model comes with default baseline economic forecasts for the United States and the Upper Mississippi region, referred to as “Control Forecasts.” A set of project costs and other direct economic consequences developed as part of this project are direct impacts. These changes to economic sectors directly affected are introduced into the model, which is then run to produce a new forecast that reflects the full impact of the changes introduced to the regional economy by the project. Impact results can be shown in terms of how the new forecast differs from the Control Forecast. The REMI model tracks these changes as changes in a large number of demographic and economic variables. Using the Upper Mississippi model, this study reports these changes between the baseline

forecast and that of each alternative flood control plan for a selected group of variables.

Figure 3: How REMI Analyzes a Problem



Project expenditure data for the various alternatives was developed by the Corps of Engineers These project costs were then applied to appropriate REMI model policy variables in order to estimate total impacts for construction activity.

No offsets were entered into REMI for project expenditures. To the extent that resources are diverted to the study region at the expense of some other region or regions, the solutions arrived at in REMI are purely gains or losses for the project states. A national summation of the regional solutions would be, therefore, generally a meaningless number.

Economic Impact of Plan C1

Providing flood protection by constructing new levees or improving existing levees as would occur in plan C1 can be expected to result in positive regional

economic impacts. Five types of economic impacts expected from improved flood protection are considered in this study: construction, economic development, land value enhancement, farm income gains, and damages averted.

Construction impacts arise from the expenditures for labor and materials required to build the levees. These impacts can be expected to occur primarily during the construction phases of levee projects.

Economic development impacts result as flood risks are reduced in the floodplains, increasing the likelihood of economic activity due to reduced risk and costs of operation. Flood insurance could become unnecessary or available at reduced rates due to having flood protection that exceeds the 100 year flood level. Portions of land previously zoned to prohibit development could become usable. Infrastructure development (highways, railroads, and utilities) might be more feasibly upgraded with levees in place, which may also spur development.

Floodplain land becomes more valuable with better flood protection. The result is a wealth increase for floodplain owners. This increased wealth is expected to be converted over time to landowners' annual income streams.

Floodplain farms become more productive with less flooding, leading to gains in farm income.

Lastly, flood damages are averted over time with better flood protection. Most flood insurance is actuarially based[5], and thus most who purchase flood insurance should enjoy reduced premiums. Those not insured can be considered to be self insured. Thus, for the majority, those residences and commercial establishments without flood insurance, better flood protection lowers the implicit premium for their self-insurance, making available increased dollars for consumption expenditures.

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[5] The exception is highly subsidized pre-FIRM rates (about 19% of all coverage).

Construction Expenditures Impact

REMI Model Inputs—Case C1

The construction schedule is given in Table 2 below. The values, after conversion to 1996 dollars are input into REMI as construction demand in the appropriate state.

Table 2: Construction Expenditures by State and Year
($04M)

Year	IA	IL	MN	MO	WI
2005	$7	$160	$21	$28	$38
2006	$18	$400	$53	$70	$94
2007	$16	$474	$64	$52	$70
2008	$14	$586	$81	$26	$34
2009	$32	$486	$49	$167	$20
2010	$58	$336		$378	
2011	$59	$324		$259	
2012	$62	$306		$81	
2013	$44	$310		$54	
2014	$17	$315		$12	
2015	$10	$331		$24	
2016		$354		$42	
2017		$221		$134	
2018		$21		$273	
2019		$45		$224	
2020		$80		$150	
2021		$50		$179	
2022		$4		$221	
2023		$2		$204	
2024				$177	
2025				$106	

REMI allocates the construction demand to the various industry inputs that go into construction and across regions based on embedded tradeflows.

The total impacts resulting from REMI model simulation for the above direct project construction expenditures are shown in Table 3.

Table 3: Costs And Total Impacts from Construction Expenditures By Region

($03B)	Cost Present Value	Avg. Annual Employment	Present Value GRP	Present Value RPI	Present Value Output
Illinois	3.493	20,724	$23.999	$21.415	$40.312
Iowa	0.247	2,340	2.768	1.508	4.699
Minnesota	0.235	291	0.548	0.287	1.002
Missouri	1.597	1,800	2.248	1.647	4.003
Wisconsin	0.231	445	0.819	0.438	1.502
5-States	**5.803**	**25,690**	**30.381**	**25.295**	**51.518**
Southern Region			0.827	-0.060	1.775

Summary of REMI Model Results From Construction Expenditures

In the five state region the present value of the cost to construct the flood control system in plan C1 is $5.803 billion. This construction activity would generate an average annual employment of 25,690 in the five state region and raise gross product by $30.381 billion in present value. Personal income would increase by $25.295 billion and output would rise by $51.518 billion.

Economic Development Impact—the Levee Effect

Steven W. McMaster, in his Master's thesis, attempted to measure a so-called levee effect, which is the effect on local economic growth of improved flood protection. His study, "The influence of Flood Protection Structures on the Level of Development in Midwestern Floodplains," was undertaken at the University of Southern Illinois at Carbondale and completed during April, 1996. TVA found no other studies that attempted to measure this effect.

Mr. McMaster's study examines how the construction of a floodwall or levee impacts residential and commercial development of an area. In the study, he tests the validity of the "levee effect" hypothesis as proposed by White and Haas (1975) and Smith (1992). He hypothesizes that building a floodwall or levee will induce new development and building renovations in the protected part of the floodplain. He tests his hypothesis by comparing growth rates in construction activity in five riverside cities. Those with a flood wall or levee are Chesterfield

and Hannibal, Missouri, and Rock Island, Illinois. The cities that did not have a floodwall are Davenport, Iowa, and Moline, Illinois.

Comparisons of construction activity for cities with flood protection are made before and after the year of completion of the flood barrier and a comparison is made between cities that have built a floodwall and cities that have not built a floodwall. Mr. McMaster finds that there is an increase in the number of newly constructed buildings or renovations done to existing structures for cities after a floodwall or levee was constructed. For cities without a floodwall or levee, floodplain development has decreased over time. In Davenport, commercial and residential development rates outside of the floodplain have increased. Mr. McMaster interprets these findings as a confirmation of the levee effect hypothesis.

Economic data for floodplains are not readily available. Mr. McMaster collected his data from tax records in each of the five cities. His focus was on the presence or absence of the “levee effect” in these floodplain cities. His research confirmed that such an effect does exist.

It is plausible that, after flood protection is constructed, the effect will be measurable at the county level. Protection in counties with only a small portion in the floodplain may induce development throughout the county due to economic linkages and transportation improvements. Transportation development is a critical component to economic development in the Upper Mississippi River and Illinois Waterway: railroad service is better in those areas protected from flooding and highway maintenance requires fewer resources in the absence of flooding.

Therefore, the more easily obtainable county data are used in this study to test the levee effect. County data are available (employment and earnings) from the Bureau of Economic Analysis (BEA) for the period 1969-2001. Using the BEA data and applying regression analysis, TVA tested the hypothesis that counties

with levees rated at least at the 200 year level of protection sustain greater economic development than those counties without this level of protection.

Levee Effect Models And Estimations

The following model provides a framework for investigating an economic development effect, if it exists, on counties without flood protection after levees are constructed. Two models[6] were examined:

$$TEMP = \alpha + \beta * POP + \gamma * LEVEE + \delta * TIME + \xi \qquad (1) \text{ and}$$

$$TEMP = \alpha + \beta * POP + \gamma * POP * LEVEE + \delta * TIME + \xi \qquad (2), \text{ where}$$

TEMP = total employment in county i and time period t

POP = population in county i and time period t

LEVEE = (1,0) binary variable for the presence or absence of a levee or wall producing at least 200 year flood protection

TIME = time trend variable.

ξ = a normal and independently distributed error term

The equations were estimated using BEA total employment data, which includes full and part-time labor, as the dependent variable. The results obtained from the estimation for equation (1) are:

TEMP = -445271+2135*LEVEE+0.574*POP+222*TIME
(31631) (307) (0.00299) (15.9)

The standard errors of the estimates are presented in parenthesis. All estimates are significantly different from zero at greater than the 99 percent confidence level. In the equation, R^2=0.9873. The equation is estimated with a pooled time series (the period 1969-2001) and cross section (28 counties) data using ordinary least squares estimation.

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[6] A third model was estimated that is the same as (2) but with a dummy variable reflecting the 1980 change in flood insurance legislation. While the variable was significantly different from zero, the change in the estimated pop*levee variable was only about 0.001 or in the range of rounding error.

The coefficient of the LEVEE variable is interpreted as the differential impact of levees on employment. In this model, the levee employment effect is the same regardless of the population base of the counties impacted by levees. In any specified time period, a county with flood protection at least at the 200 year level is estimated to have 2,135 more employees than it would have had without the protection, with all other things being equal.

The results for equation (2) are:

$$\begin{array}{lllll} TEMP = & -403471 + & 0.0526*POP*LEVEE + & 0.5596*POP + & 201*\ TIME \\ & (30812) & (0.0047) & (0.003) & (15.5) \end{array}$$

All estimates are, again, significantly different from zero at greater than the 99 percent confidence level. The coefficient of determination for equation (2) is R^2=0.9887. The coefficient of the POP*LEVEE variable is interpreted as the increment added to a county's employment base at any time period that is proportional to the population size of the county, given a change from protection at less than a 200 year level to a level that is 200 year or greater.

Equation (2) is preferable to equation (1) since it is reasonable to expect larger counties to experience larger development impacts. The estimated coefficient for the levee-population interaction variable is 5.26%; therefore the levee effect on employment is 5.26% of the county's population, all else being equal. It is assumed that the increased economic activity is not gained at the expense of counties that already have 200+ year protection and a direct impact of 27,000 employees in a region of 1.3 million employees seems entirely plausible.

Estimation Of Economic Development Impacts

Table 4 shows the 28 counties under study and the results of applying the levee effect estimation to employment data for 2001. If counties do not have a levee rated at least at 200 year protection, an "N" is shown in column 3; a "Y" indicates that a levee with 200 year protection is present. The estimated impact on employment given the presence of a 200 year levee is shown in the far right

column. For counties presently without at least a 200 year levee, these water barriers would have generated an estimated increase of 26,978 employees.

Table 4: 2001 County Employment Impacts of Levees Rated at 200 Year Flood Protection or Greater

FIPS	County	Has 200+ Year Levee	2001 Pop	Tot Emp 200+ Yr Levee Impact
17143	Peoria, IL	N	182,228	9,596
19163	Scott, IA	Y	158,965	
17161	Rock Island, IL	Y	148,830	
17179	Tazewell, IL	N	128,705	6,777
19061	Dubuque, IA	Y	89,123	
17001	Adams, IL	Y	68,143	
17195	Whiteside, IL	Y	60,679	
19045	Clinton, IA	Y	50,112	
19139	Muscatine, IA	Y	41,957	
19057	Des Moines, IA	Y	41,868	
17057	Fulton, IL	Y	37,990	
19111	Lee, IA	N	37,425	1,971
17203	Woodford, IL	N	35,942	1,893
29127	Marion, MO	Y	28,124	
17085	Jo Daviess, IL	N	22,424	1,181
19097	Jackson, IA	N	20,268	1,067
17067	Hancock, IL	N	19,969	1,052
17149	Pike, IL	Y	17,251	
17131	Mercer, IL	N	17,023	896
17015	Carroll, IL	N	16,576	873
17125	Mason, IL	N	16,008	843
17017	Cass, IL	Y	13,549	
19115	Louisa, IA	Y	12,282	
29111	Lewis, MO	Y	10,389	
17071	Henderson, IL	N	8,230	433
29045	Clark, MO	N	7,514	396
17169	Schuyler, IL	Y	7,080	
17013	Calhoun, IL	Y	5,097	
	Totals	All	1,303,751	
		Y	791,439	
		N	512,312	26,978

Since levees in the Upper Mississippi River/Illinois Waterway Comprehensive Plan will not appear instantaneously, it is necessary to apportion the levee effect over project years. The economic development impacts were estimated as follows[7]:

1) calculate the construction costs for projects completed at each site over the twenty–two year time horizon.
2) calculate the cumulative percentage of construction costs for completed projects by year for each state.
3) Spread the cumulative percentages over ten year periods.
4) obtain forecasts of annual population for the impact counties—this was done using Woods & Poole population projections ("2003 Regional Projections and Database," Woods & Poole Economics, Inc., Washington DC; available by subscription.). Sum for each state.
5) calculate unadjusted employment impacts for each state by multiplying the summed population by the regression derived factor of 5.25%.
6) calculate final estimated employment impacts by year for each state by multiplying data in (3) times data in (5) for corresponding states and years.

The next two steps estimate the impact for the three monetary variables of interest, gross regional product, output, and real personal income:

7) from the REMI simulation for all other levee impacts, calculate the ratio of gross regional product to total employment, the ratio of real personal income to total employment, and the ratio of output to total employment;

8) multiply (7) by (6) to obtain estimates of annual direct impacts for gross regional product, real personal income, and output.

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[7] Construction of levees at a specific place is a three-year project. Each state has levees constructed at multiple sites over a twenty-two year period. Additionally, economic development impacts cannot be expected to occur immediately. We assume a time frame of 10 years to reach the full impact on employment.

The total impacts for all areas from enhanced economic development due to levee construction are provided in the following table:

Table 5: Total Impacts From Construction of 200+ Year Levees

		($03B)		
Year	Emp Total	GRP	Output	RPI
2008	470	$0.034	$0.055	$0.030
2009	942	$0.071	$0.113	$0.060
2010	2,085	$0.161	$0.256	$0.136
2011	3,233	$0.254	$0.405	$0.216
2012	4,873	$0.390	$0.624	$0.330
2013	6,520	$0.532	$0.855	$0.448
2014	8,391	$0.699	$1.126	$0.583
2015	10,274	$0.874	$1.414	$0.722
2016	12,549	$1.086	$1.761	$0.898
2017	14,837	$1.312	$2.134	$1.079
2018	17,052	$1.536	$2.505	$1.262
2019	19,277	$1.769	$2.890	$1.454
2020	20,859	$1.949	$3.192	$1.600
2021	22,452	$2.136	$3.507	$1.751
2022	23,657	$2.295	$3.780	$1.878
2023	24,870	$2.457	$4.055	$2.010
2024	25,880	$2.603	$4.308	$2.132
2025	26,905	$2.754	$4.568	$2.260
2026	27,533	$2.867	$4.766	$2.356
2027	28,166	$2.990	$4.986	$2.454
2028	28,391	$3.064	$5.119	$2.518
2029	28,617	$3.139	$5.253	$2.586
2030	28,812	$3.211	$5.383	$2.652
2031	29,008	$3.283	$5.513	$2.718
2032	29,106	$3.352	$5.641	$2.776
2033	29,205	$3.419	$5.770	$2.832
2034	29,294	$3.485	$5.895	$2.888
2035	29,384	$3.553	$6.026	$2.944

Summary Of REMI Model Results From Project Economic Development Impacts

The total impacts that result from the REMI Model (over the period 2008-2035) for the above direct impacts are provided in Table 6 below.

Table 6: Impacts on Economic Development Given Enhanced Flood Protection in Alternative C1

	Avg. Annual Employment	Present Value ($03B)		
		GRP	RPI	Output
Illinois	16,765	$18.135	$15.640	$29.962
Iowa	2,076	$2.218	$1.167	$3.711
Minnesota	0	$0.000	$0.000	$0.000
Missouri	182	$0.174	$0.120	$0.279
Wisconsin	0	$0.000	$0.000	$0.000
5-States	**19,023**	**$20.527**	**$16.927**	**$33.952**

The present-valued monetary impacts appear large. It should be remembered, however, that the values are only a tiny fraction of the base 5-state values. In general, economic development impacts are likely to be large relative to some other impacts due to the expectation that the new or expanded commercial and industrial activity and its multiplier effects will persist over a long period of time.

Land Values' Impact

Land Values With And Without Flood Protection

The Upper Mississippi, Illinois, and Missouri River Association (UMIMRA) provided TVA with a sampling of land values currently found in the study region and with values that that might be expected, given construction of 500 year flood protection. General farmland in Illinois is expected to rise by $200 per acre, while the same land in Missouri is expected to rise by $300 per acre. The impact on industrial land is expected to be greater, rising to $7,000 per acre in a development in South Quincy, Illinois. Table 7 below shows the projected increase in land values.

Table 7: Land Value Gain Per Acre

Location/Use	Without Flood Protection	With 500 Year Protection	Gain In Value
Illinois			
General Farmland	$3,000	$3,200	$200
Missouri			
General Farmland	$2,500	$2,800	$300
South Quincy LDD—1,000 acres	$3,500	$10,500	$7,000
South Quincy—Remaining 9,000 Acres	$3,000	$4,500	$1,500
East Hannibal—500 acres	$3,000	$5,000	$2,000
West Quincy--500 acres	$2,800	$5,000	$2,200

Source: UMIMRA farm manager and rural appraiser interviews.

The increase in bare farmland values is attributed to the decrease in crop losses that occurs roughly in one year out of 20. Also, farmland will become more productive. Farmers will be able to construct grain storage on their farms in the floodplains, thus enabling them to drive shorter distance in farm tractors to store grain during the harvest season. Flood protection also raises the value of land set aside for industrial development.

Land Values Impacts and Wealth Effects

An increase in land values is, in effect, a one time wealth benefit to those owning the land.

Maki and Palumbo (2001) examined the phenomenon of the 1990s where household net worth rose substantially while the personal saving rate decreased rapidly. This study has relevance to the Upper Mississippi River and Illinois Waterway regional economic study because it quantifies the impact on the propensity to consume out of current income among families whose portfolios benefited from exceptional capital gains.

An increase in wealth is not a direct increase in economic development, rather, economic development is generated by only that portion of the wealth that is actually spent. Maki and Palumbo used linear regression analysis and found the

marginal propensity to consume out of wealth lies between 3 and 5 cents-to-the-dollar. Based on the Maki and Palumbo study, TVA used three percent of the increase in wealth annually by state as the direct impact.

REMI Model Inputs

The land value gain per acre factors given above were used to calculate total wealth impacts by state based on the number of acres in each of the project levee districts. The results were converted to 1996 dollars and multiplied by 3% to arrive at the annual values. Since it is not possible to input this directly into REMI as landowners' consumer spending, the direct impact is treated as a change to income resulting from increased land rents and input into the REMI Model as follows:

Table 8: REMI Inputs Due to Wealth Effects of Increased Land Values

State	Dividends, Interest, And Rent All Years ($96)
IA	$266,616
IL	$2,587,110
MO	$1,475,595

Summary of REMI Model Results From Land Value Impacts

Estimations of the total impacts that result from the above direct land value impacts are provided in the following table:

Table 9: Impacts From Expenditures Due to Enhanced Land Values in Alternative C1

(over the Period 2205-2035)

	Avg. Annual	Present Value ($03B)		
	Employment	GRP	RPI	Output
Illinois	29	$0.038	$0.064	$0.062
Iowa	5	$0.006	$0.008	$0.009
Minnesota	2	$0.003	$0.001	$0.006
Missouri	17	$0.020	$0.037	$0.033
Wisconsin	3	$0.005	$0.002	$0.008
5-States	**56**	**$0.072**	**$0.112**	**$0.118**
Southern Region	5	$0.010	-$0.001	$0.018

Farm Income Impact

Land can be expected to become more productive with increased flood protection. UMIMRA studied the relationship of increased productivity and farm income in Marion and Lewis Counties in Missouri (UMIMRA, 1999). Only the impact on corn and soybean production was studied. No weather factor was used in the study, and no wheat, barley, or milo was used on the acres studied. It was assumed that half of the land was planted in corn and half in soybeans.

Over 10 years, corn production without a levee averaged 70 bushels per acre and with a levee the averaged 140 bushels per acre. Over ten years, soybean production averaged 30 bushels per acre, and with a levee soybean production averaged 45 bushels per acre. The annual dollar impact per acre on farm income from a levee in the two counties per acre was $193.20 for corn and $193.80 for soybeans.

REMI Model Inputs

TVA assumes that the UMIMRA study is reasonably applicable to all project counties and, further, assumes that production is allocated 50 percent to corn and 50 percent to soybeans. Since the savings are approximately the same per acre for either crop, this assumption is safe. For the floodplain counties, then, it is assumed that farm income will increase an average of$193.50 per acre per year with flood protection.

Based on the level of protection and the acreage in each levee district to be impacted, the expected annual change in farm income was calculated. The results were summed to states and the average annual increase in farm income converted to 1996 dollars. Finally, the State values were apportioned across time based on the levee construction schedule. The result is changes to farm income which is entered as direct impacts into the REMI Model. The inputs are shown in Table 10 below.

Table 10: REMI Inputs from Direct Impacts to Farm Income

	Farm Income ($96B) REMI Inputs		
	IA	IL	MO
2008	0.890	14.587	1.544
2009	0.890	14.587	1.544
2010	1.590	35.980	2.124
2011	1.590	35.980	2.124
2012	4.487	48.246	10.515
2013	4.487	48.246	10.515
2014	7.585	51.603	12.312
2015	7.585	51.603	12.312
2016	8.425	63.115	12.588
2017	8.425	63.115	12.588
2018	8.425	76.025	13.514
2019	8.425	76.025	13.514
2020	8.425	76.801	19.566
2021	8.425	76.801	19.566
2022	8.425	79.732	22.886
2023	8.425	79.732	22.886
2024	8.425	79.860	27.798
2025	8.425	79.860	27.798
2026	8.425	79.860	31.725
2027	8.425	79.860	31.725
2028	8.425	79.860	31.725
2029	8.425	79.860	31.725
2030	8.425	79.860	31.725
2031	8.425	79.860	31.725
2032	8.425	79.860	31.725
2033	8.425	79.860	31.725
2034	8.425	79.860	31.725
2035	8.425	79.860	31.725

Summary Of REMI Model Results From Enhanced Farm Productivity

The total impacts that result from the above direct impacts in the REMI Model are provided in Table 11 below.

Table 11: REMI Total Economic Impacts from Enhanced Farm Productivity

	Avg. Annual Employment	Present Value ($03B)		
		GRP	RPI	Output
Illinois	569	$0.637	$1.253	$1.055
Iowa	81	$0.089	$0.121	$0.151
Minnesota	23	$0.039	$0.013	$0.072
Missouri	184	$0.187	$0.305	$0.310
Wisconsin	62	$0.093	$0.038	$0.173
5-States	**918**	**$1.045**	**$1.729**	**$1.762**
Southern Region	87	$0.162	$0.000	$0.320

Damages Avoided Impact

The Rock Island District provided to TVA the average annual damages averted (AADA) in the floodplain districts of the Upper Mississippi River and Illinois Waterway (UMR-IWW) attributable to unconstrained 500 year flood protection. The total average annual benefits of levee construction for the entire region are $30.6 million, which is a modest sum in the context of a multi-state area.

The regional economic impact from damage avoidance is difficult to determine since it is unclear how much of the damage is reimbursed from sources external to the region. In a flood event, the majority of the cost of cleanup and restoration comes from state and federal public monies; very little private insurance is in force in the UMR-IWW floodplain.

The web site of the Federal Emergency Management Agency (FEMA) web page lists $49.945 million in annual premiums in floodplain counties and $10.5 billion dollars of insurance in force. TVA estimates the value of fixed assets in the floodplain—housing, commercial fixed assets, agricultural assets, public infrastructure, and crop value and assets—to be $302 billion in 2001. Thus, the percent of total assets that are insured in the floodplain might be no more than three percent of total assets.

The cost structure of flood insurance in the floodplain falls into three categories: (1) in the floodplain where the levees are three feet higher than the elevation required to prevent the 100 year flood, no insurance is required; (2) if the levee

is certified to prevent the 100 year flood and does not have the three foot of freeboard, insurance is available at reasonable rates; (3) but, if the levee is not certified to prevent the 100 year flood, insurance is available but at very high rates.

Insurance is sold by private insurance agents, but it is underwritten by the National Flood Insurance Program (NFIP), and the rates are set by the NFIP. Any construction after the 1980 NFIP ruling must pay on an actuarial rate and, anecdotally, these rates can be very high.[8] Thus, the impact of the NFIP legislation has been to discourage development in the unprotected floodplain, and this restriction has resulted in the minimum age of the structures in the flood plain being at least 24 years.

In a flood event, insurance plus federal and state disaster relief funds do not generally compensate the affected parties for all damages. There are many items not covered by flood insurance and there are compensation limits. Thus, the long-run cost of living in the floodplain is, *ceteris paribus*, higher than in non-flood prone areas. Where insurance is not available or not purchased, owners are, in effect, self- insured.

Damages averted leads to economic development where levees that protect against the 500 year flood are constructed. Owners with property behind levees (those with 100 year flood protection and those without 100 year protection) pay insurance premiums; and these premiums would disappear or be reduced with levee construction. But, as noted above, flood insurance protection in the floodplain is very limited and may be as low as three percent of total asset value. Second, property that is flooded more regularly than others, once improved, would require less maintenance, and this money would be available for other expenditures. Additionally, taxes could fall given that infrastructure maintenance would be less with better flood protection.

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[8] Memo from Merrill W. Prange, Treasurer and Collector of Monroe County, Waterloo, Illinois, August 29, 2003.

For REMI simulation purposes, the AADA are treated as an implicit insurance premium for those without flood insurance. Two assumptions are made due the paucity of flood insurance premium data in the region. In one case, it is assumed that half of the AADA are compensated with federal and state disaster relief money. This means as much as one half of the AAD would be an increase in expenditures in the with-project condition. For the second case, it is assumed that 75 percent of the AADA are compensated from outside the region. This implies that 25 percent of the AAD would be an increase in expenditures. A range of impacts is thus provided.

REMI Model Inputs

Benefits by levee district from avoidance of property and assets damage were provided by cost engineers at the Rock Island District of the U.S. Army Corps of Engineers. TVA calculated values to enter into REMI total consumer demand (percentage change) policy variable by state. Preparation of the percentages required the following steps:

1) sum the benefits by levee district to states;
2) multiply these state totals by the cumulative percent of construction completed in each year, starting in 2008;
3) divide the annual benefit state totals by annual total consumer demand for each state derived from the base REMI model;
4) Multiply by 50% and by 25% to derive two options for the level of regional benefits.

The results for the 50% case are given in Table 12 below.

Table 12: REMI Inputs-Percentage Change In Total Consumer Spending for 50% Benefits Case

($96M)

Year	IA	IL	MN	MO	WI
2008	0.000119	0.000416	0.000157	0.000134	0.000430
2009	0.000116	0.000404	0.000151	0.000130	0.000416
2010	0.000200	0.000969	0.000369	0.000174	0.000548
2011	0.000197	0.000951	0.000360	0.000170	0.000536
2012	0.000543	0.001250	0.000352	0.000826	0.000524
2013	0.000531	0.001224	0.000344	0.000809	0.000512
2014	0.000881	0.001285	0.000337	0.000930	0.000500
2015	0.000861	0.001256	0.000329	0.000911	0.000488
2016	0.000943	0.001516	0.000324	0.000919	0.000480
2017	0.000920	0.001482	0.000316	0.000900	0.000468
2018	0.000905	0.001756	0.000311	0.000951	0.000459
2019	0.000890	0.001731	0.000305	0.000937	0.000451
2020	0.000875	0.001720	0.000300	0.001336	0.000442
2021	0.000861	0.001694	0.000295	0.001317	0.000435
2022	0.000844	0.001725	0.000289	0.001512	0.000425
2023	0.000830	0.001696	0.000284	0.001488	0.000417
2024	0.000816	0.001670	0.000279	0.001778	0.000409
2025	0.000802	0.001641	0.000274	0.001750	0.000401
2026	0.000789	0.001617	0.000269	0.001968	0.000394
2027	0.000773	0.001583	0.000264	0.001930	0.000385
2028	0.000761	0.001559	0.000259	0.001900	0.000379
2029	0.000749	0.001535	0.000255	0.001872	0.000372
2030	0.000737	0.001510	0.000251	0.001843	0.000366
2031	0.000725	0.001488	0.000247	0.001817	0.000359
2032	0.000710	0.001461	0.000242	0.001785	0.000352
2033	0.000696	0.001434	0.000238	0.001754	0.000344
2034	0.000682	0.001408	0.000234	0.001724	0.000338
2035	0.000668	0.001380	0.000229	0.001692	0.000331

Summary Of REMI Model Results From Damages Avoided

The total impacts that result from damages avoided for the 50% benefits case in the confined alternative are provided in Table 13 below.

Table 13: REMI Total Impacts From Damages Avoided in the Confined Alternative (50% Benefits Case)

	Avg. Annual Employment	Present Value ($03B)		
		GRP	RPI	Output
Illinois	86	$0.099	$0.060	$0.159
Iowa	10	$0.012	$0.004	$0.021
Minnesota	9	$0.012	$0.002	$0.021
Missouri	30	$0.031	$0.015	$0.050
Wisconsin	19	$0.024	$0.014	$0.041
5-States	**154**	**$0.179**	**$0.096**	**$0.291**
Southern Region	17	$0.027	$0.009	$0.053

Economic Impacts of Plan U1

The economic impacts associated with Plan U1 would be expected to be the same as in Plan C1 except that the lower construction expenditures results in lower construction impacts. Flood protection for the urban and agricultural areas would be greater than that needed for the 100 year flood event in both cases, thus economic development benefits is the same in both cases. Construction expenditures and total impacts for Plan C1 compared with Plan U1 are shown in Table 14.

Table 14: Construction Expenditures and Total Gross Product Impacts for Alternatives U1 and C1 for the Five State Area

(Present Values in $03B)

Region	C1 Construction Costs	U1 Construction Costs	C1 Construction Impacts on GRP	U1 Construction Impacts on GRP
Illinois	$3.493	$1.652	$5.091	$2.551
Iowa	$0.247	$0.270	$0.443	$0.362
Minnesota	$0.235	$0.235	$0.493	$0.444
Missouri	$1.597	$1.244	$1.835	$1.391
Wisconsin	$0.231	$0.231	$0.696	$0.520
Five States	$5.803	$3.632	$8.559	$5.268

In the five state region the present value of construction costs falls from $5.803 to $3.632 billion from Plan C1 to U1, a decline of about 37.4%. The present value of construction GRP impacts also falls, but not as far as the costs. The decline from Plan C1 to U1 is from $8.559 to $5.268, a drop of 38.5%.

The impacts due to construction expenditures by region for all four impact measures are shown in Table 15.

Table 15: U1 Construction Impacts By Measure And Region

	Construction Impact
GRP ($03B)	
Illinois	$2.551
Iowa	$0.362
Minnesota	$0.444
Missouri	$1.391
Wisconsin	$0.520
5-States	$5.268
Southern Reg	$0.473
Real Pers. Inc. ($03B)	
Illinois	$2.201
Iowa	$0.181
Minnesota	$0.264
Missouri	$0.904
Wisconsin	$0.315
5-States	$3.866
Southern Reg	$0.042
Output ($03B)	
Illinois	$4.553
Iowa	$0.664
Minnesota	$0.803
Missouri	$2.519
Wisconsin	$0.956
5-States	$9.495
Southern Reg	$0.999
Employment	
Illinois	1,590
Iowa	226
Minnesota	241
Missouri	940
Wisconsin	280
5-States	3,276
Southern Reg	148

Economic Impacts of Plan U3

The economic impacts associated with Plan U3 would be expected to be different than C1 and U1, given that agricultural areas would not be protected for the 100 year flood event. Thus, the economic impacts would only accrue to urban areas. Also, impacts would differ in that most of the construction would be in urban areas and thus the construction in rural areas, found in C1 and U1, would not be counted in Plan U3. It is suspected that, by not raising levees in U3 to protect against the 100 year flood, economic development in the rural areas is discouraged, leaving open the possibility of certain ecosystem restoration activities. In the simulation, economic development activities were assumed to occur only if at least one levee improvement occurred in a particular county.

Construction costs for Plan U3 are $2.671 billion. In Plan U3 construction impacts fall to $3.803 billion as compared to $5.268 billion in Plan U1. Economic development benefits fall to $18.079 billion in Plan U3 as fewer counties have levees construction at least the 100 year level of protection. Total impacts in the five state area fall to $22.029 billion in Plan U3 from $27.091 billion in Plan U1. Damages averted, increased land values and farm income all fall in Plan U3 compared to Plan U1, as fewer acres are protected from a 100 year flood event.

Construction expenditures by state are shown Table 16.

Table 16: U3 Construction Expenditures By State

State	Construction Costs ($03B)
Illinois	$0.928
Iowa	$0.168
Minnesota	$0.235
Missouri	$1.109
Wisconsin	$0.231
5-States	$2.671

The full set of impacts for Plan U3 is shown Table 17.

Table 17: All U3 Impacts By Measure And State

	Type Of Impact					Total Impact
GRP ($03B)	Construction	Economic Dev	Damages Averted	Land Values	Farm Income	Sum Total
Illinois	$1.526	$15.922	$0.034	$0.004	$0.032	$17.518
Iowa	$0.241	$2.157	$0.010	$0.001	$0.003	$2.411
Minnesota	$0.411	$0.000	$0.012	-$0.001	$0.002	$0.423
Missouri	$1.199	$0.000	$0.028	$0.001	$0.003	$1.230
Wisconsin	$0.426	$0.000	$0.016	$0.001	$0.004	$0.447
5-States	**$3.803**	**$18.079**	**$0.099**	**$0.006**	**$0.042**	**$22.029**
Southrn Reg	$0.378	$0.000	$0.020	$0.011	$0.005	$0.415
Real Pers. Inc. ($03B)	Construction	Economic Dev	Damages Averted	Land Values	Farm Income	Sum Total
Illinois	$1.297	$13.728	$0.020	$0.010	$0.056	$15.111
Iowa	$0.121	$1.134	$0.005	$0.001	$0.003	$1.264
Minnesota	$0.253	$0.000	$0.003	-$0.001	-$0.001	$0.254
Missouri	$0.793	$0.000	$0.016	$0.001	$0.000	$0.810
Wisconsin	$0.267	$0.000	$0.009	$0.000	$0.004	$0.281
5-States	**$2.731**	**$14.862**	**$0.053**	**$0.011**	**$0.062**	**$17.719**
Southrn Reg	$0.061	$0.000	$0.008	$0.031	-$0.003	$0.097
Output ($03B)	Construction	Economic Dev	Damages Averted	Land Values	Farm Income	Sum Total
Illinois	$2.723	$26.274	$0.055	$0.008	$0.051	$29.111
Iowa	$0.442	$3.612	$0.016	$0.001	$0.004	$4.075
Minnesota	$0.739	$0.000	$0.019	-$0.001	$0.003	$0.759
Missouri	$2.172	$0.000	$0.043	$0.001	$0.005	$2.221
Wisconsin	$0.782	$0.000	$0.026	$0.001	$0.008	$0.818
5-States	**$6.858**	**$29.886**	**$0.160**	**$0.010**	**$0.071**	**$36.985**
Southrn Reg	$0.777	$0.000	$0.039	$0.021	$0.010	$0.847
Employment	Construction	Economic Dev	Damages Averted	Land Values	Farm Income	Sum Total
Illinois	926	14,447	26	4	27	15,431
Iowa	149	2,031	9	1	2	2,192
Minnesota	228	0	9	-1	1	237
Missouri	827	0	25	1	2	855
Wisconsin	236	0	13	1	3	252
5-States	**2,367**	**16,478**	**82**	**5**	**34**	**18,966**
Southrn Reg	134	0	14	12	3	164

Summary

The impacts of three flood protection plans are examined in this study: (1) confined 500 year, (2) unconfined 500 year, and (3) unconfined 500 year with a maximum 99 year agricultural plan. The 500 year protection plan (termed plan C1) would achieve flood damage reduction (FDR) benefits using a purely

structural approach. The major feature would be raising existing levees and floodwalls to the 500-year protection level, with no restrictions regarding induced river stages. At such a high level of protection, levees and floodwalls could be certified for future development. With escalating land values for development (due to this extremely high level of protection), a habitat incentives/ conservation easements program would not likely be a competitive alternative land use.

The unconfined 500 year plan (termed U1) would achieve FDR benefits using levees and floodwalls in all floodplain areas except for agricultural unprotected areas. All existing urban protected, urban unprotected, and agricultural protected areas would be protected to the 500-year level. Unlike Plan C1, Plan U1 attempts to (1) limit the induced water surface rise imposed by new levee construction to below one foot for the 100-yr event, and (2) minimize impacts to the Lower Mississippi Valley Mississippi River and Tributaries (MR&T) projects. Like Plan C1, this plan would not likely compete well for future habitat development.

The unconfined 500 year plan with the associated 99 year agricultural plan (termed U3) is identical to Plan U1, except that its flood protection level in the agricultural protected areas has been lowered to less than 100 year. Since the protected agricultural areas in the U3 plan would not be eligible for certification, they could serve as a viable candidate for habitat restoration incentives and easements.

In the study five potential economic impact paths were evaluated: economic development, construction, flood damages averted, land value enhancement, and farm income gains. Since Plans C1 and U1 provide flood protection for at least the 100 year flood for urban and agricultural areas, the benefits provided should be similar, exclusive of the impacts of the construction itself. The costs for plan C1 are higher than for U1 given that more construction would be required to provide the greater level of flood protection, and thus the regional benefits due to construction should be higher in Plan C1.

The regional benefits for Plan U3 should be lower than found in Plans C1 and U1 due to levee improvements in the agricultural areas only being upgraded to protect (at the maximum) against a 99 year flood event. Costs should also be lower in Plan U3, and thus the regional benefits due to construction should be lower than in C1. Table 18 shows the project cost of the three plans as present values discounted at 5.625 percent. Plan C1 costs $5.803 billion as compared to costs for U1 and U3, respectively of $3.6 billion and $2.7 billion.

Table 18: Project Cost for Alternatives C1, U1, and U3

($03B)

	C1	U1	U3
5 State Area	$5.803	$3.632	$2.671

Table 19 shows the impacts in the five state area by type of impact and by plan (only the GRP measure is included in this summary section—real personal income and output impact measures are closely proportional to GRP impacts across regions and impact sources). Total regional benefits of the flood control projects as measured by GRP are $30.381 billion in C1, $27.091 billion in U1 and $22.029 billion in U3. Benefits are dominated by economic development and construction, together accounting for 95 percent of total benefits ($29.086 billion) in alternative C1.

Table 19: Present Value Gross Regional Product Impacts in the Five State Region for Plans C1, U1, and U3

($03B)

Category of Impacts	C1	U1	U3
Construction	$8.559	$5.268	$3.803
Economic Development	$20.527	$20.527	$18.079
Land Values	$0.072	$0.072	$0.006
Farm Income	$1.045	$1.045	$0.042
Damages Averted	$0.179	$0.179	$0.099
Five States	$30.381	$27.091	$22.029

Other impacts are significant, at least in absolute terms. The regional benefits from damages averted are estimated to be $179 million, and farm income is $1.045 billion. The economic development impact of the increase in property value is $72 million.

Table 20 shows the distribution of total GRP impacts by state for each of the three plans. Regional benefits cluster in Illinois, which accounts for approximately 80 percent of total benefits in each alternative. Iowa and Missouri account for $2.7 and $2.2 billion respectively in C1, while Wisconsin accounts for $819 million.

Table 20: Present Value Impacts on Gross Regional Product of Three Flood Control Plans: C1, U1, and U3

($03B)

Region	C1	U1	U3
Illinois	$23.999	$$21.459	$17.518
Iowa	$2.768	$2.687	$2.411
Minnesota	$0.548	$0.498	$0.423
Missouri	$2.248	$1.804	$1.230
Wisconsin	$0.819	$0.642	$0.447
Total	$30.381	$27.091	$22.029

Table 21 below shows the employment impacts by state for the three flood control alternatives. In each plan the employment impacts are largest in Illinois, which accounts for about 80 percent of the total in Plan C1. Together, Iowa and Missouri account for 4,230 employees or about 16 percent of the total in Alternative C1.

Table 21: Average Annual Employment Impacts of Three Flood Control Plans: C1, U1, and U3

Region	C1	U1	U3
Illinois	20,724	19,039	15,431
Iowa	2,430	2,397	2,192
Minnesota	291	275	237
Missouri	1,800	1,353	855
Wisconsin	445	364	252
Total	25,690	23,428	18,966

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