THE RELATIONSHIP BETWEEN LAND VALUES AND FLOOD RISK IN THE WABASH RIVER BASIN

Thesis for the Degree of Ph. D.

MICHIGAN STATE UNIVERSITY
ROBERT FOX BOXLEY JR.

1969

THESIS

MICHIGAN STATE UNIVERSITY LIBRARIES
3 1293 01061 6815

LIBRARY
Michigan State
University

This is to certify that the

thesis entitled

The Relationship Between Land Values
and Flood Risk in the Wabash
River Basin

presented by

Robert Fox Boxley, Jr.

has been accepted towards fulfillment
of the requirements for

Doctor of Philosophy degree in Agricultural Economics

Leo V. Mandersched
Major professor

Date March 31, 1969

O-169

FEB 0 6 1996
0 2 3
0 4 2 0 0 4
Nov. 20, 2002

Tl

Tr

expected

The use

discipla

native t

for such

theory

lower p

the amo

losses

object

price

pare t

obtai

by th

With

were

ABSTRACT

THE RELATIONSHIP BETWEEN LAND VALUES AND FLOOD RISK IN THE WABASH RIVER BASIN

By

Robert Fox Boxley, Jr.

This Study investigates the feasibility of estimating expected agricultural flood damages from land price data. The use of relative price relationships for flood-free and floodplain lands has frequently been suggested as an alternative to current Federal Agency procedures. The rationale for such an estimation procedure is based on land rent theory which implies that floodplain lands should command lower prices than otherwise comparable flood-free lands by the amount of the present value of the expected future losses of earnings attributable to flooding. The primary objectives of this study were to determine if the expected price differentials exist or can be measured, and to compare the estimated monetary evaluation of the flood risk obtained from land price data with the estimates prepared by the U.S. Army Corps of Engineers (COE).

Eight counties, representing three distinct areas with respect to flooding hazards and types of farming, were selected from the Indiana portion of the Wabash River

basin for
ach floo
public so
for flood
by using
estimate
both upl
the upla
regress
Free of
to esti
each fl
between
was ta
each f
estima
area
prepa

expec
esti
area
floo
rea
5.0
lev

Basin for empirical analysis. Farm sales data covering both floodplain and upland farms were obtained from public sources in each county. The average discounting for flood risk among the floodplain sales was estimated by using multiple linear regression techniques to first estimate the influence of independent variables common to both upland and floodplain tracts from the sale price of the upland observations only. This yielded value estimates (regression coefficients) for the independent variables free of any influence of flood risk which were then used to estimate a "flood-free" sale price (per acre basis) for each floodplain observation. The residual difference between the actual sale price and the estimated sale price was taken as the estimate of the flood risk discounting on each farm. These residuals were further analyzed to obtain estimates of average discounting for flood risk in each area comparable to the estimates of expected flood damages prepared by the Corps of Engineers.

In two of the three study areas, the estimates of expected flood damages were reasonably close to the estimates derived by the COE. In the Upper Wabash study area, the best estimate of the average discounting for flood risk by the land market was $56 per acre. This is reasonably close to the Crops estimate (capitalized at 5.0 per cent) of $40 per acre under present protection levels. However, this agreement may be more apparent than

ral beca
ttributa
ccurred
apitali
had alre

the Wab
ifican
receiv
tori
sales
per c
osse
ific
acre

Cou
est
lar
(u
cl
th
l
I
r

real because the land market failed to reflect any changes attributable to a substantial reduction in flood risk that occurred during the study period. Possibly, however, some capitalization of the expected benefits from protection had already occurred by the time of the study.

In the second study area along the lower reaches of the Wabash and White Rivers the analysis revealed no significant discounting for residual flood risks in areas receiving levee protection. This was consistent with *a priori* expectations. The estimated discount for farm sales without levee protection was $118 per acre. At 5.0 per cent, this is equivalent to expected average annual losses from flooding of $5.89 per acre and was not significantly different from the COE estimate of $6.81 per acre, after correcting for an error in COE computations.

In the third study area--Bartholomew and Jackson Counties in the White sub-basin--statistically reliable estimates of the flood risk could not be obtained from land price data. In Bartholomew County, the average (unadjusted) floodplain sale price per acre was very close to the average sale price of the upland sales, but there was evidence that the floodplains would command at least a $35 per acre premium in the absence of flood risks. In Jackson County, the floodplains commanded a $110 premium over the uplands even with the existing flood risk and this relationship provided no means of estimating an expected pr

flood risk.

with counti

estimate o

reconcile

in the Co

such that

the relat

capitali

analysis

of COE t

independ

that th

risk i

errors

data a

capit

relia

flood

pric

prin

con

ced

for

expected price for the floodplain sales in the absence of flood risk. However, the existing price relationships in both counties were widely inconsistent with the COE estimate of expected flood damages. In attempting to reconcile the estimates, several errors were discovered in the Corps computations. The nature of the errors was such that they could have been detected by the COE had the relative land price information been available and capitalization principles applied. Thus, the land market analysis still provided a criterion for judging the accuracy of COE techniques even though it could not provide an independent estimate of the flood risk discounting.

From the results of the analysis it was concluded that the land market apparently does discount for flood risk in a systematic manner but that the large standard errors associated with estimates obtained from land price data and the uncertainties in determining an appropriate capitalization rate make it impractical to place sole reliance on relative land prices for estimation of expected flood damages. However, information on relative land price relationships and the application of capitalization principles should add substantially to the accuracy of conventional federal agency flood damage estimation procedures. It is therefore recommended that land price data for areas slated to receive flood protection be collected a regular basis

capitalization prin

justification study

on a regular basis and that a land value check, based on capitalization principles, be made a part of each project justification study.

THE RELATI

FLOOD R

in par

De

THE RELATIONSHIP BETWEEN LAND VALUES AND FLOOD RISK IN THE WABASH RIVER BASIN

By

Robert Fox Boxley, Jr.

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Agricultural Economics

1969

Appreciati

Dr. Lester V. M

vals, the task

this thesis; an

man of the auth

also extended

Strohbehn who

thesis. Dr. S

director of th

Research Servi

during the cou

Finally a

Jennie, for ma

pleasant as it

657244
9-3-69

ACKNOWLEDGMENTS

Appreciation is extended to Dr. A. Allan Schmid and Dr. Lester V. Manderscheid who shared, at different intervals, the task of guiding the study and the preparation of this thesis; and to Dr. John Brake who served as the chairman of the author's guidance committee. Appreciation is also extended to Dr. Milton Steinmueller and Dr. Roger Strohbehn who read and made many helpful comments on the thesis. Dr. Strohbehn was also involved in the study as director of the North Central Resource Group, Economic Research Service, with which the author was associated during the course of the study.

Finally an expression of gratitude is due to my wife, Jennie, for making the time spent on this study as pleasant as it was.

ACKNOWLEDGMENTS

LIST OF TABLES

LIST OF FIGURES

Chapter

I. INTRODUC

Object
Defini
Land
Conv
Bene
Land
Resear

II. A THEORE
FLOOD C

Agricu
Land
Land
Eva
Val
Com
Sou
Land

III. PREVIOU

Verdi
Grand
Ray,
Washi
Concl

TABLE OF CONTENTS

Page

ACKNOWLEDGMENTS ii

LIST OF TABLES vi

LIST OF FIGURES viii

Chapter

I. INTRODUCTION 1

Objectives 4
Definitions 8
Land Value Model 8
Conventional or Agency Procedures . . 8
Benefits versus Damages 8
Land Value Model Applications . . . 9
Research Backgroud and Area of Study . . 12

II. A THEORETICAL FRAMEWORK FOR ESTIMATING FLOOD CONTROL BENEFITS 14

Agricultural Benefits and the Role of Land Values 18
Land Values in Practice 32
Evaluating Flood Hazards 32
Valuing Noncomparable Lands 45
Components of Land Value 50
Sources of Land Value Data 55
Land Values in Practice: Summary . . . 57

III. PREVIOUS APPLICATIONS 61

Verdigris River, Kansas 61
Grand River Reach, Missouri 64
Ray, Clay and Platte Counties, Missouri . 68
Washita River Basin, Oklahoma 74
Conclusions 77

Chapter

IV. SELECTIO
COLLECTI

Floodi
Select
The
The
The
Data S
Prop
Asse
Maps
Data C
Floodp
Uppe
Lowe
Whit

V. REGRESSI

Land F
Variab
Sale
Date
Tota
Acre
Acre
Acre
Type
Expa
Per
Sc
Valu
Hous
Type
Topo
Town
Land
Type
Floo
Preser
Regr

VI. REGRESS

Genera
Floo
Combi

Chapter		Page

IV. SELECTION OF STUDY AREAS AND DATA COLLECTION 79

Flooding Problems 83
Selection of Areas for Investigation . . 90
The Lower Wabash Area 93
The Upper Wabash Area 97
The White Subarea 99
Data Sources 100
Property Records 100
Assessment Records 101
Maps and Photographs 102
Data Collection 104
Floodplain and Upland Comparisons . . . 109
Upper Wabash Area 110
Lower Wabash Area 112
White Subarea 112

V. REGRESSION ANALYSIS: GENERAL 118

Land Price Models 118
Variables 122
Sale Price 122
Date of Sale 123
Total Acres Sold 123
Acres of Cropland by Grade 123
Acres of Pasture and Acres of Woodland. 125
Acres of Other Land 125
Type of Instrument 125
Expansion 126
Per Cent of Mineral and Oil Rights Sold 126
Value of Farm Improvements 127
House Grade 128
Type of Road 129
Topography 129
Township 130
Land Capability Unit Groups 130
Type of Farm 131
Flood Risk 132
Presentation and Interpretation of Regression Results 135

VI. REGRESSION ANALYSIS: UPPER WABASH AREA . 140

General 140
Floodplain Sales 1952-1966 140
Combined Analysis, All Sales 142

Chapter

Upland
Year
Pric

VII. REGRESSI

Upland

VIII. REGRESSI

Upland
Bart
Upland
Cour

IX. COMPARIS

Capita
Upper
Lower
White

X. CONCLUS

BIBLIOGRAPHY .

APPENDICES .

Chapter		Page
	Upland and Estimated Floodplain Sales .	146
	Year of Sale Adjustments	147
	Price and Flood Risk Adjustments . .	151
VII.	REGRESSION ANALYSIS: LOWER WABASH AREA .	157
	Upland and Estimated Floodplain Sales .	159
VIII.	REGRESSION ANALYSIS: WHITE SUBAREA . . .	165
	Upland and Floodplain Values, Bartholomew County	167
	Upland and Floodplain Values, Jackson County	171
IX.	COMPARISONS OF LAND VALUE AND FLOOD RISK .	174
	Capitalization Rates	175
	Upper Wabash Area	177
	Lower Wabash Area	183
	White Subarea	186
X.	CONCLUSIONS AND RECOMMENDATIONS	194
BIBLIOGRAPHY		204
APPENDICES		210

Table

1. Farms ar
Wabash I

2. Study Ar
Wabash I

3. Selected
Upper Wa

4. Selected
Lower Wa

5. Selected
Barthol

6. Selected
fers, Ja

7. Flood F
Value S

8. Estimat
tions U

9. Estimat
Mean Va
tions,

10. Average
tions,

11. Estimat
tions,

12. Estimat
Mean Va
tions,

13. Average
tions,

LIST OF TABLES

Table		Page
1.	Farms and Farm Characteristics by Sample Areas, Wabash Land Value Study, 1956 and 1965	94
2.	Study Areas, Reaches, and Floodplain Acres, Wabash Land Value Study	95
3.	Selected Characteristics of 406 Farm Transfers, Upper Wabash Area, 1952-1966	111
4.	Selected Characteristics of 334 Farm Transfers, Lower Wabash Area, 1962-1966	113
5.	Selected Characteristics of 81 Farm Transfers, Bartholomew County, White Subarea, 1964-1966	114
6.	Selected Characteristics of 118 Farm Transfers, Jackson County, White Subarea, 1964-1966	116
7.	Flood Frequency Zones by Streams, Wabash Land Value Study	134
8.	Estimated Regression Coefficients, 406 Observations Upper Wabash Area, 1952-1966	143
9.	Estimated Upland Regression Coefficients and Mean Values for Upland and Floodplain Observations, Upper Wabash Area, 1952-1966	148
10.	Average Land Prices and Flood Risk Calculations, Upper Wabash Area	152
11.	Estimated Regression Coefficients, 334 Observations, Lower Wabash Area, 1962-1966	158
12.	Estimated Upland Regression Coefficients and Mean Values for Upland and Floodplain Observations, Lower Wabash Area, 1962-1966	160
13.	Average Land Prices and Flood Risk Calculations, Lower Wabash Area	162

Table

14. Estimate
Bartholo
Subarea,

15. Estimate
Mean Val
Observat

16. Average
tions, B

17. Estimate
Mean Val
tions, J

18. Average
Farm Acc

19. Flood St
quencies
Damages,

Table		Page
14.	Estimated Regression Coefficients, All Sales, Bartholomew and Jackson Counties White Subarea, 1964-1966	166
15.	Estimated Upland Regression Coefficients and Mean Values for Upland and Floodplain Observations, Bartholomew County, 1964-1966 .	168
16.	Average Land Prices and Flood Risk Calculations, Bartholomew County	170
17.	Estimated Upland Regression Coefficients and Mean Values for Upland and Floodplain Observations, Jackson County, 1964-1966	172
18.	Average Rate Earned on Investment, Indiana Farm Account Cooperators, Selected Years . .	178
19.	Flood Stages, Acres Inundated, Natural Frequencies, and Estimated Average Annual Crop Damages; Reach EW-4, Jackson County, Indiana .	191

Figure

1. Capital
Land .

2. Capital
Land .

3. General

4. Physiogr

5. Major La

6. Actual L
Estimate
1966 .

LIST OF FIGURES

Figure		Page
1.	Capital Investment and Rent to Floodfree Land	20
2.	Capital Investment and Rent to Floodplain Land	23
3.	General Site Map, Wabash Basin	80
4.	Physiographic Regions, Wabash Basin	82
5.	Major Land Resource Areas, Wabash Basin . .	84
6.	Actual Land Price Indices, Indiana, and Estimated Indices, Upper Wabash Area, 1955-1966	150

Federal i

has amounted to

control policy

expenditures ar

the annual rate

investments of

able benefit-co

More than a dec

to a Task Force

that: "The acc

room for improv

results in eval

and of flood pr

growing body of

---

[1]U.S. Co
Control Policy,
<u>Flood Losses</u>, H

[2]Fred A.
Agricultural Da
zation of the E
<u>Force Report o</u>
D.C.: Governm

CHAPTER I

INTRODUCTION

Federal investment in flood protection and prevention has amounted to more than $7 billion since a national flood control policy was adopted in 1936. Currently, Federal expenditures are approximately $500 million per year and the annual rate of investment is increasing.[1] Wise investments of this magnitude depend importantly on reliable benefit-cost analyses of flood protection projects. More than a decade ago Fred Clarenbach, in a contribution to a Task Force Report on Water Resources and Power found that: "The accumulated evidence clearly indicates much room for improvement of Federal agency procedures and results in evaluations of water resource projects generally and of flood protection proposals in particular."[2] The growing body of literature and professional interest in

---

[1] U.S. Congress, House, Task Force on Federal Flood Control Policy, A Unified National Program for Managing Flood Losses, H. Doc. 465, 89th Cong., 2d sess., 1966, p. 3.

[2] Fred A. Clarenbach, "Reliability of Estimates of Agricultural Damage from Floods," in Commission on Organization of the Executive Branch of the Government, Task Force Report on Water Resources and Power (Washington, D.C.: Government Printing Office, 1954), III, p. 1277.

this field of p
observations ar

The purpo
possible avenue
use of land val
benefits. The
flood protectio
other water res
erally, to any
fall gains can
or contractual

Federal a
the benefit est
flood control p
Wilfred Pine[1] a
each used curre
strate that the
areas could not
the projects.
of errors in t
both to recomm
part of every

---

[1] [Wilfre
Board on Agric
Engineers," Ap

[2] Clarenb

this field of project evaluation suggests that Clarenbach's observations are still valid today.

The purpose of this study is to investigate one possible avenue of improvement in agency procedures--the use of land values as a means of estimating expected project benefits. The applications specifically considered are for flood protection projects but the principles apply also to other water resource development projects and, more generally, to any investment decision where substantial windfall gains can be expected to accrue to a physical object or contractual right for which a market exists.

Federal agency interest in the use of land values in the benefit estimating process can be traced to two ex post flood control project reviews made in the mid-1950's by Wilfred Pine[1] and Fred Clarenbach.[2] Both Pine and Clarenbach used current and anticipated land values to demonstrate that the structure of the land market in the affected areas could not support the estimated benefits claimed for the projects. These findings, together with other evidence of errors in the estimating procedures originally used, led both to recommend that a land value check be included as a part of every project investigation.

---

[1] [Wilfred H. Pine, et al.], "Report of Advisory Board on Agricultural Flood Damages to Army Corps of Engineers," April 27, 1956. (Mimeographed.)

[2] Clarenbach, Task Force Report, pp. 1275-1298.

The techn
their foundatio
stated, the the
value of land a
earnings--land
can be expected
comparable floo
are fully infor
into considerat
the expected re
flood losses.
damage and loss
cultural benefi
conditions one
cultural benefi
values.

The advan
benefit estima
are relatively
trast to the l
estimating pro
provides a mea
most directly
expected earni

[1] J. W.
Irrigation Be
1959), pp. 23

The techniques used by Pine and Clarenbach have their foundations in the theory of economic rent. Briefly stated, the theory implies that--to the extent the market value of land accurately reflects its expected future earnings--land subject to periodic damage from flooding can be expected to command a lower price than otherwise comparable floodfree land. If land market participants are fully informed and realistically take the flood risk into consideration, the differential in price will reflect the expected reduction in future earnings attributable to flood losses. Since the prevention of expected physical damage and loss of earnings is the major source of agricultural benefits it follows that under these idealized conditions one should be able to estimate expected agricultural benefits from flood control directly from land values.

The advantages claimed for a land value approach to benefit estimation are several.[1] For one, land value data are relatively accessible and easily interpreted. In contrast to the laborious and potentially error-prone estimating procedures currently used, the land market provides a measure that is based on the experiences of those most directly affected by the flooding hazard. In addition, expected earnings as reflected in land prices have already

---

[1] J. W. Milliman, "Land Values as Measures of Primary Irrigation Benefits," Journal of Farm Economics, 41 (May, 1959), pp. 234-243.

been discounted

term market rat

social time pre

Several o

claimed advanta

of applying the

demonstrated by

exogenous chang

land (particula

allotments unde

have conceptual

financed flood

floodplain land

characteristics

studies, the th

that land value

tant contribut

of benefit-cos

The purp

theoretical an

benefit-estima

---

[1]See, fo
and W. L. Gibs
Allotments, Te
Agricultural

been discounted to a present value by an implicit long-term market rate that presumably reflects the appropriate social time preference rate for project evaluation.

Several objections may be raised to each of these claimed advantages; nevertheless the empirical feasibility of applying the principles of economic rent theory has been demonstrated by a number of studies of the effects of exogenous changes in land rent on the market value of land (particularly changes arising from crop production allotments under government price support programs) which have conceptually similar effects on land values as federally financed flood control projects.[1] Although the market for floodplain land probably differs in several important characteristics from the land markets examined in previous studies, the theoretical and empirical evidence suggest that land value data, properly applied, may make an important contribution in improving present agency techniques of benefit-cost analysis.

Objectives

The purpose of this investigation is to examine the theoretical and practical issues involved in the use of a benefit-estimating model based on land values. The general

---

[1]See, for example: Frank H. Maier, James L. Hedrick, and W. L. Gibson, Jr., The Sale Value of Flue-cured Tobacco Allotments, Technical Bulletin 148 (Blacksburg: Virginia Agricultural Experiment Station, April, 1960).

plan of present

develop a bene

(b) to apply th

sidered for fl

bility of adop

agency procedu

The spec

1. To e

valu

the

2. To c

from

by c

and

two

appr

3. To e

olog

lan

The thi

land values a

expected dama

process. Sin

analytical te

for field app

is to evaluat

plan of presentation followed in this report is (a) to develop a benefit-estimating model based on land values, (b) to apply the land price model to areas currently considered for flood protection, and (c) to judge the feasibility of adopting such a model as a part of required agency procedure.

The specific objectives of this study are:

1. To estimate the relationships between land values and flood risks in selected areas of the Wabash River Basin.
2. To compare flood protection benefits estimated from land value data with benefits estimated by conventional benefit-estimating procedures and to evaluate the relative accuracy of the two approaches or a combination of the two approaches.
3. To evaluate land value data sources and methodological requirements for field applications of land value estimation procedures.

The third objective is conditional upon finding that land values are sufficiently accurate indicators of expected damages to warrant use in the benefit estimating process. Since the first two objectives may require analytical techniques that may be too complex or expensive for field applications, the purpose of the third objective is to evaluate possible shortcuts in data collection and analysis requi

the technique.

of implementing

evaluations.

The seco

must be resolv

benefit-estima

model contribu

damage and flo

use. The ques

first is the q

adjustment to

ing accuracy i

assuming under

second aspect

model compared

cedures. This

agency viewpoi

objective is a

The diff

mates derived

benefit-estima

objective is t

which the accur

review of conv

necessary but

analysis requirements to facilitate field applications of the technique. Also implied is an evaluation of the costs of implementing the land value approach for specific project evaluations.

The second objective reflects the basic issue that must be resolved to justify federal agency adoption of a benefit-estimating model based on land values: whether the model contributes sufficiently to the accuracy of flood damage and flood control benefit estimates to justify its use. The question of accuracy has several aspects. The first is the question of the accuracy of the land market's adjustment to risk, or equivalently, the potential of obtaining accuracy in the land value estimating technique--assuming underlying accuracy in the land market. The second aspect is the <u>relative</u> accuracy of a land value model compared to conventional benefit-estimating procedures. This is the relevant question from a federal agency viewpoint and it is to this question the second objective is addressed.

The difficulty with the direct comparison of estimates derived from a land value model and from conventional benefit-estimation procedures as proposed in the second objective is that there are no absolute standards against which the accuracy of either approach can be judged. A review of conventionally derived estimates will be made if necessary but it cannot be definitive because of uncertainty regarding the hy

embodied in the

Recognizir

which either the

be measured, the

are consistent

can serve to st

data. For examp

values react in

hazards of diff

degree of faith

mator would be

to determine if

measured. If r

for example, if

magnitude is r

useful in defin

are appropriate

would establish

degrees of risk

that the moneta

correctly evalu

raise serious q

land value appr

regarding the hydrological elements and other assumptions embodied in the conventional technique.

Recognizing there is no ultimate standard against which either the land market or conventional technique can be measured, the first objective seeks to determine if there are consistent relationships within the land market that can serve to strengthen confidence in the use of land value data. For example, if it can be demonstrated that land values react in a regular, systematic fashion to flood hazards of differing intensities, *ceteris paribus*, the degree of faith one could place in land values as an estimator would be increased. The first objective is intended to determine if such relationships exist, or if they can be measured. If relationships exist in only a limited sense, for example, if only flooding risks greater than a certain magnitude is recognized, this knowledge still should be useful in defining cases where the use of land value data are appropriate. Positive findings for this objective would establish that land prices do discriminate among degrees of risk although it may not necessarily establish that the monetary value of the expected flooding damage is correctly evaluated. Negative findings, however, should raise serious questions about the applicability of the land value approach.

At this p

some of the mor

in this report.

Land Value Mode

To avoid

term "land valu

procedure for e

trol projects t

the procedure.

Conventional or
Procedures

These ter

hand designatio

the "stage-dama

federal agencie

generally, the

attempts to rec

range of flood

point in time a

Benefits versus

Flood dam

primarily in te

physical damage

benefits from

Definitions

At this point it is desirable to explicitly define some of the more frequently used terms and concepts employed in this report.

Land Value Model

To avoid repetitious qualifications we will adopt the term "land value model" (or "approach") to designate any procedure for estimating expected benefits from flood control projects that uses land values as an integral part of the procedure.

Conventional or Agency Procedures

These terms will be used interchangeably as a shorthand designation of the "flood hydrograph-flood damage" or the "stage-damage integration" methods currently used by federal agencies to estimate flood control benefits. More generally, the terms refer to any estimating procedure that attempts to reconstruct in probabilistic terms the whole range of flood risk and associated flood damages at some point in time and space.

Benefits versus Damages

Flood damages to agricultural lands are evaluated primarily in terms of income losses and the costs of physical damages resulting from flooding. Conversely, the benefits from flood control are the expected reductions in annual flood da

with and withou

damages and floo

detail in later

point is that t

control is comp

rarely provide

suited to estim

expected flood

qualification s

reasonableness

also provides a

Thus land value

limits for expe

direct estimato

is well establi

appropriate; ho

tionship betwee

rather than exp

Land Value Mod

The steps

conceptually s

of how the lan

distinguish be

tions of a lar

annual flood damages--the differences in expected damages with and without the flood control structure. Both flood damages and flood control benefits will be discussed in more detail in later chapters; the important distinction at this point is that the two measures are equivalent only if flood control is complete. Since most flood control projects rarely provide complete protection, land values are best suited to estimating expected flood damages rather than expected flood control benefits. This is not a serious qualification since a land value-based judgment of the reasonableness of conventionally estimated flood damages also provides a basis for the judgment of expected benefits. Thus land values should be usable in establishing upper limits for expected benefits even if they are not usable as direct estimators. The "benefit estimating" terminology is well established and we will continue to use it where appropriate; however, we are more concerned with the relationship between land values and expected flood damages rather than expected flood control benefits *per se*.

Land Value Model Applications

The steps involves in applying a land value model are conceptually simple but there are differing interpretations of how the land value approach should be applied. We will distinguish between "supplemental" and "substitute" applications of a land value model.

The suppl
part of convent
expected averag
mated by conver
compared to pre
tected, and jud
can be in terms
wise comparable
of the indicate
the investment
and the capital
case is that th
with present pr
indicated price
related to pric
quality.

In this a
reliance for ac
techniques but
corroborating
of the project

---

[1]Or, equ
ferentials can
pared to the c
or benefits.
out most conve

[2]The Cor
engineering ma
of a land valu

The supplemental application would be an integral part of conventional estimating procedures. After the expected average annual damages (and benefits) are estimated by conventional techniques they are capitalized, compared to prevailing land prices in the area to be protected, and judged for reasonableness. The comparison can be in terms of current price differentials between otherwise comparable floodplain and floodfree land, or in terms of the indicated price of presently unprotected land after the investment (which will be the sum of the present price and the capitalized benefits).[1] The criteria in the first case is that the capitalized damage estimated should agree with present price differentials. In the second case the indicated price after protection should be reasonably related to prices of nearby floodfree land of comparable quality.

In this application of the land value model primary reliance for accuracy would be placed on conventional techniques but the land value data would provide valuable corroborating evidence, especially for subsequent reviewers of the project proposal.[2]

---

[1]Or, equivalently, current or indicated price differentials can be converted to annual equivalents and compared to the conventionally estimated average annual damages or benefits. All of the above comparisons would be carried out most conveniently on a per acre basis.

[2]The Corps of Engineers issued a well-reasoned engineering manual in 1957 that explained the application of a land value check and specified that project reports

In a "su

would be relie

damages and be

advocated this

model based on

cheaper to app

application ma

projects but i

to most flood

between the tw

degree of accu

the land value

sively as the

should include
between produc
values of land
validity of th
posals examine
land values in
Engineers, "Ex
Damages and Fl
Engineering Ma

[1]Edward
An Economic Ap
source Program

[2]A third
tinguished. T
used in a limi
"enhancement"
to direct dama
generally, are
makes a shift
likely to occu
idle or in a l
agricultural b
the increased

In a "substitute" application the land value model would be relied upon exclusively in estimating expected damages and benefits. Edward Renshaw, for one, has advocated this approach; arguing that a benefit-estimating model based on land prices could be more accurate and cheaper to apply than current agency procedures.[1] This application may have promise for irrigation and drainage projects but it would appear to have limited applicability to most flood control projects. The primary distinction between the two applications of the model is that a higher degree of accuracy would be required for the latter since the land value differentials would be relied upon exclusively as the measure of expected benefits.[2]

---

should include a discussion of "the extent of agreement between productivity, damage, and benefit values with market values of land, as a basis for indicating the essential validity of the former." However, none of the project proposals examined for this study included any discussion of land values in this sense. See: U.S. Army, Corps of Engineers, "Examinations and Surveys: Relation of Flood Damages and Flood Control Benefits to Market Value of Land," Engineering Manual EM1120-2-11, 13 June 57. (Mimeographed.)

[1]Edward F. Renshaw, Toward Responsible Government: An Economic Appraisal of Federal Investment in Water Resource Programs (Chicago: Idyia Press, 1957), pp. 78-79.

[2]A third, "enhancement" application, can also be distinguished. The enhancement application is currently being used in a limited way by the Corps of Engineers where "enhancement" benefits are expected to be large relative to direct damage reduction benefits. Enhancement benefits, generally, are the benefits realized when flood protection makes a shift to a higher land use feasible. This is most likely to occur in urban areas where floodplain land is idle or in a low valued use but may also be a component of agricultural benefits. The "enhancement" is equivalent to the increased rent the land can command in the higher use

Rese

This rese

the Corps of En

(COE), and the Ec

Department of A

alternative pro

flood control b

the study is to

empirical analy

under the Corps

The Wabas

analysis for ad

siderations inv

The selection o

a function of m

---

and, as a pract
expected market
is a more gener
above but the a
here also.

[1]The oth
work in the Wa
Service (SCS)
ture. The jur
the basis of s
streams or ups
less than 250,
of a land valu
but the typica
create difficu
of the scarcit

Research Background and Area of Study

This research was conducted under contract between the Corps of Engineers, United States Department of Army (COE), and the Economic Research Service, United States Department of Agriculture as a part of a larger study of alternative procedures for the evaluation of agricultural flood control benefits. Consequently, the orientation of the study is toward COE techniques and procedures and the empirical analysis is applied primarily to floodplains under the Corps' jurisdiction.[1]

The Wabash River Basin was selected for empirical analysis for administrative convenience and because of considerations involved in other parts of the overall study. The selection of specific study areas within the Basin was a function of methodological considerations only.

---

and, as a practical matter, is estimated by estimating the expected market value of the land with protection. This is a more general use of land value than the uses envisioned above but the analysis planned will have general relevance here also.

[1]The other federal agency involved in flood control work in the Wabash River Basin is the Soil Conservation Service (SCS) of the United States Department of Agriculture. The jurisdiction of the two agencies is decided on the basis of stream drainage area with the SCS restricted to streams or upstream segments of major watercourses with less than 250,000 acres of drainage area. The principles of a land value model apply equally to the two agencies but the typically small areas involved in SCS work may create difficulties in applying a land value model because of the scarcity of small-area land value data.

The origi

for a study of

of improved ut

the study is re

purposes.

The original request by the Corps of Engineers was for a study of the "influence on agricultural land values of improved utilization through flood protection." Hence, the study is restricted to lands used for agricultural purposes.

A T

The Cor

flooding as:[1]

(1) Tang

a.

b.

c.

[1] U.S.
and Reports
1120-2-101
pp. 50-50b.

CHAPTER II

A THEORETICAL FRAMEWORK FOR ESTIMATING FLOOD CONTROL BENEFITS

The Corps of Engineers classifies the damages from flooding as:[1]

(1) Tangible flood damages

a. Physical damages, including the cost of clean-up, damages to or loss of buildings or parts thereof, loss of contents, including furnishings, equipment, decorations, stocks of raw materials, materials in process and completed products.

b. Emergency costs, including those additional expenses resulting from a flood that would not otherwise be incurred such as evacuation and reoccupation, flood fighting, disaster relief, increased expense of normal operations during a flood, increased costs of police, fire or military patrol, and abnormal wear and tear on alternative routes of traffic.

c. Business and financial losses, including the various economic losses other than physical damages and emergency costs, resulting from a flood such as net loss of normal profit and earnings to capital, management and labor in the readily identifiable zone of flood influence. The estimate should exclude all losses that may be compensated for by increased economic activity in the area affected at a later date (postponed sales, etc.) or in an unaffected area at any time (alternative sales by competitors, etc.), and also losses to

---

[1]U.S. Army, Corps of Engineers, "Survey Investigations and Reports: General Procedures," Engineering Manual EM 1120-2-101 (includes change 16), 12 October 64 (Mimeographed), pp. 50-50b.

a
a
p

(2) Inta

T
be g
assi
them
or s
clas
they
valu

A further req

are to take i

increased uti

Basic e
for the e
surveyed.
trends an
flood are
most prob
and with
prospecti
project,
damage, c
for modif
damages f
average a
after cor
and adjus
tions wit
for estin
Prospecti
than that
basis for
of increa

The Co

be evaluated

as the cost

normal depre

or the incom

activities remote from the flooded area where adjustments can be made during or after flood periods to avoid or compensate for the loss.

(2) Intangible flood damages

Those detrimental effects of floods that cannot be given market or monetary values, except by assignment of arbitrary values or by assuming them analogous or equivalent to marketable goods or services. When given values they should be classed as tangible damages; when not evaluated they should be discussed objectively. No monetary value is to be placed on loss of human life.

A further requirement is that damage estimation procedures are to take into account prospective enhancement or increased utilization:

> Basic estimates of flood damages will be prepared for the existing state of development of the area surveyed. Forecasts will then be made of the probable trends and nature of developments and activities in the flood area and adjacent affected region, based on the most probable economic use of the area both without and with the project under construction . . . . The prospective "normal" state of development without the project, and the susceptibility thereof to flood damage, over the life of the project will be the basis for modifying the basic estimates of average annual damages for current conditions to determine prospective average annual damages. The modified damage data, after correlation with flood stages and frequencies, and adjustments for expected normal development conditions without the considered project, will be used for estimating probable flood control benefits. Prospective development with the project, if different than that expected without the project, will be the basis for estimating probable additional enhancement of increased utilization benefits.

The Corps specified that tangible flood damages may be evaluated by one or more of the standard approved methods; as the cost of restoration (repair or replacement less normal depreciation), comparative market or sales value, or the income evaluation method. The first two methods are

suggested for
costs; the inc
cultural crop
the estimates
than reporting
and damages pr
eliminated.

For agri
can be reduced
borne by local
these costs a
there seems l
cost to the a
specific to a
emergency har
need be consi
significant i
the agricultu

The sig
sector, then,
<u>financial los</u>
usual procedu
and "non-crop
are physical
typically enu
and debris de

suggested for evaluation of physical damages and emergency costs; the income evaluation method for evaluation of agricultural crop losses. The Corps also specified that when the estimates are to be used for project evaluation (rather than reporting on a flood of record), nonrecurring damages and damages preventable by prudent management are to be eliminated.

For agricultural areas this list of damage sources can be reduced. Emergency costs, for the most part, are borne by local (or larger) governing units. To the extent these costs are encountered in both rural and urban areas, there seems little point in allocating a portion of the cost to the agricultural sector. Some emergency costs specific to agriculture, such as farm home evacuation or emergency harvest, flood-protection, and salvage costs may need be considered. It is also difficult to conceive of a significant intangible damage source stemming solely from the agricultural sector.

The significant damage classes for the agricultural sector, then, are tangible physical damages and business and financial losses. In treating agricultural damages the usual procedure is to classify physical damages into "crop" and "non-crop" categories. Non-crop agricultural damages are physical damages to soils and farm structures. Damages typically enumerated include bank cutting, erosion, sanding and debris deposition, damages to farm buildings, fences, machinery, stor

of these damage

by the cost of

methods.

Crop dam

can be best es

automatically

(Crop damages

are functions

duration of f

or non-agricu

estimating te

essentially c

farmer--whicl

flooding les

if needed, f

a part of th

hazard precl

The sc

follow dire

major sourc

that flood

---

[1]We a
the major a
for the Wal
agricultura
Burton, Ty
the United
sity of Ch

machinery, stored crops, ditches, and livestock loss. All of these damage sources can be straight-forwardly evaluated by the cost of restoration or comparative market value methods.

Crop damages are enumerated separately because they can be best estimated by the income evaluation method which automatically considers business and financial losses.[1] (Crop damages are also enumerated separately because they are functions of the seasonality as well as the depth and duration of flooding to a much larger degree than non-crop or non-agricultural damages and therefore require special estimating techniques.) The income evaluation method essentially counts (a) the direct income loss to the farmer--which is the investment in the crop at the time of flooding less harvesting costs foregone; with allowances, if needed, for the possibility of replanting or salvaging a part of the crop; and (b) income foregone where the flood hazard precludes higher valued agricultural use of the land.

The sources of agricultural flood control benefits follow directly from the sources of flood damages. The major source is direct damage reduction. To the extent that flood control reduces or alleviates tangible crop and

---

[1]We are assuming, of course, that crop production is the major agricultural floodplain enterprise. This is true for the Wabash Basin and would also appear to hold for agricultural use of floodplains generally. See: Ian Burton, Types of Agricultural Occupance of Flood Plains in the United States, Research Paper No. 75 (Chicago: University of Chicago, Department of Geography, 1962).

and non-crop d
attributable t
In addition, f
that protectio
level of land
sources of agr
following sec

<u>A</u>

Conside
flooding haza
topography, r
this unit of
order for thi
land must be
factors of pr
managerial a
each of thes
other factor
land inputs
can visualiz
divisible sc

---

[1] The r
model presen
Between Floo
on Flood Pro
No. 70 (Chi
Geography,

and non-crop damages, the value of the reduction is attributable to the flood control project as a benefit. In addition, further benefits are possible to the extent that protection makes feasible a shift to a higher economic level of land use. The rationale for considering these sources of agricultural benefits should be clear from the following section of this chapter.

Agricultural Benefits and the Role of Land Values

Consider first a parcel of land without regard to flooding hazard.[1] Depending on its location, climate, topography, natural fertility, and other natural factors, this unit of land will have an inherent productivity. In order for this productivity to be obtained, however, the land must be combined with some minimum amount of other factors of production--seed, fertilizer, labor, and managerial and machinery services. Rather than deal with each of these inputs separately, we can consider these other factors of production as a composite bundle of non-land inputs that we conveniently denote as "capital." We can visualize these non-land inputs as being highly divisible so that units of capital can be combined with a

---

[1]The model used in this section is adapted from a model presented in: Edward F. Renshaw, "The Relationship Between Flood Losses and Flood-Control Benefits" in Papers on Flood Problems, ed. by Gilbert F. White, Research Paper No. 70 (Chicago: University of Chicago, Department of Geography, 1961).

unit of land i
a continuous p
The usua
characteristi
added to a fi
but, beyond s
relationship,
obtain a valu
as in Figure
decisions the
The value of
application i
from the orig
to that level
The uni
is assumed to
tition in fac
of all non-la
mined by its
price higher
ment on the
additional u
price we der
(P_0 P'_0).

[1]To si
production f
returns to t

unit of land in sufficiently small increments to approach a continuous production function.

The usual agricultural production function has the characteristic that as additional units of capital are added to a fixed unit of land, total product will increase but, beyond some point, at a decreasing rate. From this relationship, assuming a constant product price, we can obtain a value of marginal product (VMP) curve for capital as in Figure 1. Over the relevant range of production decisions the VMP curve is downward sloping to the right. The value of product forthcoming at any level of capital application is equivalent to the area under the VMP curve from the origin to the point on the abscissa corresponding to that level of capital.[1]

The unit cost of the non-land resources ("capital") is assumed to be (P_o). Under conditions of perfect competition in factor markets (which implies perfect mobility of all non-land resources), the price of capital is determined by its opportunity cost--capital cannot command a price higher than (P_o) and will not be available for employment on the unit of land at a price less than (P_o). If additional units of capital are available at a constant price we derive a straight line "cost of capital" function (P_o P'_o).

---

[1]To simplify the graphical presentation we assume a production function with a positive intercept and decreasing returns to the variable factor over the entire function.

Figure

Land.

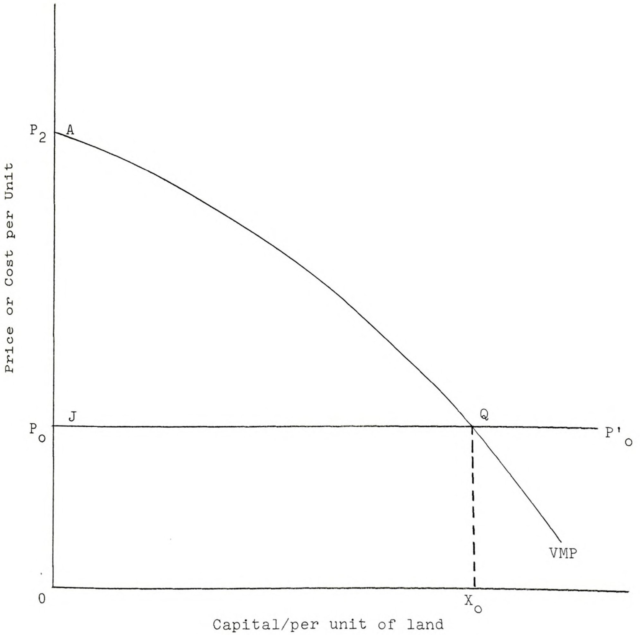


Figure 1.--Capital Investment and Rent to Floodfree Land.

Given t

to the final

units of capi

payment to ca

or the area (

or rent, that

Given a capita

mum price an

of land.

From the

of the maximum

From the VMP c

placed in prod

than (P_2). Fo

will be left i

value for prod

the cost of ca

shall see belo

effects. Ther

benefits to be

undeveloped ag

ment on compar

ing. Furtherm

for discountin

entrepreneur,

per unit of la

Given the VMP and cost of capital functions, returns to the final fixed unit of land will be maximized if (X_o) units of capital are combined with each unit of land. The payment to capital is its price (P_o) times the (X_o) units, or the area $(J\ Q\ X_o\ O)$. The residual (AQJ) is a surplus, or rent, that accrues to land as the scarce resource. Given a capitalization rate, this rent determines the maximum price an entrepreneur would willingly pay for the unit of land.

From the diagram we can deduce a theoretical measure of the maximum expected benefits from flood protection. From the VMP curve in Figure 1 we know the land will not be placed in production unless the cost of capital is less than (P_2). For capital costs greater than (P_2) the land will be left in its natural state (and have no market value for productive purposes) until events either lower the cost of capital or shift the VMP curve upward. As we shall see below, offering flood protection may have both effects. Therefore, it follows that the maximum annual benefits to be acquired from providing flood control to undeveloped agricultural land cannot exceed the annual net rent on comparable agricultural land not subject to flooding. Furthermore, if the discount rate and the time span for discounting were the same for society and for the entrepreneur, the present value of flood control benefits per unit of land could not exceed the market price of comparable fl

flood control

rents do accr

they would no

culties in th

perfect knowl

common privat

concept at le

later conside

We now

Instead, ass

floodplain s

occurrence,

reproduced a

labeled VMP_1

assumption t

(say, truck-

been combine

such as cash

represent le

postulated

The (

as the VMP

---

[1] For

intersectin

regardless

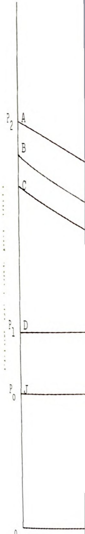
comparable floodfree land. Generally, the benefits from flood control will be less than in this example since some rents do accrue to floodplain lands at present, otherwise they would not be in production. There are other difficulties in the assumptions of competitive equilibrium, perfect knowledge, mobility of non-land resources, and a common private and social discount rate but the net rent concept at least establishes a theoretical benchmark for later consideration.

We now drop the assumption of floodfree location. Instead, assume that the unit of land is located on a floodplain subject to periodic inundation of uncertain occurrence, duration and magnitude. Figure 1 has been reproduced as part of Figure 2 with the VMP curve now labeled VMP_1. The VMP curve in Figure 1 was drawn on the assumption that the land was in its highest valued use (say, truck-farming). The non-land resources might have been combined in other ways to produce other products, such as cash-crops represented by (VMP_2), but this would represent less-than-optimum use of the land under the postulated floodfree conditions.[1]

The (VMP_1) and VMP_2) functions may still be viewed as the VMP curves for truck- and cash-crops, respectively,

---

[1]For simplicity, we draw the VMP curves as non-intersecting and assume a common cost of capital function regardless of the product produced.



Figure

Land.

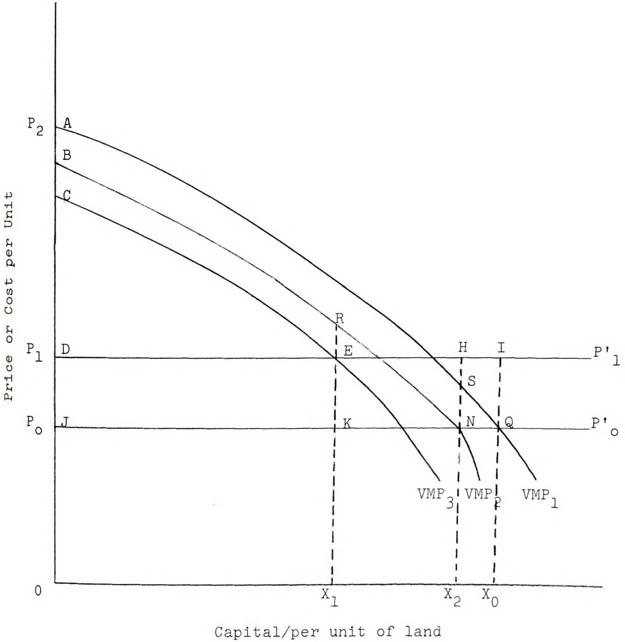


Figure 2.--Capital Investment and Rent to Floodplain Land.

on the floodp

occur. Howev

flood losses

accordingly.

especially vu

be discounte

floodplain i

crop farming

it may also

inundation a

enterprise.

for the cash

reflect the

ity distribu

(VMP_3) can b

<u>expected</u> val

enterprise i

protection t

The va

from (VMP_2)

yields and

tion there

in replanti

a flood.[1]

---

[1] Alth

other physi

be incorpor

on the floodplain tract in a year when floods do not occur. However, the entrepreneur must now take potential flood losses into account and discount his schedules accordingly. Truck farming may be a land use that is especially vulnerable to flood damages and therefore must be discounted heavily (to the point that production on the floodplain is uneconomic). On the other hand, while cash-crop farming is not as profitable on a floodfree location, it may also be a use that is better able to withstand inundation and therefore be the preferred floodplain crop enterprise. The VMP_2 schedule is not the relevant curve for the cash-crop enterprise however, because it does not reflect the expected damages from flooding. If a probability distribution can be assigned to the anticipated damages, (VMP_3) can be derived. This curve must be viewed as the <u>expected</u> value of marginal product curve for a cash-crop enterprise in the floodplain. In the absence of flood protection the (VMP_3) becomes the relevant planning curve.

The value of marginal product schedule was discounted from (VMP_2) to (VMP_3) to reflect the expected loss in yields and other direct crop damage from flooding. In addition there will likely be additional capital costs incurred in replanting, replacing leached nutrients, etc., following a flood.[1] Suppose an entrepreneur can expect to incur, on

[1]Although this exposition is in terms of crop damages, other physical damages (debris deposition, erosion) could be incorporated into the diagram. To include highly

the average,

each unit of

costs, the "c

units of capi

non-land reso

the rent accr

triangles (AC

benefits from

We can

benefits:

1. Gi

ca

ex

ca

di

th

ar

fl

of

2. Wi

ti

sc

(X

localized da
could be the
could be all

the average, additional costs equivalent to $(P_1 - P_o)$ on each unit of capital employed. Then, in terms of expected costs, the "cost of capital" function is $(P_1\ P'_1)$ and (X_1) units of capital will be used. The expected payment to the non-land resources is (DEX_1O) and the residual (CED) in the rent accruing to land. The difference in the rent triangles (AQJ) minus (CED) is the expected average annual benefits from complete flood protection.

We can further identify the sources of the expected benefits:

1. Given the decision to invest (X_1) units of capital on the floodplain land, losses are expected to be incurred from (a) additional capital costs equivalent to (DEKJ) and (b) direct crop losses equivalent to the area between the (VMP_2) and (VMP_3) curves measured by the area (BREC). These losses will be avoided by flood control measures. We term the prevention of these losses <u>direct damage reduction benefits</u>.
2. With flood control but with a decision to continue to produce cash-crops, the relevant schedules are (VMP_2) and $(P_o\ P'_o)$. Now, however, (X_1) is not the optimum capital input. Capital

---

localized damages (buildings, bank cutting), a "farm" could be the fixed unit, or the damages from these sources could be allocated over the acres flooded on each farm.

wi

co

(R

te

3. Wi

lo

Th

(V

yi

un

th

th

<u>ut</u>

In pra

and, therefo

than the dif

(CED). Howe

ment will be

shift the ex

right. The

---

[1]In CO
<u>efficiency</u> a
as <u>enhanceme</u>
terminology
useful, howe
efficiency a
separately i
accrue immed
to higher la
over time.

will be increased to (X_2). The additional cost is (KNX_2X_1), the additional return is (RNX_2X_1) yielding a surplus (RNK) which we term an efficiency benefit.

3. With flood control, cash-crop farming is no longer the best use of the flood plain land. The entrepreneur will now shift to truck-farming (VMP_1). Capital usage will increase to (X_0), yielding a surplus (SNQ), but in addition each unit of capital will now yield a higher return than in its former use. The total gain will be the area (AQNB) which we will term the higher utilization benefit.[1]

In practice flood control is not apt to be complete and, therefore, the expected annual benefits will be less than the difference between the rent triangles (AQJ) and (CED). However, the general effect of flood control investment will be to lower the expected cost of capital curve and shift the expected value of marginal product curve to the right. The result will be an expansion in the size of the

---

[1] In COE terminology, the benefits we have termed efficiency and higher utilization are considered jointly as enhancement benefits. We will continue to use the COE terminology where it is unambiguous. Our distinction seems useful, however, because of the possibility that the efficiency and higher utilization benefits may be realized separately in time. Efficiency benefits are likely to accrue immediately but, for a number of reasons, a shift to higher land usage may be delayed or occur only gradually over time.

rent triangl
and "new" tr
We hav
rent triangl
benefits and
determines t
pay for land
common capit
(CED) would
tection and
flood free l
cost to the
protection"
or value.
If the
individual c
an investmen
equalled or
the rent tri
land would s
being a retu
Therefore,
land, the pr
rent to lan

[1]The
example, th
assessment

rent triangle and the difference in area between the "old" and "new" triangle will measure the expected benefits.

We have mentioned that the difference between the rent triangles (AQJ) and (CED) is a measure of the expected benefits and also that the size of the rent triangles determines the maximum price an entrepreneur would willingly pay for land, given a capitalization rate. Thus, with a common capitalization rate, the amount of the rent triangle (CED) would determine the price of the land without protection and (AQJ) would determine the price of comparable flood free land. Or, if protection were provided at no cost to the entrepreneur (CED) would determine the "before protection" price and (AQJ) the "after protection" price or value.

If the decision to provide flood protection were an individual one, the entrepreneur would be willing to make an investment only if the annual costs of the investment equalled or was less than the difference in the amount of the rent triangles. In this case, the residual return to land would still be the area (CED); the remaining "rent" being a return to the capital invested in protection. Therefore, unless the investment became embodied in the land, the price of the land should not change since the rent to land has not changed.[1]

[1]The investment would not become embodied if, for example, the protected land was sold subject to an annual assessment equal to the annual costs of the investment.

In the

to agricultu

benefits tha

ture and tha

areas. Thes

owning the p

real wealth

counted valu

or more cert

pure windfal

borne by a s

a miniscular

---

[1]Howev
by local tax
ments as lan
value of thi
present valu
gram, the ef
reflected by
tion. If as
plains and u
reflect the

Two ge
struction on
the incremen
Jack L. Knet
Land Values,
1964), pp. 2
Analysis of
Base, Resear
sity of Kent
State of Ken
the areas be
capturing a
Harvey King,
Louisville E
December 13,

In the case of flood control reservoirs, the benefits to agricultural uses from reduced flood damages are flow benefits that are released over the lifespan of the structure and that are specific to the protected downstream areas. These benefits are captured by those individuals owning the protected land. The individuals experience a real wealth gain equivalent to the sum of the present discounted values of the future income streams made possible or more certain by the reservoir. These gains are nearly pure windfall gains since the cost of the reservoir is borne by a society in which the benefitting land owners are a miniscular proportion.[1] Thus, in the case of Federal

---

[1]However, a proportion of the gains may be captured by local taxing units in the form of higher property assessments as land prices respond to the gain and the present value of this liability should be subtracted from the present value of the increased income stream. In the diagram, the effect of higher annual tax liabilities could be reflected by an upward shift in the cost of capital function. If assessment practices are consistent between floodplains and uplands, relative land prices would automatically reflect the differences in tax liabilities, _ceteris paribus_.

Two general studies of the impact of reservoir construction on county tax revenues indicate that a portion of the increment in value is likely to be captured. See: Jack L. Knetsch, "The Influence of Reservoir Projects on Land Values," _Journal of Farm Economics_, 46 (February, 1964), pp. 231-243; and Claude M. Vaughn, Jr., _Covariance Analysis of Reservoir Development Effects on Property Tax Base_, Research Report No. 4 (Lexington, Kentucky: University of Kentucky Water Resources Institute), 1967. The State of Kentucky specifically requires reassessment of the areas benefitting from flood control with the view of capturing a part of the gain. (From conversation with Harvey King, Basin Planning Branch, Engineering Division, Louisville Engineer District, U. S. Army Corps of Engineers, December 13, 1967).

reservoir c
sould expect
part of the
As we have p
rate (or the
is the same
that the pre
installation
in the price
and the pric

There
ing Figure 2
a single par
an entreprene
This may also
control in sm
externalities
of the area i
tion may shif
increased fac
tected land.
plain followi
all users of
time the incre

[1] This wi
levee construc
associated on-
right-of-way f

reservoir construction for flood control purposes,[1] we sould expect floodplain land prices to reflect a major part of the benefits accruing to the agricultural sector. As we have previously noted, if the social time preference rate (or the long-term government investment interest rate) is the same as the private land market rate, this implies that the present value of benefits from a flood control installation accruing to land cannot exceed the difference in the price of land to be protected by the installation and the price of comparable flood-free land.

There is an additional point that can be noted regarding Figure 2. The discussion of the figure is in terms of a single parcel of land for which the external effects of an entrepreneur's decision can conveniently be ignored. This may also be true for agricultural benefits of flood control in small watersheds but for river basin work, externalities may become important in social accounting. If the area involved is large, the "cost of capital" function may shift upward following protection reflecting the increased factor demand for capital on each unit of protected land. As more units of capital are invested in the plain following hazard reduction, the cost per unit to all users of the factors involved increase. At the same time the increased output resulting from increased

[1]This will also be true of protection from Federal levee construction except that here there will be come associated on-site costs, primarily that of providing right-of-way for the levee.

investment

the VMP sch

to investor

the same ti

duct prices

where to sh

that increas

decreased pr

tion is less

effected.

If lar

of a large i

scale flood

expectations

Since the Co

methods esse

effects of b

conceivably

of net gain

likely that

effects of t

from land va

unlikely.

An occ

agency proce

possible ben

investment may depress product prices, tending to shift the VMP schedules to the left. Then the rent accruing to investors on the floodplain land will be reduced. At the same time, the increased factor costs and reduced product prices may cause operators on marginal lands elsewhere to shift their land to other uses. To the extent that increased production in the plain is offset by decreased production elsewhere, the net gain from protection is less and only a redistribution of income is effected.

If land owners are aware of the price consequences of a large increase in production made possible by large scale flood control works, they will adjust their income expectations and land prices will respond accordingly. Since the Corps of Engineers' project-by-project evaluation methods essentially ignore the accumulative pecuniary effects of basin and regional flood control investments, conceivably land prices could prove a more accurate measure of net gain than COE procedures. However, it is more likely that individual land owners also ignore the external effects of their action so that divergences for this reason from land value and conventional benefit estimates is unlikely.

An occasionally mentioned criticism of conventional agency procedures is that the procedures fail to consider possible beneficial effects to agricultural lands from flooding.[1]

restores th

or enhances

water-borne

Figure 2 ar

criticism i

be shifted

recurring b

the loss of

the benefit

value appro

it would be

the incremen

be smaller

would indic

---

[1]Clare

[2]In re
of agricultu
Undoubtedly,
that has bee
necessarily
being receiv
chances of g
getting sand
borne weed i
of constantl
important co
believe ther
COE official
but, because
fertilizers,
fits are mar
Project Plan
Engineer Dis
December 13,

flooding.[1] The benefits may arise because the flooding restores the water-table, improves the tilth of the soil, or enhances soil fertility through the deposition of water-borne silt. If the (VMP_1) and (VMP_2) curves in Figure 2 are based on yields in floodfree years, this criticism implies that, with protection, the curves will be shifted to the left because the soil is derived of the recurring benefits from flooding. If this is the case, the loss of benefits from flooding must be subtracted from the benefits gained from protection. In terms of the land value approach, the rent triangle CED is not as small as it would be in the absence of beneficial flood effects and the increment in expected prices following protection will be smaller than computations based on flood damages alone would indicate.[2]

---

[1] Clarenbach, Task Force Report, p. 1280

[2] In reviewing the literature no conclusive evidence of agricultural benefits from flooding have been found. Undoubtedly, delta regions are examples of a stock resource that has been built up by flooding but this is not necessarily evidence that a flow benefit (resource) is being received on all floodplains. It would seem that the chances of getting too much water at the wrong time, or of getting sand instead of silt, or the chances of water-borne weed infestation would mitigate against expectations of constantly recurring benefits from flooding. The most important consideration, however, is whether landowners believe there are positive benefits from flooding. Some COE officials state that this opinion once was widely held but, because of the almost universal heavy use of inorganic fertilizers, it is now considered that the potential benefits are marginal. (Conversation with Russell Whistler, Project Planning Branch, Engineering Division, Louisville Engineer District, U. S. Army Crops of Engineers, December 13, 1967.)

The d

views of re

ibrium, per

known disco

fications (

were ignore

examine the

the validit

general hea

1. T

f

2. T

n

3. T

v

4. S

Evaluating

The d

that the ma

are known w

actually ma

rent is rec

a number of

sidered, in

Land Values in Practice

The diagrams in Figures 1 and 2 are highly simplified views of reality based on assumptions of competitive equilibrium, perfect knowledge, mobility of resources, and known discount rates. In addition, certain other qualifications (e.g., "comparable" land, market data sources) were ignored. We now wish to relax these assumptions and examine their effect on the model. The factors affecting the validity of the assumptions can be listed under four general headings:

1. The efficiency of the land market in evaluating flood hazards.
2. The consistency of the land market in valuing non-comparable lands.
3. The state of knowledge about components of land value.
4. Sources of land value data.

Evaluating Flood Hazards

The diagram in Figure 1 is drawn on the assumption that the marginal efficiency and cost of capital schedules are known with some certainty and that entrepreneurs actually make the adjustments indicated so that the full rent is received and reflected in land prices. Although a number of other value-influencing factors need to be considered, in a well-settled, homogeneous, agricultural area we can usua

to the lan

The

knowledge

mine the <u>ex</u>

floodplain

issue here

land market

that must b

can be expe

to flooding

experienced

The w

ture strong

mation of t

flood hazar

are underes

(area CED i

lead to an

on more acc

overpriced

parison wil

In effect,

indemnify c

we can usually expect land prices to be reasonably related to the land's productivity.

The assumption that land-buyers also possess full knowledge of the flooding hazard to enable them to determine the expected VMP and cost of capital curves for floodplain locations, however, is less tenable. A basic issue here would seem to be whether participants in the land market--to whom the flood hazard is only one element that must be considered in a decision to buy or sell land--can be expected to evaluate expected losses attributable to flooding as accurately as can specialists trained and experienced in the field.

The weight of the available evidence in the literature strongly suggests a human tendency toward underestimation of the nature and extent of the flood hazard. If flood hazards and, hence, expected losses from flooding are underestimated, the expected rent accruing to land (area CED in Figure 2) will be overestimated. This will lead to an "overpricing" of land relative to a price based on more accurate expectations. If the floodplain land is overpriced in view of the flood hazard, a land value comparison will underestimate the benefits of flood control. In effect, part of the benefit of protection will serve to indemnify current owners of floodplain land for their past mistakes, a

tection wil

A sea

that have d

as a device

pance or th

of agricult

number of pa

of the Unive

the agricul

studies are

floodplains

---

[1]Theor
floodplain l
realistic ap
over a perio
trol structu
a "wait and
factors prob
pricing.

[2]Gilbe
Geographical
States, Rese
Regulating F
(1958); Gilb
pance of Flo
No. 57 (1958
in a Flood D
(1960); Gilb
Research Pap
cultural Occ
Research Pap
Choice Perce
No. 78 (1962
Floods, Rese
trial Flood
Research Pap
Management a
Paper No. 10

mistakes, and the increment in land values following protection will be less than otherwise would have occurred.[1]

A search of literature failed to reveal any studies that have directly examined the land market's effectiveness as a device for evaluating the hazard of floodplain occupance or that have specifically evaluated the attitudes of agricultural operators of floodplain land. However, a number of papers sponsored by the Department of Geography of the University of Chicago[2] have general relevance to the agricultural areas of the Wabash Basin. The Chicago studies are primarily of urban and industrial uses of floodplains but the behavioral and informational factors

---

[1]Theoretically, the opposite could occur; i.e., floodplain lands could be underpriced in terms of a realistic appraisal of flood hazards. This might occur over a period of time following the installation of a control structure if occupants of the former floodplain adopt a "wait and see" attitude about its effectiveness but most factors probably act in the other direction toward overpricing.

[2]Gilbert F. White, Human Adjustment to Floods: A Geographical Approach to the Flood Problem in the United States, Research Paper No. 29 (1945); Francis C. Murphy, Regulating Flood-Plain Development, Research Paper No. 56 (1958); Gilbert F. White, et al., Changes in Urban Occupance of Flood Plains in the United States, Research Paper No. 57 (1958); John R. Sheaffer, Flood Proofing: An Element in a Flood Damage Reduction Program, Research Paper No. 65 (1960); Gilbert F. White, et al., Papers on Flood Problems, Research Paper No. 70 (1961); Ian Burton, Types of Agricultural Occupance of Flood Plains in the United States, Research Paper No. 75 (1962); R. W. Kates, Hazard and Choice Perception in Flood Plain Management, Research Paper No. 78 (1962); Gilbert F. White, Choice of Adjustment to Floods, Research Paper No. 93 (1964); R. W. Kates, Industrial Flood Losses: Damage Estimation in the Lehigh Valley, Research Paper No. 98 (1965); W. R. Derrick Sewell, Water Management and Floods in the Fraser River Basin, Research Paper No. 100 (1965).

involved i

areas. We

the nature

flooding, s

The I

factor aff

is that fl

the true r

The fl
plain c
floods,
relucta
or fron
may be
the flc
mind ir
water.
exagger
experie
early e
far toc
tions a
detaile
anticir
are no
progres
interes
at leng
there n
mentior
subdivi
and spe
seek tc
Thus, a
as give
appear
Anoth
in deal
laymen
highest

---

[1]Whit

involved in human occupancy probably apply also to rural areas. We will discuss these factors under four headings--the nature of the flood hazard, the expected frequency of flooding, seasonality, and disaster relief.

The Nature of the Flood Hazard.--The most important factor affecting the validity of the land value approach is that floodplain occupants may have little knowledge of the true risks involved. As White notes:[1]

> The flood hazard is underestimated by most floodplain dwellers because of the infrequency of major floods, the frailties of human memory, and the reluctance of some people, for economic reasons or from sheer obstinacy, to admit that past floods may be repeated or exceeded . . . As a general rule, the flood hazard tends to wax and wane in the public mind in direct relation to the occurrence of high water. Immediately after a flood, losses are exaggerated and distorted. The almost invariable experience of men who survey flood damages is that early estimates appearing in newspaper headlines are far too high, that later estimates by local organizations are also high but less exaggerated, and that detailed surveys yield totals substantially less than anticipated by the flood sufferers. So long as there are no other floods, the memory of the last one grows progressively dimmer. Its scars disappear, public interest in preparedness or protection weakens, and at length its ravages are forgotten. In time, indeed, there may develop a pronounced aversion to public mention of past flood disasters. Unscrupulous land subdividers, false inflators of municipal reputation, and speculative promoters of drainage enterprises seek to eliminate the hazard simply by ignoring it. Thus, average past or prospective losses from floods as given in estimates of competent engineers, may appear unrealistic to the people involved . . . .
>
> Another discrepancy between concept and reality in dealing with floods exists in the tendency of laymen and technicians alike to assume that the highest flood of record will never be exceeded. In

---

[1]White, Human Adjustment to Floods, pp. 51-52.

virtual
occupan
is take
that th
probabl

In co

esting that
Association
Capital Sto
the enginee
probable lo
quency of f
been experi
a report on
and Northea
both region
concluded t
severe comb
some future
in all of t

White
occupants a
the frequen
land subjec
land prices

[1]Amer
and Flood D
Association

[2]Ibid

> virtually all flood plains of the United States, occupance has been arranged, where any account is taken of the flood hazard, in the tacit belief that the largest flood of record also is the probable maximum flood.

In connection with White's last point it is interesting that a report issued by the American Insurance Association on the feasibility of flood insurance by Capital Stock Companies states: "(T)he investigations of the engineers strongly indicate that neither the maximum probable loss from floods nor the maximum probable frequency of flood occurrences in any given period has yet been experienced in the United States."[1] This study was a report on the catastrophic floods in the Pacific Coast and Northeastern States in 1955. Although areas in both regions experienced record peak discharges, it was concluded that neither had yet experienced "the most severe combinations of meterological events that will at some future time produce catastrophic floods in part or in all of the area."[2]

Whites' observations indicate that floodplain occupants awareness of flood risk is partly a function of the frequency of flooding. Thus, the flood hazard on land subject to frequent inundation may be reflected in land prices while land located at an elevation slightly

---

[1]American Insurance Association, Studies of Floods and Flood Damage 1952-1955 (New York: American Insurance Association, 1956), p. 4.

[2]Ibid., p. 11.

above the fr

for the haza

enough to si

to land. In

higher eleva

attributable

This p

defining the

among engine

take the lin

synthetic "

In many area

discerned th

flood of rec

is that if

year flood,

ing the flo

do not reco

ferences be

floodfree l

for flood r

the plain.

land values

used as a c

---

[1]The

most of the

generally u

interval in

above the frequent inundation level may reflect no discount for the hazard although it may still be flooded frequently enough to significantly affect the expected annual rent to land. In this case a land value check applied to the higher elevations will fail to reveal a price differential attributable to flooding.

This possibility immediately creates the problem of defining the relevant floodplain. A general practice among engineers and other flood control specialists is to take the limits of the historical flood of record or the synthetic "hundred year" flood as defining the floodplain.[1] In many areas of the Wabash an alluvial valley can be discerned that may or may not coincide with the historical flood of record. The problem for the land value approach is that if any of these measures (flood of record, hundred year flood, or apparent valley limits) are taken as defining the floodplain in an area where land buyers and sellers do not recognize the risk of the larger floods, any differences between land values on this "floodplain" and floodfree land will under-estimate the true discounting for flood risk that did occur on the lower elevations of the plain. This possibility does not rule out the use of land values, of course, since land values could still be used as a check of damage computations over that part of

---

[1]The 1913 flood implicitly defines the floodplain in most of the COE project studies for the Wabash. The SCS generally uses a synthetic flood with a 50 year recurrance interval in PL 566 projects.

the frequenc

recognize, b

tion of the

Even i

cally evalua

pants cannot

expected flo

hydrologist

recognize an

and land val

bility of ca

it may be en

high water m

maximum floo

on the other

that has hap

measurable

adjust expe

To the exte

events that

will undere

White

the land ma

---

[1]In a
of all reco
to six floo
Between Flo
White (ed.)

the frequency distribution that floodplain occupants recognize, but this must be known a priori to the application of the check.

Even if land buyers and sellers attempt to realistically evaluate flood hazards, individual market participants cannot be expected to have the same knowledge of expected floodings as that possessed by the engineer or hydrologist. Land buyers may have little ability to recognize and discount for the hazards of the larger floods and land values may completely fail to reflect the possibility of catastrophic events.[1] Lacking better information, it may be entirely rational for an individual to take the high water mark of the largest known flood as a measure of maximum flood danger he faces as White suggests. Society, on the other hand, will want to evaluate not only the worst that has happened in the past but also that which has some measurable probability of happening in the future, and to adjust expectations and investment decisions accordingly. To the extent that individuals ignore the possibility of events that have no recorded historical precedents, they will underestimate the risks of floodplain occupance.

White's observations also suggest the hypothesis that the land market tends to reflect the occurrence of the rare

---

[1]In a 52-year period ending in 1957, more than 40% of all recorded losses in the United States were attributed to six floods. See: Edward F. Renshaw, "The Relationship Between Flood Losses and Flood-Control Benefits," in G. F. White (ed.), Papers on Flood Problems, p. 41.

flood event

a major floo

the receding

diately foll

collapse as

mistically.

again as the

If such a pa

over- or und

the check is

the expected

Sheaf

proofing str

evidence tha

experienced

to 1959 (the

recent large

a stage elev

probable flo

regional flo

Sheaf

their city w

[1]Sheaf

[2]A max
assumption o
those leadin
flood was de
expected to
graphic regi

flood event in a predictable way. As time passes without a major flood, land values may gradually rise reflecting the receding awareness of the flood hazard. Then, immediately following a major flood, the market may tend to collapse as the hazard is re-evaluated, perhaps pessimistically. In a few years, land values may begin to rise again as the physical evidence of the flooding disappears. If such a pattern exists, a land value check will tend to over- or underestimate expected benefits according to when the check is made. It will be an accurate reflection of the expected damages only coincidentally.

Sheaffer, in a study of the feasibility of flood proofing structures in Bristol, Tennessee, found other evidence that confirms White's observations.[1] The city had experienced 31 floods during a 92-year period from 1867 to 1959 (the year of Sheaffer's survey), with the most recent large flood occurring in 1929. The 1929 flood had a stage elevation 10 feet lower than the extimated maximum probable flood and 4.3 feet lower than the estimated regional flood.[2]

Sheaffer found that many Bristol residents believed their city was no longer subject to flooding since nearly

[1]Sheaffer, Flood Proofing.

[2]A maximum probable flood was computed under the assumption of occurrence of less extreme conditions than those leading to the maximum possible flood. A regional flood was defined as a flood which can reasonably be expected to occur anywhere within the (Bristol) hydrographic region at any time. Ibid., p. 65.

30 years ha

hypothesize

flood in th

the minds o

Many rente

were livin

of the haz

maximum po

then under

to their p

had taken

proofing t

cost ratio

reasons gi

fear of a

the visibl

flood proo

She

the city

actual fl

on a sepa

stream fl

optimism

that land

control i

unless st

30 years has expired since the last major flood. He hypothesized that if an area has not suffered a major flood in the past 25 years, for all practical purposes in the minds of the inhabitants it is not subject to flooding. Many renters and property owners were unaware that they were living on a flood plain. The owners who were aware of the hazard consistently regarded the 1929 flood as the maximum possible flood that could occur in Bristol but even then underestimated the height of that flood in relation to their property. Few owners who recognized the hazard had taken protective measures or were interested in flood proofing their buildings even when shown that the benefit cost ratios of doing so were substantial. One of the reasons given for not undertaking flood proofing was the fear of a negative effect on property values arising from the visible proof of the flood hazards evidenced by the flood proofing.

Sheaffer reported that stream flow improvements within the city that had not been carried far enough to provide actual flood height reduction and the construction of a dam on a separate watershed that would have no effect on the stream flowing through Bristol, were cited as reasons for optimism regarding future flooding. This would indicate that land market participants are likely to view any flood control installation as offering complete protection unless strong efforts are taken to inform them otherwise or until ev

This findin

approach in

partial pro

damages fro

to warrant

may fail to

of (a) the

currently c

possibility

the levees.

The c

plain occu

inhabitants

with highe

expected to

than urban

in their d

greater kn

it should

destructiv

is a funct

price sens

between do

flood expe

or until events prove that their optimism was unfounded. This finding also has implications for the land value approach in areas receiving partial protection, especially partial protection from levees. Although the residual damages from greater-than-design floods may be great enough to warrant further protection, the lands behind the levees may fail to reflect the expected residual damages because of (a) the tendency to overestimate the level of protection currently offered and (b) the tendency to discount the possibility of lower-frequency floods that would over-top the levees.

The degree of flood hazard awareness by urban flood-plain occupants is probably less than that expected of inhabitants of agricultural lands bordering major streams with higher incidence of flooding. Farmers should be expected to be more aware of the unpredictability of nature than urbanites simply because of their closeness to nature in their day-to-day work. This may not give them any greater knowledge of expected frequency of flooding but it should increase their awareness of the potential destructiveness of floods. However, if flood awareness is a function of flood experiences, we may find that land price sensitivity varies from basin to basin--and even between downstream and upstream reaches within a basin--as flood experiences vary. This may mean that land price differentia

will have l

<u>The E</u>

part of con

the frequen

curve shows

maximum yea

occurrence.

occurrence

year can be

stage is kn

by multiply

probability

all stages.

floods grea

valent to a

and the dam

expectation

The f

assumption

assumption

a flood of

unaffected

---

[1]This
or cycle st
tive result
pendence.
of Flood Lo
<u>Problems</u>, p

differentials and research findings for a particular area will have little relevance for other areas.

The Expected Frequency of Flooding.--An integral part of conventional methods of flood damage estimation is the frequency analysis of flood flows. A flood frequency curve shows the relationship between the magnitude of maximum yearly flood flows and their probability of occurrence. Given the frequency curve, the probability of occurrence of floods of specified magnitudes in any given year can be derived. If the damage expected at each flood stage is known, the average expected loss can be obtained by multiplying the expected loss at each stage by the probability of occurrence of that stage and summing over all stages. If land owners ignore the possibility of floods greater than some specified magnitude this is equivalent to assigning a probability of zero to these floods and the damages they would cause will not enter into expectations.

The frequency curves and analysis are based on the assumption that flood flows are independent events.[1] This assumption implies that the probability of occurrence of a flood of any specified magnitude in a given year is unaffected by the flood events of preceding years; that is,

[1]This is a commonly accepted assumption. Most trend or cycle statistical tests of flood frequencies yield negative results; however, these tests cannot "prove" independence. See: Roland C. Haynes, "Composition and Size of Flood Loss," in G. L. White (ed.), Papers on Flood Problems, p. 11.

the occurre

probability

fore, the i

of the <u>time</u>

probabiliti

individual

as that fac

100 years o

In Sh

variations

occur again

floodplain

independent

or if indiv

events are

gence betwe

ual and soc

horizons.

same effect

tors previo

adequately

---

[1]The
interval ma
as it is ea
"since the
chance of i
therefore l
Even though
lead indivi

the occurrence of a major flood will have not effect on the probability of a major flood in the following years. Therefore, the interpretation of flood probabilities in terms of the _time_ of occurrence has no validity; the relevant probabilities for an investment decision faced by an individual with a planning horizon of 10 years is the same as that faced by society with a planning horizon of 50 or 100 years or more.

In Sheaffer's study, several respondents expressed variations of the argument that a major flood would not occur again in their lifetime. This indicates that not all floodplain occupants subscribe to the view that floods are independent events.[1] If flood events are not independent--or if individuals simply act on the assumption that the events are not independent--there will tend to be a divergence between the relevant probabilities facing the individual and society because of the difference in their planning horizons. Viewing floods as non-independent events has the same effect as the other behavioral and informational factors previously mentioned; the individual will fail to adequately discount expected land returns.

---

[1]The practice of labeling floods by their recurrence interval may contribute to this view of non-independence as it is easy to fall into variations of the argument that "since the one in 100 year flood has already occurred, the chance of it occurring again in the immediate future is therefore lower than it would be if it were yet to come." Even though this argument has no statistical basis it may lead individuals to underestimate the flood risks they face.

Seaso

flood risks

various riv

well-define

Thus, in ad

frequencies

occurrence

within a ba

source of a

cultural lo

of-season f

risk, the i

he underest

the compoun

even greate

Disas

to lead a p

expected re

flood risk

directly af

cost of cap

financial b

available t

[1]Robe
Papers on F

Seasonality.--Another source of underestimation of flood risks may arise from the fact that flooding in the various river basisn of the United States tends to follow well-defined, but not perfect, patterns of seasonality.[1] Thus, in addition to a probability distribution of flood frequencies there is also a distribution of time of occurrence within years. If the median time of occurrence within a basin is winter or early spring, and if the major source of agricultural flood losses is crop damage, agricultural losses will typically be low escept for the out-of-season flood. Thus to realistically appraise the flood risk, the individual needs to know both distributions. If he underestimates the probability of occurrence of either, the compounding of probabilities involved will lead to even greater underestimation of flood risks.

Disaster Relief.--The factors discussed above all act to lead a prospective land purchaser to discount the expected return to land less than a realistic view of the flood risk would dictate. Another factor that does not directly affect the expected value of marginal product or cost of capital schedules but which acts to reduce the financial burden of flood losses is the disaster relief available to floodplain occupants paid, for the most part,

[1]Robert W. Kates, "Seasonality," in G. F. White (ed), Papers on Flood Problems, pp. 114-131.

by the occu

relief aid

the time of

aid may be

disaster lo

In addition

may be cffs

for relief

To th

compensate

strategy fo

tion each y

flooding do

losses and

public aid.

plains is e

contributio

Valuing Nor

A key

value data

estimating

---

[1]Whit

[2]Subj
for rural a
ever, the p
this effect
cost of the
to Amend th
Provide For
90th Cong.,

by the occupants of nonflood areas. In addition to direct relief aid offered by the Red Cross and other agencies at the time of the flood; loans, grants, and rehabilitation aid may be available from Federal and State agencies, and disaster losses can be used to offset income tax liabilities.[1] In addition, direct income losses resulting from a flood may be offset by increased off-farm employment opportunities for relief or rehabilitation work.

To the extent direct and indirect disaster relief aid compensate for direct flood losses, an income maximizing strategy for a floodplain farmer would be to plan his operation each year as if flooding will not occur. In the years flooding does occur, he will be compensated for income losses and his capital investments will be restored by public aid. In effect, continued occupancy of the floodplains is encouraged by the public through these voluntary contributions and taxation.[2]

Valuing Noncomparable Lands

A key phrase in any discussion of the use of land value data is the term "comparable land." The argument for estimating flood damages or expected banefits assumes that

---

[1]White, Human Adjustment to Floods, pp. 196-199.

[2]Subjectively, this factor is probably not important for rural areas except for the rare catastrophic flood; however, the proposed national flood insurance plans would have this effect to the extent the insurees do not bear the full cost of the insurance. See: U.S. Congress, Senate, A Bill to Amend the Federal Flood Insurance Act of October 1956 to Provide For a National Program of Flood Insurance, S. 1985, 90th Cong., 1st sess., 1967.

land (and a

parable in a

true compara

prices must

hazard. In

parability,

are compara

absence of

floodplain

the compari

lands with

that physic

for price c

One o

a portion o

(from a lev

remaining l

ity may be

changes in

provide som

price relat

similar pro

time period

in abstract

related pri

land (and associated price data) can be found that is comparable in all respects except for flooding hazard. With true comparability, any difference in the associated land prices must reflect the market's evaluation of the flood hazard. In this sense, "comparability" implies price comparability, i.e., a floodplain and floodfree tract of land are comparable if they would command the same price in the absence of flood risk. However, the expected price of floodplain land with protection is unknown. Therefore, the comparisons will generally have to be in terms of lands with physical comparability under the assumption that physical comparability is a sufficient condition for price comparability.

One obvious exception to the above is the case where a portion of a homogeneous floodplain receives protection (from a levee, say) and where benefits from protecting the remaining lands are to be computed. Here price comparability may be a reasonable assumption. Also, the *ex post* changes in floodplain land prices following protection may provide some guides for evaluating, *ex ante*, the expected price relationship in a similar area that is to receive similar protection, but here the problems of selecting a time period that encompasses the captialization period and in abstracting from general price trends and nonflood-related price factors may be severe.

A str

comparabili
projects wh
or presence
plain will
upland area
up by alluv
may have li
the uplands
differ mark
floor may p
for cultiva
areas a fla
of its adap
or, convers
ponding pro
of physical
parability

If th
from the p
less than
lands will

---

[1]In
on the flo
lems. See
Basin Deve
Basin, ed.
Illinois P

A strong case for expecting both physical and price comparability could be made for irrigation and drainage projects where the only physical difference was the absence or presence of water on part of the land. However, a flood plain will seldom be physically comparable to bordering upland areas. On a floodplain defined by scour and built up by alluvial fill, the fertility of the flood plain soil may have little relationship to the fertility of soils on the uplands. Slope, elevation, and internal drainage may differ markedly. In mountainous regions, the valley floor may provide the only extensive level areas available for cultivation in the region. Even in relatively level areas a flat floodplain may command a price premium because of its adaptability to irrigation or continuous cropping or, conversely, this land may suffer internal drainage and ponding problems because of the lack of slope.[1] The lack of physical comparability thus implies lack of price comparability.

If the advantages of floodplain occupance stemming from the positive factors such as fertility and slope are less than the risks of flood damage, then the nonflood lands will command the higher price per acre, but the

---

[1]In parts of the Upper Wabash Basin, drainage problems on the floodplains are cited as outweighing flooding problems. See: J. Charles Headley, "Agriculture and Wabash Basin Development," in Regional Development and the Wabash Basin, ed. by Ronald R. Boyce (Urbana: University of Illinois Press, 1964), p. 51.

price diffe

was the onl

not be adeq

market pric

advantages

the floodpl

this case,

even higher

current pri

either expe

If ph

free land a

means of ad

parability,

relationshi

not be know

how the lan

various lan

the most in

agricultura

such as soi

one approac

farm accoun

terms of c

tion rate,

indicated

price differential will be less than if flood risk alone was the only noncomparable element. Therefore, it will not be adequate to take only the difference in current market prices as a measure of control benefits. If the advantages of floodplain location outweigh the risks, the floodplain lands will command the price premium. In this case, flood control would be expected to result in even higher relative prices for the floodplain land, but current price data will provide few guides for estimating either expected land prices or benefits.

If physical differences between floodplains and flood-free land are great, it will be necessary to have some means of adjusting one of the sets of land prices for comparability. The difficulty, however, is that generally the relationship between physical and price comparability will not be known; i.e., we do not have complete knowledge of how the land market evaluates the relative values of various land attributes. A reasonable assumption is that the most important value determinants of land purchased for agricultural use will be those related to productivity such as soil fertility, slope, and drainage. Therefore, one approach is to determine from experimental data or farm accounting records what these differences mean in terms of crop yields. Given price data and a capitalization rate, fertility differences can be converted into indicated value differences, but there is no assurance the

market cons
may lack th
of the fert
be correlat
ferent type
may be attr
in turn, ma

If a
mer, the pr
yield unrea
tions requi
approach (c
whole farm
about flood
Practically
systematica
is specific

The c
empirical c
basis, depe
ability and
adjust mark
appraisers,
be able to
within the
cision, mor

market consistently imputes value in this manner. Buyers may lack this detailed knowledge of the income implications of the fertility differences. Or, because soil types may be correlated with floodable and nonfloodable lands, different types of buyers with different risk preferences may be attracted to land on and off the flood plain. This, in turn, may affect the relevant capitalization rates.

If a number of adjustments must be made in this manner, the process can rapidly become very complicated or yield unrealistic results because of the number of assumptions required. A particular problem associated with this approach (or related approaches based on enterprise or whole farm budgeting) is the scarcity of specific data about flood plain yields, production practices, or costs. Practically no regularly published agricultural data are systematically collected below the county level, and none is specific to floodplains.

The question of land comparability is largely an empirical one that must be answered on a case-by-case basis, depending on the degree of departure from comparability and the availability of data necessary to adjust market values. In some cases, skilled land appraisers, extension agents, or knowledgeable farmers may be able to estimate the value of noncomparable elements within the bounds of required precision. For greater precision, more involved adjustment procedures may be required.

eliminate

procedures

<u>Components</u>

One

Figures 1

fixed fact

all other

opportunit

imputed ir

present ow

is known,

a well-fur

one capita

the opport

exists, be

attached t

capital ir

is essenti

vert land

equivalent

elements i

Unfo

constitute

natively,

relative d

required. As a result, cost (and time) considerations may eliminate the use of land values as a check on conventional procedures.

Components of Land Value

One of the assumptions underlying the diagrams in Figures 1 and 2 was the assumption that land is the only fixed factor and,therefore, the residual claimant after all other factors of production have been paid their opportunity cost. If the return to a tract of land is imputed in this manner and if the price at which the present owner would sell and a prospective buyer would buy is known, the capitalization rate can be determined. With a well-functioning capital market, there would tend to be one capitalization rate which would be closely tied to the opportunity cost of capital--the difference, if any exists, being attributable to the difference in the risk attached to holding land and the risk of alternative capital investment. Knowledge of the capitalization rate is essential to the land value approach in order to convert land price differentials (a stock value) to annual equivalents(and also to correct for the noncomparable elements if necessary).

Unfortunately, there is little agreement about what constitutes the opportunity cost of capital; or alternatively, there are no good methods of measuring the relative degree of risks of alternative capital investments.

Arguments
marshalled
prime mort
priate cap
equally pe
the choice
of subject
of little
comparison

A p
problem f
would be
relations
return an
plain lan
check. H
tion that
same. Re
to gamble

---

[1]Pa
Henry Hol
Barlowe,
New Jerse

[2]Ec
Losses an
Papers on

Arguments of varying degrees of persuasiveness can be marshalled for the choice of a particular rate such as the prime mortgage rate or landlord's return as the appropriate capitalization rate, but for each choice there are equally persuasive objections. Wendt's appraisal[1] that the choice of a capitalization rate "is essentially one of subjective estimation" seems valid. The choice may be of little consequence in applications involving relative comparisons but can be critical to the land value approach.

A possible resolution for the capitalization rate problem for the small area applications considered here would be to find the rate implied by net land return/price relationships. This would require the use of upland return and price data since to compute net return to floodplain land would involve the use of data we are seeking to check. However, the use of upland data requires an assumption that the capitalization rate for both areas is the same. Renshaw suggests that individuals with a propensity to gamble are likely to be lured into the floodplain.[2]

---

[1]Paul F. Wendt, Real Estate Appraisal (New York: Henry Holt and Company, Inc., 1956), quoted in Raleigh Barlowe, Land Resource Economics (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1958), p. 193.

[2]Edward F. Renshaw, "The Relationship Between Flood Losses and Flood-Control Benefits," in G. F. White (ed.), Papers on Flood Problems, p. 31.

A pronounc

up floodpl

pay.[1]

If F

the tende

farmers wi

They have

more to g

ing will

because t

<u>expected</u>

given yea

(or no fl

capital o

cation.

as his pl

major flo

extended

to averag

annual re

---

[1]To
farming r
these ope
by a sele
ence in r
separate
apparent
operator
true ris
gies).
tion to
60 (Augu

A pronounced risk taker (i.e., a "gambler") is apt to bid up floodplain prices over the price a risk averter would pay.[1]

If Renshaw is correct, it may also be likely that the tendency to gamble on flood occurrences is higher among farmers with land located entirely on the floodplains. They have more to lose from flooding but they also have more to gain if they plan their operation as though flooding will not occur, and it does not. This can occur because the (VMP_3) and (P_1 P'_1) curves in Figure 2 are expected curves, given the associated flood risk. In any given year, however, only a flood of a certain magnitude (or no flood at all) occurs and, ex post, some level of capital other than (X_1) may have been the optimum application. Thus, the entrepreneur who views (VMP_1) and (P_o P'_o) as his planning curve and who hits a run of years free of major floods will receive the rent (AQJ). Over any extended period of time, however, this strategy will lead to average capital losses of (E L X_0 X_1) and an average annual rent (CED). Thus, to the risk adverter, the

---

[1]Tolley suggests that familiarity with the floodplain farming may convey comparative entrepreneurial advantage to these operators. If the floodplain land market is "made" by a select group of buyers and sellers with prior experience in managing floodplain lands, this may result in two separate agricultural land markets in a region. Thus, an apparent risk preference on the part of the floodplain operators may actually reflect greater knowledge of the true risks involved (or of special risk-minimizing strategies). See: G. S. Tolley, "Analytical Techniques in Relation to Watershed Development," Journal of Farm Economics, 60 (August, 1968), pp. 653-665.

expected r

while the

average re

A mo

that land

increasin

may also b

both land

returns f

returns t

It is pos

as the re

but if la

imputed l

a case ca

operators

earnings

land valu

had econo

---

[1]A
has been
similar r
sources a
study.

[2]Th
for a goo
cal verif
ductivity
Farm Tenu
of Illino

expected rent (CED) will determine his bid price for land while the risk taker will gamble on receiving a greater average return and bid for land accordingly.[1]

A more general problem with the model, however, is that land may not be the only residual claimant. There is increasing awareness that in many cases, farm operators may also be immobile or fixed in an economic sense. Then, both land and labor become residual claimants to the returns from agricultural production and, by definition, returns to land and labor cannot be allocated separately. It is possible to impute a return to labor and treat land as the residual in order to deduce the capitalization rate, but if labor is fixed, there is no assurance that the imputed labor return is the correct one. In particular, a case can be made that under certain circumstances, farm operators will be led to capitalize part of their labor earnings into land values.[2] This will result in higher land values than would otherwise prevail if farm operators had economic mobility. If an annual return to this land

---

[1]A special field of economics (Portfolio Analysis) has been developed that deals with decision-making in similar rate-of-return/risk tradeoff situations but data sources appear too scarce to make applications to this study.

[2]The circumstances will not be discussed here, but for a good theoretical discussion and an attempt at empirical verification, see: Roger W. Strohbehn, <u>Resource Productivity and Income Distribution With Implications for Farm Tenure Adjustment</u>, Bulletin 720 (Urbana: University of Illinois Agricultural Experiment Station, August, 1966).

is compute
capitaliza
rate), the

In a
of labor r
there are
expectatic
land that
"warrantec
returns ar
anticipati
technologi
values or
reservoir
for land
farmers w
labor ear
<u>relative</u>
should no
to determ
related t
county or
any speci
affect th
specify t
Corps of

is computed on the basis of some standard proxy for a capitalization rate (such as the average mortgage finance rate), the expected return to land will be overstated.

In addition to the possibility of the capitalization of labor returns into land values under certain conditions, there are other factors associated with landowner's expectations or with the supply and demand schedules for land that may result in land prices above or below the "warranted value" of the land based on current realized returns and a nominal capitalization rate. For example, anticipations of price inflation or accelerating rates of technological changes may become capitalized into land values or landowners displaced by land purchases within a reservoir site in one area may greatly expand the demand for land in other surrounding areas. Generally, if all farmers within a county or region are capitalizing their labor earnings or expectations at about the same rate, relative land prices between the uplands and floodplains should not be affected but it may be extremely difficult to determine that portion of land prices that are directly related to land productivity. Again, land prices in each county or region will have to be evaluated on the basis of any special considerations that are known or believed to affect the price structure of that area. In particular, to specify the use of a single capitalization rate as the Corps of Engineers does (the average long-term mortgage financing

applicabi

Sources o

Imp

value mod

for uplan

determine

product e

not well

quently,

that cann

refelct t

grantor-g

bearing c

regular m

it will b

the prima

The

registere

1964 and

sales in

of these

thousand

[1]U.

tions and

financing rate)[1] may impose serious restraints on the applicability of the land value approach.

Sources of Land Value Data

Implicit in the preceeding discussion of the land value model is the presumption that a single-valued price for uplands and for floodplains exist or can easily be determined. However, "land" is a very heterogeneous product even in its natural state. The market for land is not well organized, specific tracts are traded infrequently, land sales may include sunken capital investments that cannot be valued separately, and land prices may refelct the influence of a number of factors (location, grantor-grantee relationships, etc.) that have no direct bearing on land productivity. Skilled land appraisers and regular market participants may be of aid, but frequently, it will be necessary to rely on recorded deeds of sale as the primary data source.

There are a number of drawbacks to reliance on registered deeds as a source of farm sales data. Between 1964 and 1966, the average turnover rate for all farm sales in Illinois and Indiana was 44.3 per thousand; 27.4 of these were voluntary with the remaining 16.9 per thousand representing foreclosures, estate settlements,

---

[1]U. S. Army, Corps of Engineers, "Survey Investigations and Reports," p. 59.

and other

farms repo

counties c

Wabash Bas

average of

country, p

and 14 inv

Thes

sales in t

smaller; p

in the cou

Office rep

are in lar

market exc

The

transferri

can be pla

of conditi

retains ti

complete t

with the C

varies wit

[1] U.
Market Dev

[2] U.
1964, Vol.
"Indiana,"
Government

and other involuntary sales.[1] In terms of the number of farms reported in the 1964 Census of Agriculture for 39 counties of Indiana and Illinois that are within the Wabash Basin,[2] these turnover rates are equivalent to an average of 31 voluntary sales and 19 involuntary sales per country, per year for all farms; and 23 voluntary sales and 14 involuntary sales for commercial farms.

These sales estimates, of course, are based on all sales in the county. Sales of floodplain land will be smaller; perhaps in proportion to the amount of floodplain in the county. However, personnel in the Louisville COE Office report that much of the desirable floodplain lands are in large, closely-held farms that seldom reach the market except as estate settlements.

The increasing use of land contracts as a means of transferring ownership also decreases the reliance that can be placed in deed records. A land contract is a form of conditional sales contract for land in which the seller retains title of the land as security against failure to complete the contract. The contracts can be registered with the County Recorder, but this practice probably varies with local custom or according to the advice of

---

[1]U. S. Department of Agriculture, Farm Real Estate Market Developments (Compiled from various issues, 1964-66).

[2]U. S. Bureau of the Census, Census of Agriculture, 1964, Vol. I, Statistics for the State and Counties, pt. 11, "Indiana," and pt. 12, "Illinois" (Washington, D.C.: Government Printing Office, 1967).

the lawye

that some

that all

The

that the

reduced.

the land

payment a

mortgages

to financ

represent

The

source ma

as a chec

land valu

feasible

as a part

Divisions

it may be

county of

The

retical l

---

[1]Re
physical
as public
marketabl

the lawyer involved in the transfer.[1] Thus, the fact that some land contracts are recorded is no assurance that all contracts are.

The first effect of the use of land contracts is that the number of current observations of farm sales is reduced. In addition, one of the primary attractions of the land contract is its greater flexibility in the down-payment and repayment terms compared to conventional mortgages. To the extent that this flexibility is used to finance the larger sales, deed records will not be representative of all farm sales in the county.

The use of "informed persons" as the primary data source may be adequate for some applications of land values as a check on conventional procedures. For more detailed land value data, the regional COE Offices might find it feasible to regularly collect data for anticipated needs as a part of other routine work (through the Real Estate Divisions, for example). However, for specific studies, it may be necessary to collect the data directly from the county offices and this may involve appreciable costs.

Land Values in Practice: Summary

The possible sources of divergence from the theoretical land market are several and, taken together, may

---

[1] Registering the contract is not universal because physical possession of the land by the buyer (which serves as public notice) and the seller's promise to convey a marketable title are the buyer's primary defenses.

generate

must be r

are also

of assump

expect ab

vant ques

model con

tional pr

The

cal model

the relat

In most c

data for

tion is t

sellers t

likely to

of recent

temporari

flooding.

expected

risk is s

case, how

tional te

of observ

frequency

generate pessimism about its applicability. However, it must be remembered that conventional agency techniques are also error-prone and subject to numerous uncertainties of assumptions and data. Thus, it is unreasonable to expect absolute accuracy from either approach. The relevant question, generally, will be whether the land value model contributes significantly to the accuracy of conventional procedures to justify its use.

The sources of possible divergence from the theoretical model have been presented without attempting to assess the relative effects on the applicability of the model. In most cases the possible divergences require empirical data for evaluation. Probably the most important consideration is the likelihood of failure of land buyers and sellers to fully recognize the flood hazard. This is likely to lead to overpriced floodplain lands in absence of recent or frequent flooding but may also result in temporarily depressed floodplain values after severe flooding. The land market is least likely to reflect the expected damages from flooding in areas where the flood risk is slight or from catastrophic floods. In the latter case, however, flood frequency data as used in conventional techniques are also suspect because of the lack of observations needed to establish the upper end of the frequency curve.

The

of detern

poses. T

areas whe

considera

land pric

price car

Minor prc

zation; i

tance of

trading c

ability n

An

is that l

influenci

ductivity

hedge aga

cultural

for other

---

[1] Fo
Mississip
of the va
terms of
land and
such as l
statistic
shadowed
See: J.
Farm Land
Region, l
sity Stat
Experimen

The next major consideration is probably the problem of determining comparable lands for price comparison purposes. This consideration may restrict the number of areas where the model will be applicable. A mitigating consideration here, however, is that most micro-studies of land prices indicate that most variation in farm sale price can be explained in terms of a few major variables.[1] Minor productivity differences can be overcome by fertilization; improved transportation facilities reduce the importance of farm location as a function of distance from trading centers; and so forth. Therefore, price comparability may not be a problem within fairly broad limits.

An inherent difficulty in working with land values is that land prices may reflect a number of value-influencing components not directly related to its productivity. Agricultural lands may be purchased as a hedge against inflation, in anticipation of future agricultural technological advances, or to provide employment for otherwise unused resources, particularly family labor.

---

[1]For instance a study of the farmland market in the Mississippi River Delta cotton region found that up to 97% of the variation in farm sale price could be explained in terms of differences in acreage of cotton allotment, woodland and openland. Thirteen other variables for factors such as land productivity or type of road were occasionally statistically significant but their effect was far overshadowed by the influence of the three major variables. See: J. B. Penn, Bill Bolton, and Willard F. Woolf, The Farm Land Market in the Mississippi River Delta Cotton Region, 1964-1965, D.A.E. Research Report No. 372 (University Station: Louisiana State University Agricultural Experiment Station, April, 1968), p. 61

To the e

an "appa

current

return re

these fa

small-are

Si

culate a

the retu

tripartit

and the

two fact

issues m

tionships

rates be

price re

empirica

enterpri

or regio

can prob

on appro

the prob

prices a

of a cap

To the extent that these considerations affect land prices, an "apparent" rate of return calculated on the basis of current agricultural yields understates the true rate of return realized from land ownership. The importance of these factors is difficult to evaluate, especially in a small-area land market.

Since the purpose of a land value model is to calculate a return to floodplain land that is comparable to the return estimated by conventional procedures, the tripartite relationship between net returns, land values and the capitalization rate requires that both the latter two factors be known. In this review of theoretical issues more emphasis has been placed on land value relationships than on the determination of capitalization rates because the theoretical issues of relative land price relationships are more numerous. Again, this is an empirical question but, in practice, available data from enterprise or representative farm studies and from state or regional data on rates of return to land investments can probably serve to establish relatively narrow limits on appropriate capitalization rates. Beyond this point, the probably range of error associated with both land prices and estimated land returns make precise estimation of a capitalization rate improbable.

A

advocat

evaluat

in the s

applicat

mentione

reviews

value st

specific

In

for the

Fred Cla

Oklahoma

projects

cerned "

of the r

chiefly

[1]C

CHAPTER III

PREVIOUS APPLICATIONS

Although numerous researchers and authors have advocated the application of a land value check in project evaluation, only a few actual applications have been found in the search of the literature. Two of the earliest applications found were the studies by Clarenbach and Pine mentioned previously. Both of these studies were *ex post* reviews of completed project investigations. Two land value studies completed since then were independent of specific project evaluations.

Verdigris River, Kansas

In his investigation of Federal agency procedures for the Task Force Report on Water Resources and Power, Fred Clarenbach examined four projects; one each in Oklahoma and Kansas, and two in Texas.[1] Two were COE projects and two were SCS projects. His inquiry was concerned "primarily with the reasonableness and reliability of the *results*" reported by the COE and SCS. He looked chiefly at estimated agricultural flood damages (mainly,

[1]Clarenbach, *Task Force Report*.

to crops) and the estimated benefits from land enhancement. His analysis of the claimed benefits for the proposed Toronto dam on the Verdigris River in southeastern Kansas illustrate his techniques and are typical of his findings for all four projects.

Clarenbach chose the immediate downstream reach from the dam site for analysis. This reach contained 10,430 cultivated floodplain acres. The COE claimed annual benefits from four categories:[1]

1. Flood losses prevented ($183,552) based on "experienced" floods. This was equivalent to assuming flood losses prevented were equal to flood damages and apparently assumed complete protection against recurrence of past floods of record.

2. Project flood benefits ($1,334) from additional possible benefits from protection against a "design" flood larger than any of record.

3. Increased land utilization ($124,627) stemming from increases in net income from agricultural production, after protection, resulting from a higher land use and improved timing of farm operations.

4. Future development ($45,888) calculated at 25 percent of "experienced" flood losses prevented, as an allowance for damage prevention to "future development under present flood conditions."

Categories 1 and 2 can be considered estimates of direct damages to crops and are equivalent to $9.09 per acre annually, based on 1953 prices. However, in an earlier draft report using 1949 price data the Corps had

---

[1] *Ibid.*, p. 1280. (The description of the benefit categories has been paraphrased.)

est

vat

$9.

an

acr

unc

iza

val

mar

als

sou

res

$9

inc

3 a

$7.

$28

of

Cla

est

to

ana

estimated that the "net earning power" per acre of cultivated land in flood-free years was $8.28. Converting the $9.09 direct damage estimate to the same 1949 base yielded an estimated annual crop damage of $6.87 per cultivated acre and a residual return to cultivated land of $1.41 under existing flood conditions. At a 5 per cent capitalization rate this residual return would justify a land value of only $28 per acre. The Corps' estimate of the market value of this land was $94 per acre. The Corps also claimed other (non-crop) direct damages from several sources that totaled to 97 cents an acre leaving a residual of 44 cents or an indicated value of land of about $9 an acre.

The Corps of Engineers also claimed benefits from increased land utilization of $6.29 per acre (categories 3 and 4, above). The total benefits claimed ($6.29 + $7.84) would support an increase in capitalized value of $280 per acre following protection. The Corps' estimate of the value of land after protection was $99.77.[1] Clarenbach concluded that the inconsistencies between COE estimates and apparent land values were sufficiently great to completely refute the benefits claimed.

Perhaps the most significant factor of Clarenbach's analysis is that it required a minimum of data about the

---

[1] _Ibid._, p. 1285.

lev

fro

one

at

cor

app

rev

det

abo

lar

tim

did

exp

"Ad

ist

for

off

in
pro
wat
ben
of
per
she
75.

level of land prices in the area. The obvious conclusion from his analysis is that a simple exercise such as the one he followed could have revealed these inconsistencies at the time the project analysis was prepared. A second conclusion affecting the applicability of the land value approach is that gross estimating errors would be revealed by applications of the principles of land value determination and do not depend importantly on assumptions about a capitalization rate or require exact knowledge of land price levels or differentials.[1]

Grand River Reach, Missouri

Another *ex post* review conducted at about the same time took the land value approach further than Clarenbach did in that land price differentials were used to estimate experienced flood damages. This report was prepared by an "Advisory Board" consisting of a farm management specialist, a banker, and a retired College Dean. The Board was formed at the request of the Kansas City District COE office and was assisted by economists William Green of the

---

[1]Renshaw used a procedure similar to Clarenbach's in examining the U. S. Department of Agriculture's (SCS) procedures for PL566 watershed projects. In the Sny watershed in eastern Illinois he found that capitalized benefit estimates ranged from a fraction of a per cent of average Census land and building values to 2370.8 per cent and averaged 92.2 per cent for the entire watershed. (Renshaw, *Toward Responsible Government*, pp. 73-75.)

Un
of

cr
th
re
re
la
si
in
ex
in

Boa
flo
haz
haz
of
act
yea

and
per
tec

United States Department of Agriculture and Wilfred Pine of the (then) Kansas State College.[1]

The board was requested to evaluate crop and non-crop agricultural flood damages along the main stem of the Mississippi River. They selected the Platte River reach in the Omaha COE District and the Grand River reach in the Kansas City COE District for analysis but later found that the Platte River reach had not experienced significant flooding in the 10 year period prior to their investigation. The Board took this lack of flooding experience as prima facie evidence that the flood hazard in this reach was negligible.

In the Grand River reach the major conclusion of the Board was that the estimates of average annual agricultural flood damages contained in the Corps' report on the flood hazard were in no sense indicative of the existing flood hazard. The Board was convinced that the Corps' estimate of agricultural damages was about fourfold greater than actual monetary damage over a representative period of years.[2]

The Corps of Engineers estimated average annual crop and pasture damage in the Grand River reach to be $25.50 per acre after allowing for the effect of existing protective works. The Board estimated average annual

---

[1]Pine, <u>Report of The Advisory Board</u>.

[2]<u>Ibid</u>., p. 6.

agricultural damages of between $5 and $8 per acre. The Board used several approaches to derive this estimate; two of which involved the use of land value data. First, an analysis of land prices covering a period of 10 years indicated a price difference of about $140 per acre between average land in the Grand River reach and flood-free land of comparable quality. At average capitalization rate in the area (considered to be 5 per cent) this differential indicated that average annual net returns on flood-free land were from $6 to $8 per acre higher than on floodable land in the reach. Interviews with 70 flood-plain farmers in the reach indicated that, on the basis of average conditions, flood protection would be worth about $110 per acre, indicating an annual net return of about $5.50.

Further collaborating evidence for these estimates was found by carefully reviewing the assumptions and data used by the COE in their conventional hydrographic analysis. Serious biases in the choice of assumptions or data were found at nearly every stage of the Corps' analysis and the Board concluded that:

> After groping at great length with the many complex and related problems of agricultural science, economics, and hydrology involved in damage appraisal, the utility of land price analysis seems even more apparent and the need even more urgent.[1]

---

[1] *Ibid.*, Supplement IV, p. 1.

The land value analysis was based on a total of 48 sales, 19 of which were protected by Federal levees. The land sold was considered comparable except for the presence or absence of levee protection; adjustments in sale prices for time of sale were made by a land price index series for the State of Missouri; and the analysis was essentially restricted to comparison of average prices per acre with some effort to estimate reasonable ranges of error in the price data.

The Board recognized several potential shortcomings of the land value approach. They pointed out that the technique may be inappropriate for areas of infrequent flooding, that obtaining an adequate number of sale observations may be a problem, and that locating "comparable" land data may be difficult. Therefore, they urged that a need for flexibility in application of land price data be recognized and recommended that a land classification system be developed to facilitate separate analyses of areas differing materially in physical characteristics, land use and flood hazards. However, the Board strongly recommended that a land sales analysis of some type be used as a check upon the accuracy of all flood damage computations on agricultural land.

sla

lan

Est

Dis

app

sit

345

was

ing

abs

pro

Cor

and,

was

find

only

repo

betw

Pres

of E
345-
Miss
St.

Ray, Clay and Platte Counties, Missouri

A recent study of two areas along the Missouri river slated to receive levee protection employed professional land appraisal techniques.[1] The study was made by the Real Estate Research Corporation (RER) for the Kansas City COE District. The purpose of the appraisal was to evaluate approximately 41,000 acres of Missouri River bottom land situated in two proposed levee districts known as Project 345-330-L and 409-L along the Missouri River. The appraisal was to include the market value of the farm areas considering appropriate highest and best use and assuming (a) the absence of any levee protection, (b) the present state of protection and (c) protection by the proposed levees.[2] The Corps' reason for sponsoring the appraisals was not stated and, if an *ex post* check was intended, the RER apparently was not furnished with the Corps' estimates. Since the findings for the two areas to be protected are similar, only the empirical data for Project 345-330-L will be reported.

The areas to be protected by the levee system lie between the Missouri River and the bluffs of the River. Presently protected lands are primarily agricultural,

---

[1]U. S. Army Engineer District, Kansas City, Corps of Engineers, "Appraisal Analysis on Agricultural Levees 345-330-L and 408-L, Ray, Clay, and Platte County, Missouri," prepared by the Real Estate Research Corporation, St. Louis, Missouri, July, 1967. (Mimeographed.)

[2]*Ibid*., p. 1.

con

tha

pro

var

to

Cor

wer

com

tha

of

par

in

was

lim

val

and

of p

of t

non-

lan

fron

aver

ent

lan

consisting of highly developed farms. The RER reported that it was not difficult to find sales of land in areas protected by private levees. The quality of these levees varied from good to very poor. It was extremely difficult to find sales of comparable land as if protected by a Corps-built agricultural levee as most protected areas were too remote from the studied areas to be considered comparable. It was also difficult to find sales of land that could be considered completely unprotected because of the numerous private levees in existence.

The RER began the study by contracting for the preparation of soil maps and productivity ratings of soils in the study area. A productivity rating of from 1 to 10 was assigned to the soils but, "because of statistical limitations,"[1] the ratings could not be related to land values. Instead, the soils were grouped into calcareous and non-calcareous soil groups. Average values per acre of productive calcareous land was found to be 103 per cent of the average of all sales compared to 93 per cent for non-calcareous lands. In area 345-330-L 40 sales of farmland covering a period from 1960 to 1967 were abstracted from county records. Adjusted for time (by moving averages), the average price per productive acre for the entire sample was $566. There were 23 sales that included land substantially flooded in 1965 and therefore could be

---

[1] Ibid., p. 32.

con

ave

lan

man

sal

Lev

Ent

Cal

Non-

buil

esti

of $

used

esti

esti

(inc

prod

rece
calc
posi
attr
risk

considered subject to flooding. These tracts sold for an average of $536 per crop acre. Sixteen sales involved land that had not flooded since 1951 and these sales commanded an average of $609 per acre. The breakdown of sales by soil type and flooding conditions was:[1]

Levee Project 345-330-L	Unflooded Cropland	Flooding Cropland	Differential
Entire sample	$609	$536	$73
Calcareous soil	627	552	75
Non-calcareous soils	566	498	68

The RER also estimated present values for farm buildings and waste or idle land to derive an aggregate estimate of market value for the entire area (28,974 acres) of $18,025,362 under present conditions. The RER then used the unflooded cropland values, by type of soil, to estimate aggregate land values after protection. The estimate included allowances for higher building value (increased 25 per cent) and some shifts of land from non-productive to productive use behind the levee (some land

[1] *Ibid.*, p. 37. The calcareous soils were primarily recent alluvium in first bottom positions while the non-calcareous soils were of older alluvium in high bottom positions. It seems possible that the price differentials attributed to soil differences also represented some flood risk differential.

that would be outside the proposed levee was valued downward). The total market value after protection was estimated to be $18,748,024.

The difference between the present and projected market values of $722,662 apparently can be considered the present value (at the land market rate of discount) of the COE levee; i.e., in the absence of annual operating costs the land market data would apparently justify a one-time capital investment in levee construction of up to $722,622. Unfortunately, neither COE cost nor benefit estimates were reported so that it is difficult to evaluate this figure in terms of conventional benefit estimating procedures.[2]

The RER also estimated values under the three conditions using an income capitalization approach. The composite net return per productive area (no flood condition) was budgeted as $35.14. This indicated a capitalization rate of 5.8 per cent for the floodfree cropland (at $609 per acre). The annual expense of flood occurrence for each crop grown was estimated on the basis of clean-up and replanting costs for the predominantly spring floods. The private levees had been overtopped twice in the past 15 years. Therefore, the return interval was assumed to be once every 7.5 years, yielding a probability of occurrence of 0.13 in any year. Land outside levees was

---

[2]The RER also estimated the aggregate market value of land in the absence of all protection ($16,843,041) but there were errors (discussed later) in the per-acre values used for this calculation.

estima

abilit

then c

by the

floodp

across

acre u

all pr

(at 5.

The in

no pro

the CO

values

present

interpr

is a we

(with c

floodfr

under t

should

protect

include

the val

market

adequat

estimated to flood once every 2.3 years, or with a probability of 0.43. The expected annual cost of flooding was then calculated by multiplying the appropriate probability by the annual cost of flooding for each crop grown on the floodplain and computing a weighed composite loss per acre across all crops.

The estimated composite risk of loss was $2.39 per acre under existing conditions and $7.89 in the absence of all protection. These correspond to capitalized values (at 5.8 per cent) of $41 and $136 per acre, respectively. The indicated land prices, therefore, would be $473 with no protection, $568 behind present levees, and $609 with the COE levee.

From market value data RER had previously estimated values of $536 for land without protection and $566 for the present level of protection but this apparently is a misinterpretation of what the Corps intended. The $566 value is a weighed average of $536 for land subject to flooding (with or without private levee protection) and $609 for floodfree land. Technically, this represents "land values under the present level of protection" but, logically, what should have been calculated was the value of land presently protected by private levees. Similarly the $536 figure includes some land with private levee protection and is <u>not</u> the value of completely unprotected land. Therefore, the market value data presented in the RER report is not adequate for comparison with the income capitalization approac

exist b

by priv

value d

and pro

the est

in the

M

firm we

report

adjustme

presence

flood ri

values p

with agg

tion to

tions if

Although

were mad

data.[1]

[1]Th
enabling
of $536 a
tial prot
not quite
t test an

approach or to determine if differentials in market value exist between completely unprotected land and land protected by private levees. The method used to calculate aggregate value differences between the present state of protection and protection by a COE-built levee is apparently valid but the estimated difference of $722,662 cannot be evaluated in the absence of comparable Corps figures.

Methodologically, the procedures used by the appraisal firm were similar to those used in the Advisory Board report discussed earlier in that relatively simple time adjustments and average values per acre were used. The presence of two non-comparable elements (soil type and flood risk) complicate an analysis based solely on average values per acre but this problem was handled by working with aggregate data to derive final estimates. The limitation to this approach is the possible lack of class observations if a number of non-comparable elements are present. Although sample data for farm sales were used, no attempts were made to evaluate the possible range of errors in the data.[1]

---

[1]The price data were presented in the report enabling a test of difference to be made for the estimates of $536 and $609 per acre values under present and potential protection levels, respectively. The difference was not quite significant at the 0.05 level using a one-tailed *t* test and assuming equal variances.

A r

provides
obtained
flood cor
issue tha
the Oklah
essential
Conservat
study; th
that were
ture.

A t

sion anal
effects c
tected wa
courthous
cultural
sheds. S
There wer
89 sales
ables in
plain lan

---

[1] Jo
Upstream
Farmland
Series P-
Experimen

Washita River Basin, Oklahoma

A recent study of six upstream watersheds in Oklahoma[1] provides some indication of the results that might be obtained from a rigorous application of land value data of flood control evaluation problems and illustrates the major issue that must be resolved in judging its feasibility. In the Oklahoma study, three of the six watersheds had been essentially developed for flood protection by the Soil Conservation Service for three or more years prior to the study; these were paired with three unprotected watersheds that were similar in general location and type of agriculture.

A two stage analysis was performed. First, a regression analysis was used to obtain empirical estimates of the effects of watershed development on land prices in the protected watersheds. Sales data were obtained by searching courthouse records for bona fide sales of tracts of agricultural land containing some floodplains in the watersheds. Sales data from 1947 through 1962 were collected. There were 95 sales in the three protected watersheds and 89 sales in the unprotected watersheds. Independent variables in the regression analyses included acres of floodplain land, acres of upland cropland, assessed value of

[1]John E. Waldrop and Daniel D. Badger, Effects of Upstream Watershed Development on Prices and Values of Farmland in the Upper Washita River Basin, Processed Series P-529 (Stillwater: Oklahoma State University Experiment Station, March, 1966).

farm impr

priate va

nificant

protectio

in land v

this wate

talizatio

earlier w

The

of a line

changes i

to waters

programmi

direct ag

tion accr

The

in land v

compared

from the

capitaliz

increase

were:[1]

[1]Ib

farm improvements, mineral rights transferred and appropriate variables for time of sales and location. A significant increase in land values attributable to flood protection was found in two of the watersheds. No increase in land values was found for the third watershed, but in this watershed there was reason to believe that the capitalization occurred prior to the study as a result of earlier watershed development activities.

The second stage of the analysis involved the use of a linear programming model to estimate directly the changes in the productivity value of farm real estate due to watershed development. The major implication of this programming analysis was that by far the major portion of direct agricultural benefits resulting from flood protection accrued to the land protected from flooding.

The SCS estimates were also available. The increases in land values indicated by the regression analysis were compared to the productivity values of protection derived from the linear program and the SCS direct estimates (both capitalized at five per cent). The resulting estimated increase in value per acre attributable to protection were:[1]

---

[1] Ibid., p. 35.

Watershed	Regression	Programming	SCS Estimates
Barnitz Creek	$121.28	$391.00	$447.40
Calvery Creek	0.00	275.80	338.60
Saddle Mountain	50.76	102.80	97.80

Both the regression and the programming analysis indicate that a part of the direct agricultural benefits of flood protection are imputed as returns to land. However, from the larger viewpoint of the relative accuracy of the land value approach, these results are inconclusive. In the two watersheds yielding positive results, the SCS estimates indicate (at a five per cent rate) two or three-fold greater benefits compared to the land value data. The difficulty is that the analysis provides no basis for deciding which are the correct (or more nearly correct) estimates. The programming results more nearly agree with the SCS estimates, but this may only reflect the fact that "without protection" yields in the model were derived from SCS crop damage factors.

Waldrop and Badger did not attempt to reconcile these figures beyond noting some possible sources of the discrepancies. However, the results are in accord with the implications drawn in the preceding chapter. This indicates that the most important question to be answered is no

accur

value

ples

gross

The p

porat

culty

some

land

range

criti

damag

favor

land

flood

does

asses

Board

land

of CO

the E

evalu

is not whether land values reflect flooding risks, but how *accurately*.

Conclusions

The Clarenbach study did not deal with relative land values *per se* but it is a good example of how the principles of value determination may be applied in discovering gross inconsistencies in the benefit-estimation process. The procedures are very simple and could easily be incorporated into project evaluation methodology. The difficulty, however, is its limited applicability, assuming some improvement in COE procedures since 1955. Ideally, land values should provide point estimates to which some range of confidence can be attached and this range may be critical where small changes in per acre estimates of damages or benefits determines the difference between a favorable and unfavorable benefit-cost ratio.

The other three studies at least establish that the land market apparently does recognize and discount for floodrisk. The Real Estate Research Corporation report does not present enough data to evaluate the land market's assessment of expected damages or benefits. The Advisory Board report would indicate close agreement between the land market and the Board's estimate based on revisions of COE techniques within a range of $5 to $8. However, the Board reported that it was not able to completely evaluate all of the assumptions and data required by the floo

care

conc

appr

the

reco

ent

the

flood hydrograph-flood damage integration method and a careful application of the conventional approach could conceivably reduce the apparent agreement between the approaches used.

The Waldrop-Badger study most clearly illustrates the dilemma likely to be encountered in attempting to reconcile estimates of flood benefits derived from different sources. Thus, the question of relative accuracy of the land value approach becomes paramount.

CHAPTER IV

SELECTION OF STUDY AREAS AND DATA COLLECTION

The Wabash River Basin encompasses an area of 33,100 square miles.[1] The Basin includes a small portion of the state of Ohio, the major part of central and southern Indiana, and the southeastern section of Illinois (Figure 3). The length of the Basin is about 285 miles and its maximum width is about 190 miles. The Wabash River, a major tributary of the Ohio River, originates in Mercer County, Ohio and flows in a northwesterly direction to the vicinity of Huntington, Indiana and thence generally southwest to its confluence with the Ohio River between Mount Vernon, Indiana and Shawneetown, Illinois. The gradient of the Wabash River averages approximately 1 1/2 feet per mile, ranging from approximately 4 feet per mile in the headwaters to about 0.6 feet per mile near

---

[1]The discussion in this section is based primarily on the following sources: U.S. Department of Agriculture, "Wabash River Basin Comprehensive Basin Study: Appendix H, Agriculture," WAC Review Draft, September, 1968 (Mimeographed); U. S. Army Engineer District, Louisville, Corps of Engineers and Cooperating Agencies, The Wabash River Basin: Water Resources Planning (32 page brochure, no date, number nor publisher given); and Ronald R. Boyce, ed., Regional Development and the Wabash Basin (Urbana: University of Illinois Press, 1964).

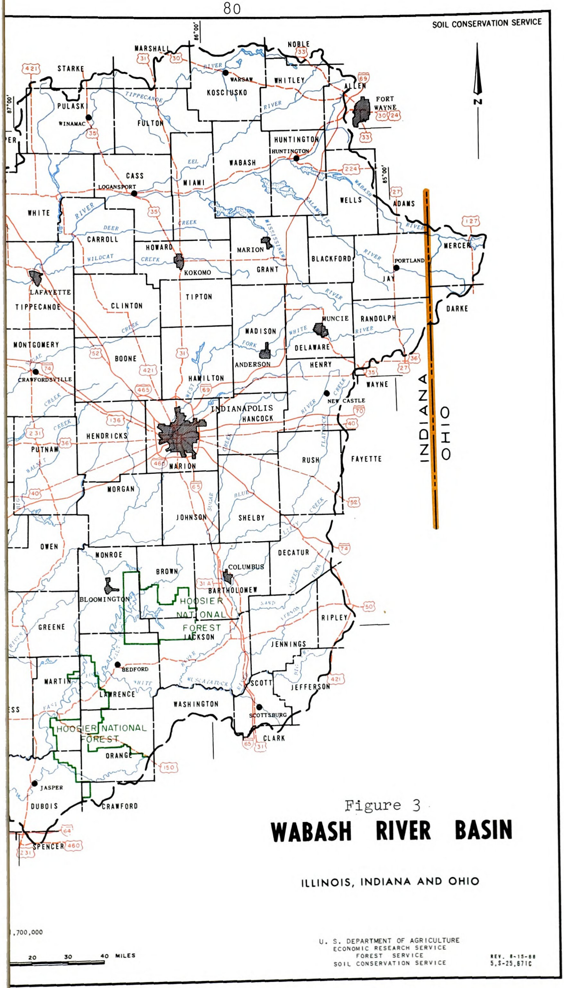


Figure 3
WABASH RIVER BASIN

ILLINOIS, INDIANA AND OHIO

the mouth. The principal tributaries of the Wabash include the Salamonie, Mississinewa, White, Embarass, Little Wabash and Patoka rivers.

The terrain of the Basin varies from nearly flat to gently rolling plains and lowlands in the north and central portions of the Basin to the relatively strong reliefs of the Crawford and Norman Uplands in southern Indiana (Figure 4). Natural drainage is frequently poor in the level areas. Coal, interbedded with Pennsylvanian shales and sandstone, is found in the southwestern part of the Basin in the Wabash Lowlands, Mount Vernon Hill Country, and Springfield Plain areas. It is currently mined (primarily by stripping) in the eastern portion of this area. Petroleum and natural gas are also produced from a number of pools located principally in the Mount Vernon Hill Country, Springfield Plain and the southwestern part of the Wabash Lowland physiographic units.

The climate of the Basin is classed as humid continental. Rainfall is fairly well distributed throughout the year. Average annual precipitation varies from 36 inches in the northern part of the Basin to 45 inches in the southern part. The average precipitation during the growing season (April through November) is 26 inches. The average growing season varies between 145 to 200 days over the Basin.

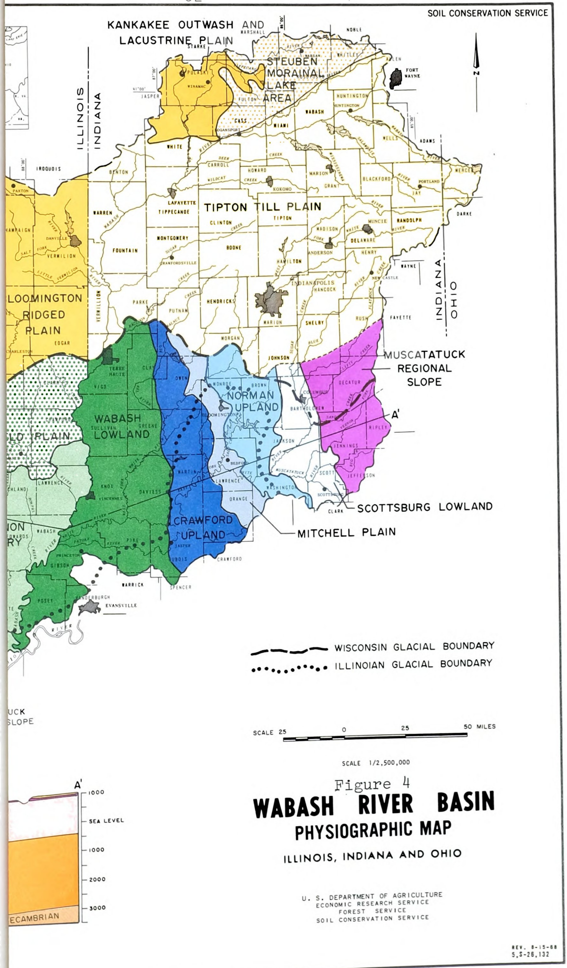


Figure 4

WABASH RIVER BASIN

PHYSIOGRAPHIC MAP

ILLINOIS, INDIANA AND OHIO

U. S. DEPARTMENT OF AGRICULTURE
ECONOMIC RESEARCH SERVICE
FOREST SERVICE
SOIL CONSERVATION SERVICE

Ba

du

va

f

a

r

a

a

The largest single economic activity in the Wabash Basin is farming. The agricultural sector is highly productive and the Basin's location conveys additional advantages from its favorable marketing position. Manufacturing is the next significant major economic activity and is concentrated in east-central Indiana.

The Basin's farms produce a wide variety of crops ranging from extensive acreages of corn, soybeans, wheat and oats to the intensive production of commercial fruits and vegetables. Feed grains, hay and pasture support a large livestock population. The major livestock enterprises are the production of pork and beef. The major types of farming regions are delineated in Figure 5.

Flooding Problems

The floodplains of the Wabash River and its tributaries comprise over a million acres but about one-half of this acreage receives levee protection.[1] The major flood damages occur on the exposed floodplains located primarily in the southern one-third of the Basin. There have been 15 major floods on the Wabash since 1875. Flood damages from the 1913 flood were $30 million; from the 1943 flood, $21 million; and from the 1950 flood, $6 million, all in 1953 dollar terms.[2]

---

[1]Boyce, Regional Development, p. 42.

[2]Ibid.

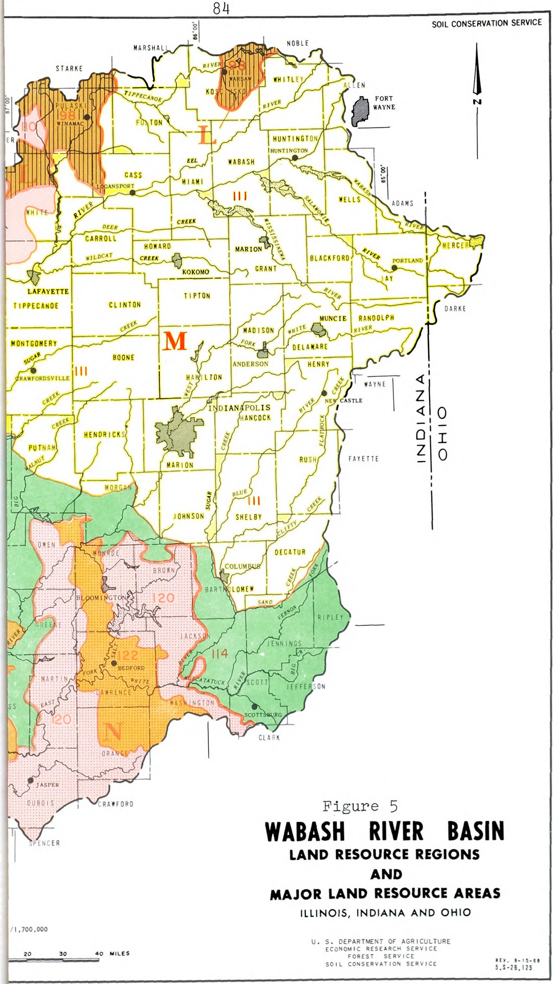


Figure 5

WABASH RIVER BASIN
LAND RESOURCE REGIONS
AND
MAJOR LAND RESOURCE AREAS
ILLINOIS, INDIANA AND OHIO

th
re
pr
se
f
e
e
s
t
f
p
d
c

The "Water Resources Planning" brochure states that ". . . the average annual damages in the basin, as reduced by the limited flood control works built to date, presently amount to about $35,000,000."[1] This estimate seems high considering that the damages from the 1913 flood (generally the flood of record in the Basin) was estimated at only $30 million in 1953 dollar values. An estimate of current average annual damages for the main-stem of the Wabash River (reaches W-1 through W-11) places the average annual damages at $3.9 million after allowing for protective works now in place.[2] Nearly half (49.4 per cent) of this amount is attributed to agricultural crop damage and another 42.2 per cent to non-crop agricultural damages. The remaining damages are distributed about equally between damages to transportation facilities, levees and urban areas.[3]

Floods in the Wabash Basin are primarily late winter-early spring floods resulting from a combination of rainfall on frozen or saturated ground and snow melt. Late spring or summer floods are usually the result of convection-type storms of limited aerial extent. Kates,

---

[1]U.S. Army Engineer District, Louisville, The Wabash River Basin: Water Resources Planning, p. 5.

[2]Data supplied by the Louisville District Office, U.S. Army Corps of Engineers.

[3]The COE data for urban damages are residual to all local protection in place or authorized.

in his study of seasonality of flooding in the Ohio River Basin,[1] found that flooding in the Wabash and White watersheds was less seasonal (less concentrated) than in the other major watersheds of the Ohio Basin. The cumulative concentration of flood events by months did not exceed 70 per cent until the month of May, and the mode of occurrence was March-April.[2] Thus, flooding in the Basin encroaches on the crop-planting and early growing season to a much greater extent than in other watersheds of the Ohio Basin.

In 1967, the COE reported that there were 28 separate Congressional Resolutions outstanding which request study of portions or all of the Wabash River Basin.[3] The earliest comprehensive report of survey scope dealing with water resources of the Wabash Basin was completed in 1932.[4] This survey found that improvements of the Wabash River by the Federal Government were not advisable at that time. A subsequent survey report in 1944 concluded that flood control by levees would be the most attractive

---

[1]Robert W. Kates, "Seasonality," in G. F. White (ed.), Papers on Flood Problems, pp. 115-128.

[2]Modes were March for the northeast and north-central portions of the Ohio basin and along the main stem of the Ohio River, and January-February for the southern tributaries of the Ohio.

[3] U.S. Army Engineer District, Louisville, Corps of Engineers, "Wabash River Basin Comprehensive Study," Interim Report No. 3, Vol. III, Appendix C, p. 2. (Hereafter referred to as Interim Report No. 3).

[4]U.S. Congress, House, Wabash River, Ohio, Indiana and Illinois, H. Doc. 100, 73rd Cong., 1st sess., 1932.

im

re

fe

to

fl

ma

lo

fu

ir

Sa

re

Ac

fa

s

I
I

R
8
L
B
S

V
p
f
r
S

improvement from a financial viewpoint.[1] Since the 1944 report, which lead to the authorization of several federally-financed levee projects, emphasis has switched to construction of multi-purpose reservoirs as the primary flood control medium. The reservoirs are operated primarily for flood control purposes but also fulfill some low-flow augmentation and water-based sport and recreation functions.

Presently there are six federally-financed reservoirs in the basin: Monroe, Cagles Mill, Mansfield, Mississinewa, Salamonie, and Huntington. Construction of five additional reservoirs was authorized by Congress in the Flood Control Act of 1965.[2] In addition, the third Interim Report found favorably for five additional reservoirs.[3]

Prior to federal assumption of the financial responsibility for flood control work, reliance for flood

---

[1] U.S. Congress, House, Wabash River and Tributaries, Indiana and Illinois, H. Doc. 197, 80th Cong., 1st sess., 1944.

[2] See: U.S. Congress, Senate, Lafayette and Big Pine Reservoirs, Wabash River Basin, Indiana, S. Doc. 29, 89th Cong., 1st sess., 1965, and U.S. Congress, House, Lincoln, Clifty Creek, and Patoka Reservoirs, Wabash River Basin, Indiana and Illinois, H. Doc. 202, 89th Cong., 1st sess., 1965.

[3] Louisville, Helm, Big Walnut, Big Blue, and Downeyville. The Interim Reports are so called because they are part of a Wabash River Basin Comprehensive Study scheduled for completion in 1969. Interim Reports No. 1 and No. 2 recommended construction of the reservoirs authorized by S. Doc. 29 and H. Doc. 202 (footnote *supra*).

protection was placed primarily in levee construction, either through individual efforts or through local levee districts. The Corps has incorporated many of these privately-owned levees and build additional levees into an extensive system, particularly along the lower reaches of the Wabash. From examination of topographic maps it appears that almost all areas in the Basin where the ratio of area protected to levee miles required is favorable are receiving some type of levee protection. Many of the private levees are inadequately designed and maintained but even a small levee can be effective in preventing inundation from the frequent small floods.[1]

In the process of this study essentially all the floodplains in the Indiana portion of the basin that are accessable by automobile were examined. The general impression one receives is that the flood risk is recognized by the majority of the floodplain inhabitants and adjustments have been taken to minimize risk. Where topography permits, farmsteads have been located off the floodplain or to take advantage of elevations existing on the floodplain. In the areas of extensive floodplains (Knox and Sullivan counties), the type of agriculture is such that on-farm residency is not required and the rate

---

[1]According to Corps personnel in the Louisville District office, there are 145 named levees in the Wabash Basin, with the majority constructed by private interests. In addition, there are other smaller levees that the COE has not enumerated.

of abandonment of existing structures is high. In this area, there are some low-grade summer homes or fishing shacks located behind leveed areas but most substantial housing is located so that the main inconvenience from all but the largest floods would be isolation. The farming areas behind levees are nearly all cleared and intensively cultivated, except for sloughs in former riverbeds. Corn for grain, soybeans, some wheat and an occasional field of alfalfa were observed in the summers of 1967 and 1968. In unprotected areas crop production appeared restricted primarily to corn production and the amount of idle or uncleared land was greater. There is little fencing, or need for it, in the floodplains.

It was also noticed that the major stream valleys tend to be "U-shaped" in cross-section, particularly in the Upper Wabash area and along some of the unprotected areas of Knox and Sullivan Counties. As a result, moderate-sized floods (say, those associated with a 5 to 10 year recurrance interval) tend to inundate essentially all the valley floor. Larger floods result in greater depths of inundation but add relatively little to the areal extent of flooding. From examination of topographic maps this characteristic appears typical of the Basin. For this reason the Wabash Basin did not provide opportunities for fully testing the relationship between land values and flood risk on infrequently flooded land.

Selection of Areas for Investigation

Because of the nature of the Wabash Basin and the study objectives, the selection of counties and areas within counties for investigation was made on a systematic basis. The counties selected for this study are not necessarily representative of all agricultural areas in the Basin and the results probably cannot be aggregated to represent the Basin or portions of the Basin affected by a specific project. However, conclusions about techniques and principles should have relevance to similar agricultural areas both within and outside the Wabash Basin.

The selection procedure involved, first, elimination of certain counties that, *a priori*, appeared unfavorable for a land value check and then selecting from the remaining areas counties with flood risk and farming conditions consistent with the objectives of this study but which could also be considered "typical" of a range of conditions likely to be encountered in applying a land value check.

The consideration of study areas was restricted to counties located downstream from existing or proposed flood control reservoirs to insure that COE damage estimates were available for comparison purposes. Areas with large urban centers were excluded because urban site

values may unduly affect the price for agricultural land, especially along streams which may have residential site value with protection, and because the large number of urban lot transactions make deed searching time-consuming. Counties excluded from consideration for this reason were Marion (Indianapolis), Vigo (Terra Haute) and Tippecanoe (Lafayette).

A tier of counties along the East Fork of the White River in the Crawford and Norman Uplands and the Mitchell Plain was not considered favorable for a land value check because these counties contain large holdings of federal and state forest lands that would complicate land value determinations. The White River is deeply entrenched and what farming is found on the narrow floodplains appears to be of a subsistance nature.

Personnel at the Louisville District Office have characterized farming in the extreme lower reaches of the Wabash (roughly, from Mt. Carmel, Indiana to the Ohio River) as being highly speculative. This area includes Gibson and Posey Counties, Indiana, and White and Gallatin Counties, Illinois. Parts of Posey and Gallatin are subject to backwater flooding from the Ohio and other areas--such as land in Gibson County between the White and Patoka Rivers--are subject to overland flows. Because of the flooding and the slow drainage, many large tracts are uncultivated. The Rochester and McClearys Bluff Federal

Levees afford protection to part of the area, and other levees are under construction or authorized which may further speculation in land values in anticipation of future protection. Therefore, these counties were ranked low as potential study areas.

The analysis used in this study depends importantly on being able to locate tracts of land on topographical maps to facilitate determination of the flood risk. The United States Geological Survey has published topographic maps ("quadrangles") covering the entire Indiana portion of the Basin at a scale of 1:24,000 (1 inch = 2,000 feet). These maps cover a quadrangle of 7 1/2 minutes of latitude and longitude, and generally show 10 feet contour intervals (and 5 feet supplemental contours in some cases).

Mapping of the 7 1/2 minute quadrangles is much less advanced in Illinois, and only 15 minute maps are available for most areas of the Illinois portion of the Basin (the exceptions are primarily the area bordering the Wabash River in the lower part of the state). The scale of the 15 minute maps is 1:62,500 (1 inch = approximately 1 mile) and contour intervals are 10 or 20 feet. This scale is much less satisfactory for the intended use in this study.

The greater scale of the 7 1/2 maps favored the choice of counties in Indiana. The areas of Illinois that are covered by the 7 1/2 minute quadrangles border the Wabash and reflect essentially the same topographical and

flooding conditions as found on the Indiana side of the river. Since working on only one state would facilitate some data collection activities, it was decided to confine the study to counties in Indiana.

From the remaining counties, three sample areas containing eight counties were designated for the analysis of land market transactions. The choice of each area reflected different land market or flood risk characteristics that were desired to have represented in the analysis. The counties and areas chosen were:

1. Knox and Sullivan Counties in the Lower Wabash area;
2. Carroll, Cass, Miami, and Wabash Counties along the upper reaches of the Wabash; and
3. Bartholomew and Jackson Counties in the White Subarea.

Some general agricultural characteristics of the three areas are presented in Table 1, together with the corresponding figures for the State of Indiana. The river reaches and acres of rural floodplain in the counties are indicated in Table 2.

The Lower Wabash Area

Knox and Sullivan Counties were chosen because they include reaches of the Wabash and White Rivers with the largest rural floodplains in the Basin. The unprotected floodplains of the two counties are subject to considerable

TAB

Ite

All

All

Cha

Pr

Av

Av

Va

Va

C

S

TABLE 1.--Farms and Farm Characteristics by Sample Areas, Wabash Land Value Study, 1956 and 1965

Item	Unit	State	Upper Wabash	Lower Wabash	Subarea
All Farms 1964	Nr.	108,082	5,163	2,355	2,388
All Farms 1956	Nr.	128,160	6,195	3,019	2,635
Change 1956-64	%	-15.6	-16.6	-22.0	-9.4
Proportion of Land in Farms	%	77.4	89.0	80.4	69.8
Average Size 1964	Ac.	165.9	175.7	212.6	172.7
Average Size 1959	Ac.	145.2	151.0	174.3	150.0
Value of Land and Bulidings					
Per Farm 1964	$	51,645	61,854	58,051	48,142
Per Acre 1964	$	309.84	349.99	270.49	287.24
Per Acre 1956	$	265.00	316.77	217.90	228.60
Change 1956-64	%	+16.9	+10.5	+24.1	+25.6
Value of Product Sold per Farm	$	10,227	13,390	13,288	9,359
Commercial Farms 1964					
Proportion of All Farms	%	69.6	80.5	76.0	63.8
Average Size	Ac.	212.8	207.6	266.9	278.9
Average Value Acre	$	312.55	349.08	266.1	283.34

Source: U.S. Bureau of the Census, Census of Agriculture, 1964, Vol. I, Statistics for the State and Counties, pt. 11, Indiana (Washington, D.C.: Government Printing Office, 1967).

TAB

Stu

Upp

Low

Whi
Sub

re

TABLE 2.--Study Areas, Reaches, and Floodplain Acres, Wabash Land Value Study.

Study Area	Stream	Reach	Rural Flood-plain acres	Floodplain acres per stream mile
Upper Wabash	Wabash	W-8*	6,000	561
	-do-	W-9	19,400	462
	-do-	W-10	11,500	590
	-do-	W-11*	3,400	199
Lower Wabash	Wabash	W-2*	114,000	2,092
	-do-	W-3	99,700	3,357
	-do-	W-4*	154,000	1,700
	White	WH-1	24,200	469
	-do-	WW-1*	120,000	1,367
White Subarea	E.F. White	EW-3	15,600	382
	-do-	EW-4	71,600	1,311
	-do-	EW-5	3,400	596
	Clifty Creek	CC-1	3,400	185
	Driftwood	DR-1	8,600	573
	Flatrock	FR-1	9,400	379

*Only part of reach included in the study area.

Source: Compiled from various project justification reports, Wabash River Basin.

fl

wo

bo

We

fr

wa

ti

of

an

al

bu

le

Kn

Pa

th

le

Wh

re

ri

fo

ce

Bu
Ex

flood risk. It was believed that Knox County, especially, would yield a high number of observations because it is bounded on three sides by the Wabash, the White, and the West Fork of the White. Sullivan County has a long frontage on the Wabash.

The second factor in the choice of these two counties was that both contain extensive levee systems. The combination of terrain and levee systems thus provided three types of land--unprotected flood plains, protected flood plains, and uplands--for which sale data could be obtained. Nearly all the levees on the Wabash River are part of the COE-built systems (Brevoort, Niblack, and Gill Township). Two levee systems are authorized for the White River within Knox County but the existing levees were privately built. Parts of these levees have been repaired and upgraded by the COE but the system is not as complete as the Wabash levee systems.

Both Knox and Sullivan Counties are in the corn, wheat and truck type-of-farm area.[1] Truck farming is restricted primarily to a "sand hill" area bordering the river valley. The floodplains are intensively cultivated for cash grain production. The townships in the north-central part of Knox and the eastern part of Sullivan

---

[1]Lynn Robertson, *et al.*, *Types of Farming in Indiana*, Bulletin 628 (Lafayette: Purdue University Agricultural Experiment Station, December, 1955), p. 23.

appear less productive and it is in this area that strip-mining is found. Of the three areas, Knox and Sullivan Counties have the largest farms and highest proportion of commercial farms, but the lowest per-acre values of land and buildings (Table 1).

The Upper Wabash Area

A tier of four counties from Carroll to Wabash along the upper reaches of the Wabash River was chosen to represent an area that has undergone a significant recent change in flood risk.[1] One purpose of choosing this area was to determine if land values on the floodplain have responded to this change, as an indication of the responsiveness of land values to varying flood risk.[2] These counties, which include parts of reaches W-8, W-9, W-10 and W-11, may also be representative of a number of other reaches of the Wabash and its tributaries with moderately narrow floodplains (around 500 acres per stream mile) with respect to the problems likely to be encountered in working with land values on floodplains of this size. Because the floodplains are relatively narrow, four counties were selected to increase the number of observations of farm

---

[1]Construction of the Mississinewa, Salamonie, and Huntington Reservoirs is expected to essentially eliminate flooding down river to Logansport.

[2]This objective is developed further in the anlysis sections of this study.

sales on the floodplains. Only sales of land in townships bordering the river were taken.

Because of the narrowness of the floodplains the majority of the farms in the area "overlap" or are only partly embraced by the floodplains. The farmsteads are generally located on the upland portion of the farm or on the fringe of the floodplain.

The parts of the four counties for which sales data were taken are in the Central Grain and Livestock area of Indiana.[1] Robertson describes this region as a glaciated area which contains more fairly good farm land and produces a greater total value of agricultural products than any other area in the state. No other area is higher in average productivity of all land.[2] Carroll County is the most agricultural of the four counties and appears to have many characteristics similar to the area between Terra Haute and Lafayette with respect to the size of floodplains and agricultural development. Census land values in all four counties are the highest of the counties selected (Table 1).

Cass, Miami and Wabash Counties each contain a city of over 10,000 population, with Logansport in Cass County being the largest. These cities are only slowly expanding their populations and do not appear to exert much influence

---

[1]Robertson, Types of Farming in Indiana, p. 22.

[2]Ibid.

on land values outside their immediate vicinity. The north bank of the Wabash between Logansport and the Wabash County line is a historic travel route and land ownership patterns are cut-up by old rights-of-way for a canal and an interurban line, and by an existing highway (U.S. 24) and a rail line.[1]

The White Subarea

Bartholomew and Jackson counties were chosen for the third study area because, being much less homogeneous, the area provides a wide contrast in topography, type of farming, and nature of flood risk--both within the area and in contrast to the other study areas. The "average" floodplain size is intermediate to the floodplains in the Upper and Lower Wabash areas but this average is made up of one reach with 1,311 acres per stream mile and other reaches with very narrow floodplains on the tributaries of the East Fork of the White River (see Table 2). Most of Bartholomew County and the floodplains of Jackson County are in a corn-wheat-hog farming area with the remainder in a general farming area. The two counties are within the area expected to receive protection from one reservoir proposed in the Second Interim Report, and two reservoirs proposed in the Third Interim Report. Therefore, current

[1]The analysis of land values indicated no difference in value for land lying north or south of the Wabash that might be attributed to this factor. The abandoned right-of-ways are cultivated where this is physically possible.

examples of conventional COE estimating procedures are available for these reaches.

Data Sources

The general sources of data for this study included public records at the county level; U.S. Geological Survey topographical maps; USDA Soil Conservation Service soil maps and reports; county plat maps; aerial photographs obtained through the Agricultural Stabilization and Conservation Service, USDA; COE working material, and miscellaneous primary and secondary data on file with the North Central Resource Group, Economic Research Service. The public records at the county level include warranty deeds and contracts of sale registered with the County Registrar of Deeds and farm appraisal data from the Office of the County Tax Commissioner.

Property Records

The property records on file with the County Registrar of Deeds include deeds of sales, contracts for sale, and mortgage instruments. Information available from the instruments includes:

Type of instrument	Acres transferred
Date of recording	Sub-surface rights reserved
Date of sale	Special convenants and easements
Grantor-grantee	Price paid
Legal description	Federal Revenue Tax paid

S

w

r

s

a

d

f

A

r

a

a

f

r

a

a

t

i

i
C
C

s
C
a

a
C
t
t

Some of this information was directly usable, the remainder was useful in determining if the property sold could reasonably be expected to be agricultural land[1] and if the sale was a bona fide transaction between a willing buyer and seller. The data for analytic purposes included the date of sale, price paid, legal description, acres transferred, and mineral or other rights reserved.

Assessment Records

The State of Indiana is currently on a seven-year real property appraisal schedule. The last statewide appraisal for tax purposes was made in 1961. Another appraisal was scheduled for 1968, but the records available for this study reflected the 1961 appraisals updated to reflect physical changes since 1961.[2] Real property is assessed at one-third its appraised value.

The County Assessor maintains an office file of the actual worksheets used by the appraisers. In addition to the usual assessment data, these cards provide considerable information on the physical features of each tract,

[1]The presumption was that, in the absence of other indications to the contrary, sales of sizeable tracts in open agricultural areas were for farming purposes. For convenience, we may occasionally refer to these tracts as "farms." However, since many tracts are bought for farm expansion purposes, the tract itself may not have all the characteristics (such as a set of farm buildings) usually associated with the concept of a farm as an entity.

[2]The counties maintain only the last proceeding appraisal in an inactive file. Thus, the existence of adequate appraisal data is likely to be the major obstacle to the collection of sales data over any extended period of time.

including acreage of land by use and grade, topographical features, and building grade factors. The use of appraisal data always raises questions of accuracy and consistency; however, appraisals are the only practical source of building value data. The information on physical features were checked against other sources where possible.[1]

Generally, an appraisal card is maintained for each tract of land even where one person owns several tracts, including contiguous parcels of land operated as a unit but with different ownership histories, so that few problems of separating appraisal data for combined units were encountered.

Maps and Photographs

A complete set of USGS topographic maps were assembled for each area. These were taken to Louisville where they were matched to COE floodplain charts. The inundation limits of natural or synthetic floods for a range of

---

[1]Acreage figures from both deed and assessment records were spot-checked against local agricultural stabilization and Conservation (ASC) office records in several counties. The deed and assessment records were more detailed and considered more reliable than the ASC records because the ASC filing system is designed for a specialized use and was not well suited to matching with other sales records. The ASC also maintains records of the feed-grain base on each farm but this was not considered a significant determinant of value. Studies have indicated that the profitability of participation in the feed-grain program is quite sensitive to grain prices and therefore capitalization of a feed-grain base was not expected. See: James Vermeer, Profitability of Participation in the 1962 Feed Grain Program in the Corn Belt, ERS-362, U. S. Department of Agriculture (Washington, D. C.: Government Printing Office, n.d.).

exceedence frequencies was transferred to the maps and provided the basis for flood risk determination for floodplain sales. In the editing process the boundaries of each floodplain tract sold was located on the topographic map. All upland sales were spotted on the maps to check for any unusual topographic conditions that might affect the sale (quarries, frontage on small streams that might present local flooding hazards, etc.).

Ownership plat maps were obtained locally or from commercial sources.[1] The plat maps, together with the legal descriptions of the tracts sold, were used to check locations on the topographic maps and aerial photographs. All plat maps were current (1963 to 1966) except for Miami County for which only a 1957 map was available.

Index sheets (a photograph of all aerial photographs of a section of a county laid out in proper spatial relationships) were obtained for each county with the intention of ordering enlarged photographs of the relevant areas of the county. However, the index sheets, with magnification, were found usable and advantageous for easier location of each tract. Every tract for which a data schedule was obtained was located and examined on the photograph. All counties had been photographed since 1960.

---

[1]Rockford Map Publishers, 4525 Forest View Avenue, Rockford, Illinois 61108.

Soil maps were available for Miami, Cass, Carroll, Knox and Bartholomew Counties. Wabash, Sullivan and Jackson County are being surveyed but only generalized soil maps were available for this study. The use of the soil maps is discussed in a later section of this report.

Data Collection

Farm sales data were collected from county records in the eight study counties by enumerators hired from the Statistical Reporting Service, U.S.D.A. Because recording practices are not uniform from county to county it was necessary to give each enumerator individual instructions at his assigned county courthouse. The first stage of data collection involved a search of deed record books to record all eligible sales between the dates assigned for each county. In the Lower Wabash and White Subarea, the dates were from January 1, 1964 to December 31, 1966. The dates were chosen on the basis of a pre-test in Knox County which indicated that about three years of sales records would yield an adequate number of floodplain sales for statistical reliability. The dates initially chosen for the Upper Wabash were the calendar years 1955-56, 1960-61, and 1965-66. In these counties it was desired to have data on farm sales over a span of time in order to investigate the effect of flood risk reduction on floodplain land values. Inadequacies in earlier assessment records determined the starting date of 1955.

The enumerators were instructed to record all transactions of more than 10 acres[1] that were outside corporate limits, that carried tax stamps or a statement of price paid, that were general or special warranty deeds or land contracts, and that were not otherwise ineligible. Transactions were not recorded if:

1. The special warranty deed was given to settle a tax claim or mortgage foreclosure.
2. The transaction was for the purpose of granting an easement or quit-claim.
3. The transaction was made as a gift, a life estate was retained, or the sale was for reconveyance.
4. Personal property that could not be valued separately was included.
5. Only timber or subsurface rights were transferred.
6. An undivided partial interest was granted. (However, the transaction was recorded if undivided partial interests were conveyed, as in the case of a buyer assembling partial interests from several heirs, and all interests could be accounted for).

---

[1]The minimum acreage was deliberately set low to determine if these small acreage sales could be used to supplement the number of usable observations. However, it was found that sales of tracts containing between 10 and 19 acres contained a disproportionately high percentage of purchases for residential purposes. Consequently, the final sample contains only sales of 20 acres or more.

7. The transaction involved a corporate deed or a business firm not clearly identified with farming purposes.

The criteria were designed to ensure that the sales recorded were primarily bona-fide market transactions of agricultural land. Further office checks were made to locate kinship sales and sales with locational attributes that might affect sale price.

The schedules from the first stage of data collection were mailed to the East Lansing office as they were completed. Here they were checked for completeness and accuracy and edited. In addition, grantor-grantee information was transferred to a second schedule to facilitate the collection of farm assessment data for each sale. For the second stage of data collection, three of the enumerators (one for each area) were instructed to search the county assessment records for assessment data. In addition, the enumerators checked questionable schedules collected in the first stage and, in the Upper and Lower Wabash areas, made additional searches for sales in years not originally assigned.

A search for additional sales in these two areas was decided upon after the initial returns of first data collection stage indicated that fewer floodplains sales than expected had occurred in the Upper Wabash area. The number of floodplain sales in the Lower Wabash was about

as expected but relatively few involved sales of unprotected lands. Rather than resume a search of deed records for all sales in the years not originally assigned, a listing was made of all floodplain landowners as determined from the ownership plat maps. The enumerators were instructed to check this list against records in the County Auditor's office to determine if any ownership transfers had occurred over the period and, if so, to record the information from the deed and assessment records. This procedure required less enumerator time than would have been required to search the deed books but the time saved was offset by the clerical requirements of compiling and alphabetizing the ownership list. The procedure was not used in the White Subarea because the initial returns indicated a sufficient number of floodplain observations was being obtained.

In the office, the schedules were again checked and edited. Each eligible sale was located on a plat map, soil map (where available), aerial photograph and topographic sheet in order to identify locational attributes, soil characteristics, and topographic and flooding conditions. This information was then coded and transferred to punch cards for processing and analysis.

In the Upper Wabash, sales were collected for the townships bordering the Wabash River and covered a period from 1952 through 1966. After final editing, there were

406 sales recorded, of which 60 contained some floodplain land. This included 15 sales that were subject to flooding from minor tributary streams. Sales on these streams were not deliberately sought but were picked-up as part of the collection of upland sales.

In the Lower Wabash, sales in all of Knox county were collected. In Sullivan County all sales of land lying west of Range 8W were selected. This eliminated three civil townships and parts of two others that contained no floodplains. The final count yielded 334 sales covering the period 1962 through 1966. There were 74 sales containing some floodplain land, of which four were along minor streams.

In the White Subarea all of Bartholomew and Jackson counties were originally sampled but sales from Harrison, Ohio, and Jackson Townships in Bartholomew and from Salt Creek, Pershing, and Owen Townships in Jackson were subsequently eliminated because they lay in the Norman Upland physiographic region. This region is heavily forested, farms are small and differ considerably from farms in the lowland regions of the two counties. There were a total of 199 observations after final editing; of these 52 were floodplain sales. The sales covered the period of 1946-66 only.

Floodplain and Upland Comparisons

Tables 3 through 6 present a comparison of the upland and floodplain sales in the three study areas. In the preliminary regression analysis sales in each county were analyzed separately and in combinations. The results of the separate analysis for the four Upper Wabash counties were quite similar and therefore all observations were combined for subsequent analysis. Several tests of the regressions based on the combined county observations revealed no significant difference in sale price attributable to county location.

The separate analyses for Knox and Sullivan counties were also in agreement although not to the degree found in the Upper Wabash counties. Part of the difference appeared attributable to differences in the importance of the farm buildings in the two counties. When the regression analysis for the combined counties was adjusted for this factor, there was no significant difference in sale price attributable to county location. Therefore, sales in these two counties were analyzed jointly in the final regressions.

Bartholomew and Jackson counties differed substantially in several important respects and it was not possible to aggregate the sales data for these counties. The primary difficulty was that the average price per acre for upland tracts in Jackson county was much lower than for upland tracts in Bartholomew or floodplain tracts in either county.

Upper Wabash Area

In the Upper Wabash, upland farms commanded a price premium of slightly over $100 per acre relative to floodplain sales (Table 3). However, these prices are unadjusted for differences in the composition of the average upland and floodplain farm. For example, although the floodplain sales are approximately 40 acres larger, on the average, than upland sales, the major part of the acreage difference is made up of pasture and woodlands. The initial regression analysis indicated that these lands are very low valued.

The average upland and floodplain tract had about the same percentage of cropland graded A or B but the floodplain sales contained more grade D and E cropland. (There was little land in either case graded A or E and therefore these acreages were combined with grades B and D.) There were no strong relationships between floodplain land graded D or E and the degree of flood risk on the land. Apparently these grades represent primarily quality differences rather than a downgrading of A, B or C land because of the flood hazard.

The upland sales cluster around 1955-56, 1960-61 and 1965-66 because the original deed search was confined to those years. The upland sales for the remaining years were picked-up in the process of recording additional floodplain sales in the years not originally searched.

TABLE 3.--Selected Characteristics of 406 Farm Transfers, Upper Wabash Area, 1952-1966.

Item	Upland Sales		Floodplain Sales	
	Unit	%	Unit	%
Number of Observation	346		60	
Price per Farm	$ 26,929		$25,572	
Average Price/Acre	$325.39		$221.03	
Cropland Acres/Farm:				
Grade AB	17.0	25.2	22.4	27.5
Grade C	32.6	48.2	31.2	38.4
Grade DE	18.0	26.6	27.7	34.1
TOTAL	67.6	77.5	81.3	63.8
Total Pasture Acres	8.7	10.0	24.5	19.2
Total Woodland Acres	8.5	9.7	17.4	13.6
Other Land Acres	2.4	2.8	4.3	3.4
TOTAL Land in Farm	87.2	100.0	127.5	100.0
Value of Farm Improvements	$5,238		$4,300	
Purchases for Expansion	115	32.2	12	20.0
Land Contract Sales	51	14.7	5	8.3
Special Warranty Sales	57	16.5	7	11.7
Year of Sale:				
1952-54	5	1.4	6	10.0
1955	56	16.2	5	8.3
1956	49	14.2	9	15.0
1957-59	2	0.6	4	6.7
1960	44	12.7	2	3.3
1961	50	14.5	3	5.0
1962-64	7	2.0	13	21.7
1965	60	17.3	10	16.7
1966	73	21.1	8	13.3

Lower Wabash Area

Floodplain tracts sold in the Lower Wabash Area averaged twice the size of the upland tracts, and in addition contained a higher percentage of cropland (Table 4). However, the cropland grade distribution was nearly the same for the two sales groups. Very little pasture was found on the average floodplain farm. The low percentage of pasture land is primarily a reflection of the fact that only a few farms contained any pasture at all. Similarly, the lower average appraised value of farm improvements on the floodplain is partially a reflection that many tracts sold were without buildings.

White Subarea

Separate tables are presented for Bartholomew and Jackson counties in order to point out the difference in the average upland and floodplain tracts in the two counties. Several regression runs were made with the two counties combined but the results were unsatisfactory and indicative of conditions in neither county. Therefore, these two counties in the White Subarea were analyzed separately.

Bartholomew county is similar to the counties in the other study areas in that the floodplain sales were, on the average, larger than the upland farms sold (Table 5). However, 65 per cent of the floodplain cropland was graded A or B, in contrast to the grading in the other

TABLE 4.--Selected Characteristics of 334 Farm Transfers, Lower Wabash Area, 1962-1966.

Item	Upland Sales		Floodplain Sales	
	Unit	Per Cent	Unit	Per Cent
Number of Observations	260		74	
Price per Farm	$24,196		$39,752	
Average Price per Acre	$303.33		$255.65	
Cropland Acres per Farm:				
Grade ABC	15.0	26.8	31.0	22.5
Grade D	30.1	53.9	76.0	55.0
Grade E	10.8	19.3	31.1	22.5
TOTAL	55.9	66.8	138.1	82.5
Total Pasture Acres	12.8	15.3	4.3	2.6
Total Woodland Acres	9.2	11.0	14.3	8.5
Other Land Acres	5.8	6.9	10.7	6.4
TOTAL Land in Farm	33.7	100.0	167.4	100.0
Value of Farm Improvements	$3,276		$2,676	
Purchases for Expansion	123	47.3	46	62.2
Land Contract Sales	48	18.5	5	6.8
Special Warranty Sales	36	13.8	11	14.9
Sand Hill Location	63	24.2	20	27.0
Year of Sale:				
1962-63	10	3.8	11	14.9
1964	80	30.8	24	32.4
1965	87	33.5	26	35.1
1966	83	21.9	13	17.6

TABLE 5.--Selected Characteristics of 81 Farm Transfers, Bartholomew County, White Subarea, 1964-1966.

Item	Upland Sales		Floodplain Sales	
	Unit	Per Cent	Unit	Per Cent
Number of Observations	65		16	
Price per Farm	$23,248		$35,815	
Average Price per Acre	$348.83		$335.29	
Cropland Acres per Farm:				
Grade AB	21.8	41.5	53.8	65.0
Grade C	14.2	27.1	16.0	19.3
Grade DE	16.5	31.4	13.0	15.7
TOTAL	52.5	72.4	82.8	73.1
Total Pasture Acres	6.2	8.6	5.4	4.8
Total Woodland Acres	11.5	15.8	16.5	14.6
Other Land Acres	2.3	3.2	8.5	7.5
TOTAL Land in Farm	72.5	100.0	113.2	100.0
Value of Farm Improvements	$3,469		$7,356	
Purchase for Expansion	29	44.6	7	43.8
Land Contract Sales	2	3.1	1	6.2
Special Warranty Sales	7	10.8	3	18.8
Sandhill Location	1	1.5	2	12.5
Year of Sale:				
1964	20	30.8	6	37.5
1965	28	43.1	3	18.7
1966	17	26.2	7	43.8

areas or on the upland farms of this county. The high percentage of land graded A or B plus the fact that floodplain land sold at an average price per acre very close to the price for the upland tracts indicate that the floodplains are desirable farmlands despite the flood risk.

The situation is even more pronounced in Jackson County (Table 6). Here the floodplain lands commanded a \$110 price premium. The low price per acre for the upland sales is primarily a reflection of the poor quality of these tracts which contained relatively little of the higher grades of cropland. The upland and floodplain tracts both averaged 80 acres in size but 64 per cent of the average floodplain tract was in cropland compared to 48 per cent for the uplands.

In Jackson county the upland farms were primarily located either on the edge of the Norman Uplands which is a dissected plateau of strong relief, or in an area of very poor drainage along the Muscatatuck River. By contrast, the floodplain consists primarily of a large (71,600 acres including some land in Bartholomew County), level area lying between the East Fork of the White River and the Little White Creek. Most of this land is cleared and intensively cultivated.

There were no land contracts recorded in Jackson county and only three in Bartholomew during the period

ABLE 6.--Selected Characteristics of 118 Farm Transfers, Jackson County, White Subarea, 1964-1966.

Item	Upland Sales		Floodplain Sales	
	Unit	Per Cent	Unit	Per Cent
umber of Observations	82		36	
rice per Farm	$17,583		$22,479	
verage Price per Acre	$227.54		$338.32	
ropland Acres per Fram:				
rade AB	1.7	3.6	11.7	18.4
rade C	13.2	27.8	33.5	52.8
rade DE	32.6	68.6	18.3	28.8
TOTAL	47.5	59.4	63.5	78.6
otal Pasture Acres	11.2	14.0	6.8	8.4
otal Woodland Acres	17.3	21.6	6.1	7.5
ther Land Acres	4.0	5.0	4.4	5.5
TOTAL Land in Farm	80.0	100.0	80.8	100.0
alue of Farm Improvements	$3,472		$2,666	
urchase for Expansion	41	50.0	21	58.3
pecial Warranty Sales	5	6.1	8	22.2
and Hill Location	7	8.3	8	22.2
ear of Sale:				
1964	34	41.5	14	38.9
1965	20	24.4	15	41.7
1966	28	24.1	7	19.4

1964-66. Presumably, this is a reflection of local custom regarding the recording of contracts rather than an indication of the prevalence of the use of contracts in transferring land.

CHAPTER V

REGRESSION ANALYSIS: GENERAL

Land Price Models

The analytical technique selected for the analysis of the land value data was multiple regression analysis. Regression analysis provides a means of determining how one factor (the dependent variable) varies with changes in other factors (the independent variables) that are believed to significantly affect the dependent variable under the circumstances being considered. In this case, the dependent variable would be some measure of land prices and the independent variables would be those quantifiable factors--including measures of flood risk--that are believed to affect market value of land. Regression techniques provide a means for "holding constant" other factors that may affect the market value of land while measuring the effect of variables related to flood risk. Estimates of the regression coefficients for variables included in the model also provide a means for adjusting the sale price of "non-comparable" tracts of land for comparison purposes to the extent the non-comparable elements are quantifiable and included in the regression model.

Basically, two models of the land market were constructed. Both models postulate a given structure of the land market but differ in the way in which the variables were entered into the model. The general form of both models is:

$$Y = f\ (X_1, X_2, \ldots, X_i, X_j, \ldots, X_k / X_m, \ldots, X_n)$$

Model I can be defined as a "total sale price" model. Y, the dependent variable, is the total sale price of the land and buildings composing a tract of land (a "farm"). Total sale price of a floodplain farm is postulated to be a function of (1) certain factors that are common to all farm sales such as acres of cropland, acres of woodland, or value of buildings, designated by the variables $X_1, \ldots, X_i$; (2) certain variables unique to floodplain sales such as acres of land inundated at selected exceedence intervals, designated by the variables $X_j, \ldots X_k$, and (3) certain other factors, variables $X_m, \ldots, X_n$, representing those influences on land values that have not been quantified and therefore must be "controlled" by either holding the sample constant with respect to their influence (i.e., by editing out sales known to be divergent with respect to some unquantified factor) or by assuming that the influence of the unquantified factors is randomly distributed.

Model II--the "average sale price per acre" model--postulates the same basic structure as Model I but in this model the dependent variable Y is entered as average price per acre for each farm (i.e., total sale price divided by total acres sold). With Y defined on a per acre basis it is also necessary to define the independent variables in a consistent manner. This can be done by expressing the continuous variables as percentages. Thus, for example, Model II would read as: Average sale price per acre is a function of per cent of cropland on the tract, per cent of land inundated at the 5-year interval, and so forth.

The multiple regression equation consistent with either model is of the form:

$$Y = b_o + b_1X_1 + b_2X_2 + \cdots + b_iX_i + \cdots + b_kX_k + \varepsilon$$

The dependent variable, Y is either total sale price or average sale price per acre. The X_i are the independent variables that were quantifiable on at least a nominal scale and that were believed to significantly affect land values. Linear relationships between the dependent and the independent variables were assumed (with one exception discussed in Chapter VI).

The error term, ε, represents those factors (variables $X_m,\ldots,X_n$) that could not be specified or quantified, including some elements of "randomness" of human behavior in a bargaining situation. We assume that these disturbance terms have a normal distribution and that the observations for this study are random samples from this population of disturbance terms.

Ordinarily, one would expect Model I to explain a very high percentage of the variation in sale price (have a high R^2) because the sale price of a tract of agricultural land is basically a linear function of a price per acre for cropland times the acres of cropland, a price per acre for other land use categories times the corresponding acres plus the value of farm buildings, plus other adjustments for location, soil fertility, and amenities. These latter factors, to the extent they are thought to be important value determinants, can be incorporated into the regression equation by the use of discontinuous variables. The difficulty with this model, however, is that the betas for the discontinuous variables must be interpreted at mean total sale price and it may be unrealistic to draw inferences about the price effect of the discontinuous factors for the very small or very large farms.[1]

This difficulty can be avoided by using average sale price per acre for the dependent variable as in Model II. With this model, the beta for a discontinuous variable can

[1]For example, if a discontinuous variable for a certain soil type were included, the beta would be interpreted as indicating that a farm with that soil type would command a total sale price differential equivalent to the beta value--regardless of whether the farm contained 20 acres or 200 acres. Logically, however, the effect of soil quality on total farm sale price should vary also with size of farm.

be interpreted as the per-acre price differential for sales with the attribute. The initial regressions were run with Model I but Model II was adopted for the final analysis because it yielded more consistent estimates for the discontinuous variables (which include some variables measuring flood risk). Model II yields lower R^2 (approximately 0.60 vs. 0.80) but the relative standard errors of the estimates were at least equivalent or smaller than those for Model I.

Variables

Listed below are the variables or data sources available for the analysis. All were used in the regressions at one time or another but only the statistically significant variables[1] were included in the final estimating equations.

Sale Price

Sale price, the dependent variable, is the total sale price of the tract including farm buildings and associated structures. For Model II, sale price was converted to an average price of land and buildings per acre. If the price was stated in the deed or contract this price was used. Otherwise sale price was computed from the Federal Revenue Tax stamps on the deed. Since the tax is

[1]The criterion was to include in the equations only those variables that reduced mean square error.

imposed at the rate of 55 cents per 500 dollars of sale price, the price represented by the last 55 cents was estimated by comparing the stated sale price with the price computed from the tax stamps for those deeds containing both. The average value of the last 55 cents for these sales was $397. This was rounded to $400 and used to adjust the calculated price of the remaining sales. Sales subject to mortgages were included if the outstanding balance of the mortgage could be determined.[1]

Date of Sale

The date the sale occurred was recorded and used as a time or trend variable in the regression equations.

Total Acres Sold

The total acres sold was either stated in the deed (most cases) or estimated from the legal description. Checks on total acres in farm were available from plat maps and assessment records.

Acres of Cropland by Grade

The best source of data on cropland on the tract was found to be the farm appraisal worksheets used by the county or township assessors. In Indiana, farm land is appraised for tax purposes by determining the categories

---

[1]The amount of the outstanding balance of the mortgage was required because this amount is not subject to the Federal transfer tax used in computing sale price.

of land use on the farm, assigning a letter grade from A to E to the land by use category, and then assigning a standard price by grade and category. It was possible to interview several of the assessors during the data collection stage and they indicated that they attempted to evaluate as many factors--topography, drainage, location, and soil characteristics--as possible in assigning grade categories. In particular, they evaluated land according to its use-potential rather than its actual use. Thus pasture capable of being cropped was appraised as cropland and the pasture category was reserved for land with limitations preventing higher use.

It is impossible to determine precisely all the factors evaluated by the individual assessors or to judge the accuracy of their work either relatively or against some objective standard. However, the best judgment that can be offered of the appraisal work is that the price relationships between grades as determined by the regression analysis were consistent in all counties except Jackson. In Jackson, part of the difficulties appear attributable to the wide heterogeneity of land quality in that county.

The acreage by land use categories (but not by grade categories) was spot checked against Agricultural Stabilization and Conservation records in several counties and all sales were located on aerial photographs as a rough check.

Acres of Pasture and Acres of Woodland

These acreages were also determined from appraisal worksheets. The grades for these land use categories were not significant in any regressions and only total pasture or wood acreage was included. The appraisers rarely assigned a grade of C or better and tracts with these higher grades were usually found to have residential or commercial site potential and were eliminated from the sample.

Acres of Other Land

On tracts sold for agricultural purposes acreage in this category was small and included land in ditches, roads, farmsteads and waste.

Type of Instrument

Sales were coded according to whether the sale was by general warranty deed, special or commissioner's warranty deed, or by land contract. Special warranty deeds were primarily deeds given by court appointed executors for estate settlement sales. Information from land contracts was taken if the contract was recorded but it could not be determined if the practice of recording contracts was universal.

Expansion

A tract was presumed to be purchased for farm expansion purposes if the grantee owned other land nearby, as determined from plat maps and assessment records.

Per Cent of Mineral and Oil Rights Sold

The per cent of mineral and oil rights transferred to the grantee was determined and coded separately. Knox and Sullivan Counties were the only counties in which an appreciable number of transactions involved transfers of less than 100 per cent of mineral and oil rights. Most of the mineral (primarily coal) rights were alienated from surface rights around the turn of the century when underground coal mining first began. Since present production is based on strip mining in limited areas of the counties, the absence of mineral rights to the land should not be expected to appreciably affect sale price and this variable was not found significant in any regressions.

There are several producing oil pools in the two counties but most transfers of agricultural land included all oil and gas rights. In most cases where oil rights were retained by the grantor the rights were to revenue from producing wells. No significant difference in sale price attributable to the oil rights was found.

Value of Farm Improvements

The appraised value of the farm residence and of other farm buildings was taken from farm appraisal worksheets in county offices. The appraisals were made in 1961 but the sheets are updated for any material changes in the buildings between appraisals. Only values for the buildings on the farm at the time the sale occurred were recorded. The appraisal sheets contained considerable information about the farm dwelling (type of construction, number of rooms, etc.) and listed all farm buildings by type. The appraiser also judged the relative quality of all buildings (intermediate, low average, poor, etc.). The following was recorded on the data collection schedule: appraised value of the house, a letter equivalent of the house grade, total value of all other farm buildings existing at the time of sale, and a brief description of the types of buildings.[1]

The average appraised value of the farm buildings is relatively low (Tables 3 to 6, Chapter IV) but the prices are consistent with the general quality of the buildings, both as indicated by the appraisers' grading and descriptions and from visual observation of farmsteads in the study area. The farm dwellings, for the

[1]The enumerators were instructed to describe in detail any buildings on a tract that were not normally associated with farming as a check in the editing process.

most part, are old and outbuildings are minimal. However, one would expect some tendency for the appraisals to understate actual building value (at least in the Lower Wabash and White study areas) because of the time difference between appraisal date and sale date. A number of investigations were made of the relationship between sale price of farm and appraised value of improvements in the initial runs using Model I. Here the working hypothesis was that one dollar of appraised value of buildings added a dollar to sale price of the farm; i.e., that the beta for the Value of Improvement variable was equal to one ($1.00). The betas for Upper Wabash, Bartholomew and Jackson sales generally were not significantly different from $1.00. Betas for Sullivan County ranged between $2.00 and $2.40, indicating either that buildings in this county were under-appraised or that buyers valued the buildings more highly than in the other counties. The beta values for Knox were about $1.00 for farms purchased by grantees not owning other land in the vicinity but only $0.53 for farms presumably purchased for expansion purposes.

House Grade

House Grade was also included as an independent variable for some runs of Model I. House Grade was generally positively related to sale value but the relationships were not strong enough to warrant inclusion of this variable in the Model II runs.

Type of Road

The sales were coded according to whether they were located on primary, improved (secondary), or unimproved roads as a possible measure of some locational and access values. The difficulty was that all the counties had good road systems with very few unimproved roads remaining and location on primary or arterial roads did not appear to offer sufficient advantages over secondary roads to be reflected in price. Consequently this variable was deleted early in the investigation. A variable for distance from town was considered but not developed because the spatial distribution of the towns and villages in all counties was good and no area could be considered isolated from the major trading centers.

Topography

A general classification of topography (river bottom or level, rolling, or hilly) was taken from the appraisal sheets and checked against topographical maps. However, the effects of topography are also reflected in land use and land grade categories and this variable was not significant in the initial regression runs.

Some appraisers made notations on the appraisal sheets about farm drainage condition ("wet," "tiled," etc.). It appears that the notations were made in order to justify quality grades assigned to the land and therefore a separate variable for drainage was not developed.

Other than notations on the worksheets, there were no data available on drainage installations.

Township

A variable for township was included, primarily as an alternative (to type of road and distance from town) measure of location. Only in Knox and Sullivan were any township variables found to be significant and *ex post* explanations are generally available for the differences in each case.

Land Capability Unit Groups

Soil maps of varying currency were available for Miami (published in 1927), Cass (1939), Carroll (1940), Knox (1934) and Bartholomew (1936) Counties. It was not feasible to develop variables for individual soil types on each farm because of the large number of soils found on a typical farm. Instead, the soils were grouped in land resource area/land capability units (LRA/LCU) which represent soils with similar management requirements and productive characteristics. However, the LRA/LCU system requires fairly recent soil maps based on current soil definitions. Only Carroll County had a sufficiently current soil map, but by keying soil descriptions in Miami and Cass to the Carroll County maps, LRA/LCU groupings were developed for all three counties. This was not possible for Knox or Bartholomew Counties however, and sale tracts in these counties could not be related to LCU groups.

Even with the LRA/LCU groupings, several LCU's were usually found on a typical farm. It was not possible to accurately measure the acreages in each group or precisely delineate cropland areas, therefore the predominant LCU was estimated by using a calibrated overlay on the soil map after locating cropland boundaries with the aid of aerial photographs.

There were seven LRA/LCU's suitable for cropland in the Upper Wabash counties and each observation was coded according to the predominant LCU on that tract. However, the LRA/LCU variables were not significant in any run of Model I or II. The probable explanation is that with one exception (an LCU with an estimated corn yield of 80 bushels), the estimated corn yields under high level management practices were within 14 bushels (103 to 117 bushels per acre) over the LRA/LCU's. This indicates that the cropland soils of the Upper Wabash are quite homogeneous with respect to crop yields.

Type of Farm

Since LCU groupings could not be developed for Knox or Bartholomew because of the outdated soil maps, land in these counties was grouped into "type of farm" categories based primarily on soil characteristics. Generalized soil maps were used for Sullivan and Jackson Counties to

develop similar categories. The type of farm designations were, for Sullivan, Knox and Jackson: River Valley, Sand Hills, and Uplands; and for Bartholomew: River Valley; Sand Hill; Gravel Benchlands; Upland Corn, Wheat and Livestock; and Upland General Farming. The Sand Hill area is a pronounced region between the Wabash River and the Upland areas of Knox and Sullivan Counties. The soils are especially adapted for truck cropping and orchard production (although the number of orchards is declining and no sales of orchard land were included in the sample). A similar area is found in Bartholomew and Jackson but of much small extent.

Flood Risk

The following information was coded for each observation with land on the floodplains: The stream designation; whether the tract had stream frontage; levee protection if present, coded according to whether the levee was privately constructed, COE repaired, or COE constructed; whether any buildings were subject to flooding and the frequency; and the acres of open land and acres of all land located in up to five frequency zones.

Each tract sold was located on an aerial photograph and on a topographic map on which the limits of floods of selected exceedence frequencies had been superimposed. Acreages were estimated by using calibrated overlays to first estimate the proportion of open land and other land in each flood zone. These proportions were then converted to acreages on the basis of known acreages, by land use classes, in the farm. Open land (cropland plus pasture) was measured instead of cropland because the two classes could not be sufficiently distinguished in the aerial photographs.

The limits of flooding along the major rivers and streams were obtained from flood charts and/or flood profiles obtained from the Louisville COE office. Some upland farms were located in small watersheds and subject to some flooding from these streams. The extent of flooding on these farms was estimated from data and maps in several PL 566 project work plans.[1] The PL 566 information was generally sketchy and usually presented only the limits of a synthetic 50 year flood. Information for these streams was coded if available but in some cases observations were deleted for the lack of adequate information.

Table 7 presents the flood frequency data available by streams in the sample. Land lying outside levees (i.e., between the levee and river) on tracts receiving levee protection was coded according to actual risk. Land inside levees was considered subject to flooding from levee

---

[1]In order to simplify terminology, we will refer to these small upland streams as "SCS streams," indicating that they are the <u>type</u> of streams over which the SCS normally has jurisdiction for development work. This terminology is not meant to imply that all the small watershed streams in this sample are currently under consideration for PL 566 projects.

TABLE 7.--Flood Frequency Zones by Streams, Wabash Land Value Study.

Stream	Recurrance Interval (years)				
	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
Wabash	1	2	5	25	100
White	1	2	5	25	100
West Fork White	1	-	5	25	100
East Fork White	1	-	5	10-25	100
Flatrock	-	1.7	7.7	-	100+
Driftwood	0.5	-	-	20	100+
Clifty Creek[a]	1	-	5	10-25	100
SCS Streams	-	-	-	50	-

[a]The only sales on Clifty Creek were in the backwater area of the East Fork of the White. The recurrance intervals are for the White.

Source: From information supplied by the Louisville District, U.S. Army Corps of Engineers.

overtopping from floods with a recurrance interval of 20 to 25 years and coded in zones 4 and 5.

Presentation and Interpretation of Regression Results

In the following three chapters, the results of the regression analysis of farm sale data in each of the three study areas are presented. In Chapter IX the results of the land value analysis are compared with the Corps of Engineers estimates of expected average annual damage.

In reporting the results of the regression analysis in each of the study areas, the estimating equation used can be read from the appropriate table accompanying the discussion (see, for example, Table 8, Chapter VI). The dependent variable in each equation is average sale price per acre ($\overline{Y}$). The independent variables (the $X_{i's}$) can be read from the left-hand column of each table (variable names are assigned to each variable instead of variable numbers to facilitate reading the tables).

All of the regression coefficients may be read directly as dollars. The variables for cropland by grade are continuous variables and were entered into the regression as decimal fractions of all land in the tract. "Log Acres" and improvements by size of farm are also continuous variables. The remaining variables are discontinuous variables that take the value of one if the observation possesses the attribute and take the value of zero

otherwise. The regression coefficients for the discontinuous variables may be interpreted as the difference in average sale price per acre for observations possessing the attribute relative to the average price per acre for observations without the attribute. For example, a variable for "Year of Sale, 1966" would take on a value of one if the observation was transferred in 1966 and the remaining year-of-sale variables would assume values of zero. The coefficients for year-of sale should be interpreted as the difference in average price per acre for sales in the year indicated over the average price per acre in the base year (which varies in each study area). The interpretation of the other discontinuous variables should be self-explanatory from their names except that it might be noted that the coefficients for "Contract" and "Special" variables are relative to sales transferred by general warranty deeds.

The variable "Log Acres" is defined as the total acres of land sold for each observation and is entered in logarithms to the base 10.

The use of average price per acre as the dependent variable in Model II creates special problems in generating consistent variables for value of buildings. The building variable cannot be entered simply as average value per acre because a poor set of buildings on a small farm would average out to the same per acre value

as a good set of buildings on a large farm. After experimenting with several attempts to subtract out building value from sale price, the observations for each study area were divided into three approximately equal groups on the basis of total acres in farm. The size categories chosen were less than 50 acres, 50 to 120 acres, and more than 120 acres. The value of buildings, per acre, was then calculated with each observation falling into only one of the three categories. This procedure yields independent variables that are consistent with the dependent variable while minimizing the effect of wide variance in total acres on building value per acre. When defined in this manner the independent variables for building value are expressed in the same units (dollars per acre) as the dependent variable. Therefore, the regression coefficients for these variables should be interpreted as the relative contribution of an additional dollar of appraised value of buildings, per acre, to total sale price of the land and buildings, per acre. Thus a coefficient of 1.0 would indicate that $1.00 of appraised value of buildings per acre contributed $1.00 to sale price. Similarly a coefficient of less than (greater than) 1.0 indicates that $1.00 of per-acre appraised value added less than (more than) $1.00 to per-acre sale price.

A three-step procedure was used in the analysis of sale data for each of the three study areas. First, a

general regression analysis was made of all observations (both upland and floodplain) for each study area in order to determine the general nature of the value relationships and to test if the average sale price of the floodplain tracts differed significantly from the upland tracts. An analysis of specific flood risk-land value relationships is limited in this type of analysis, however, because it is possible that some of the influence of flood risk may be picked up by other independent variables (such as proportion of cropland by grade) which are more strongly correlated with sale value in the combined regression analysis.

Therefore, in the second step of the analysis, the upland sales were analyzed separately. The purpose of this step was to estimate the influence on sale value of those variables common to both upland and floodplain tracts of land from observations that were free of flood risk. The regression coefficients obtained therefore should be free of any discounting for flood risk.

In the third stage of the regression analysis in each study area, the sale price of each floodplain observation was estimated on the basis of the regression coefficients estimated from the upland observations in the second step. The assumption in this process is that in the absence of flood risk those factors common to both upland and floodplain sales would influence price in the same way. The residual differences between the actual

per-acre sale price of the floodplain observations and the estimated price, given the above assumption, therefore represents the component of floodplain land values attributable to flood risk. These residual differences thus provided the basis for additional investigations into flood risk-land value relationships.

CHAPTER VI

REGRESSION ANALYSIS: UPPER WABASH AREA

General

The final regression analysis for the four counties in the Upper Wabash area was based on 406 observations of farm sales for the years 1952 through 1966. There were 60 sales of farm tracts containing floodplain land but 15 of these were subject to flooding from SCS streams. The remaining 45 observations represent essentially a complete accounting of all registered transactions of floodplain land that can be considered bona-fide sales of agricultural lands and for which adequate information was available for anlaysis. Conceivably, the number of observations could be increased if the circumstances surrounding some sales between related persons could be determined but most of these transactions obviously were made at less than full market value.

Floodplain Sales 1952-1966

As a part of the search for eligible sales, a listing was made of all ownership tracts in the four counties that included land on the floodplain. The listing was compiled from county plat maps and included all tracts of 20 acres or more. Tracts in Peru township, Miami County and Eel

township, Cass County as well as tracts in the immediate vicinity of Wabash in Wabash County and Delphi in Carroll County were excluded as urban property. An effort was made to consolidate all tracts held by the same person. There were 307 identifiable ownership units. This list was checked against real property transfer records in the auditors office of each county beginning with the records for 1951-52. Of the 307 total ownership units, 186 were held in the same name the entire period. There were 62 transfers that, prima facie, represented bona-fide sales (on the basis of information in the auditors office) but 17 of these were found to be subject to extra-market influences. There were 73 transfers involving tracts that passed by descent, gift, divorce settlements, or litigation and tracts sub-divided or commercially developed.[1]

Although this enumeration may be subject to some errors (in defining floodplain tracts, consolidating ownerships units held in one name, etc.) it is indicative of approximate turn-over rates. It also indicates that a major difficulty with the land value approach in areas of narrow floodplains may be that of obtaining an adequate number of representative farm sales for analytical purposes.

---

[1]These categories sum to 321 because there were some multiple transfers over the period and some tract divisions or consolidations.

Combined Analysis, All Sales

The results of the regression analysis of all sale observations in the Upper Wabash area are presented in Table 8. The mean sale price per acre for all observations (including floodplain sales) was \$309.97 with a standard deviation of \$151.42. The estimating equation had an R^2 of 0.67 and the standard error of estimate was \$89.42.

"Expansion" was a discontinuous variable that took on the value of one if the farm was purchased for farm expansion purposes. These sales commanded an average of \$18 per acre over sales to grantees not owning other land in the immediate vicinity. The positive coefficient for expansion is in accord with economic logic.

"Log Acres" is a measure of the effect of total size of the tract on the average price per acre. The negative coefficient indicates that as total size increases, price per acre decreases. This occurs in part because building value is included in the total price per acre and one would expect value of buildings to exert a greater influence on average price per acre for small farms than large farms. When sale prices were adjusted for buildings the magnitude of this coefficient was greatly reduced but still negative in sign. The variable was entered in logarithmic form after experimentation with various first and second order forms of the variable indicated the function was approximately of a logarithmic form.

TABLE 8.--Estimated Regression Coefficients, 406 Observations Upper Wabash Area, 1952-1966.

Item	Regression Coefficient	Standard Error	Significance Level
Number of Observations	406		
R^2	0.68		
$\overline{Y}$	309.97	89.43[a]	
Constant	286.93	55.00	
Independent Variables:			
Expansion	18.32	9.98	0.064
Log Acres	-144.95	24.34	0.0005
Proportion Crop AB	275.23	23.63	0.0005
Proportion Crop C	181.15	24.71	0.0005
Proportion Crop DE	94.44	27.82	0.001
Contract	90.15	13.68	0.0005
Special	30.87	12.80	0.016
Improvements:			
Small Farm	0.91	0.09	0.0005
Medium Farm	0.99	0.12	0.0005
Large Farm	1.49	0.24	0.0005
Year of Sale:			
1955	22.62	30.75	0.469
1956	30.91	30.62	0.314
1957-59	-5.35	45.75	0.873
1960	44.72	31.51	0.153
1961	26.50	31.04	0.398
1962-64	45.20	33.74	0.178
1965	112.97	30.63	0.0005
1966	154.82	30.04	0.0005
Floodrisk:			
Frontage	-15.13	18.48	0.419
No Frontage	-15.08	29.73	0.618

[a]Standard error of estimate.

The variables for proportion of cropland by grades AB, C and DE were highly significant and of the correct relative magnitudes, indicating that the grading system was consistent with the land market's evaluation of tract value. Pasture and woodland coefficients were not significantly different from zero.[1]

Several considerations suggest that farms sold by land contracts should command a price premium over farms sold by general warranty deeds with conventional financing. Sales by special warranty, on the other hand, are sold under conditions approaching a public auction and would be expected to command about the same price as general warranty sales, or perhaps at slightly lower prices because of the element of timeliness involved in these involuntary sales. The positive sign and magnitude of the coefficient for special sales was not expected;[2] nor was the magnitude of the coefficient for the contract sales. The magnitude of these coefficients may indicate, then, that some of the general warranty sales were made at less than full market value. In view of this possibility, the editing procedure

---

[1]The coefficients for the cropland grade variables can be interpreted as percentages by adjusting the decimal point; e.g., a 10 per cent increase in the per cent of Cropland grade A or B in the farm would, on the average, increase average price per acre by $27.52, ceteris paribus.

[2]However, the positive coefficient may indicate only that the commissioners handling the sales were especially diligent in obtaining the best price.

for all observations was reviewed but there were no obvious examples of sales that should be excluded.[1]

The coefficients for value of farm improvements by size of farm indicate that one dollar of appraised value of building per acre on the large farms add more to average sale price per acre ($1.49) than one dollar of appraised value per acre on the small farms ($0.91). Several hypotheses can be offered in explanation for this difference. For example, to the extent the smaller farms are more likely to be purchased for expansion purposes, the farm buildings on the tract may be redundant and therefore not valued highly by the purchaser. Similarly, on the large farms the purchase price may tend to be high relative to the appraised value of both land and buildings. However, explanations for the differences in coefficients by size of farm were not pursued because (1) both the coefficients for small and large farms are within one standard error confidence limits of the coefficient for medium-sized farms and (2) the interpretation of these coefficients are not critical to the purposes of this study.

The coefficients for year of sale measure the difference in average price per acre attributable to year of sale relative to the base years 1952-54. The coefficients

---

[1]There were three sales (two by land contract and one by special warranty) that were made at relatively high prices per acre ($750-$900). When these were eliminated the coefficients were $77.51 and $29.29 for contracts and special warranty sales, respectively.

indicate a tendency for prices to increase over time but the significant increases occurred only in 1965 and 1966. There were only six sales recorded between 1957-59 and this estimate is particularly poor. The year of sale variables are discussed further below.

In this particular equation the variables for flood risk are for observations on the Wabash only. There were 34 observations with frontage and 11 observations subject to flooding but without direct Wabash frontage. The coefficients have a negative sign but are not statistically significant at the 10 per cent level. Other variables for flood risk tried (with slightly different sets of other independent variables) included variables for flooding from the Wabash River and from SCS streams. In no equation was the SCS variable significantly different from zero. The variable for Wabash flooding was significant and negative (around $-21 and at the 0.03 significance level). The relationship between flood risk and land prices is examined in more detail below.

Upland and Estimated Floodplain Sales

The analysis of the combined observations includes 60 floodplain sales and therefore reflects, in part, the influence of flood risk on the sale price of the floodplain farms. Depending on how the flood risk is defined, the analysis indicates that there is a negative land price component attributable to flood risk but the information provided by a flood risk variable in the over-all analysis is limited. Therefore, the sample of Upper Wabash sales was broken into two classes: upland and floodplain sales.

The 346 upland observations represent sales of land free of flood risk and sold for an average price of $325 per acre. These sales were analyzed separately and the regression coefficients obtained (Table 9) therefore represent the influence of the independent variables on the price of land free of any floodrisk.

Year of Sale Adjustments

The precision of the estimates of the influence of year of sale on the average price per acre for the upland observations alone was improved considerably relative to the analysis of all sales combined, although the standard error still exceeded the estimated beta value for the years 1957-59. However, this estimating equation yielded only single estimates for the years 1957-59 and 1962-64. Since the number of floodplains sales that occurred during these years were relatively important[1] it was considered desirable to develop individual estimates for each of these years.

The individual yearly estimates were developed by converting the beta values obtained from the upland regression for each of the years 1955-56, 1960-61, and 1965-66

[1]There were two floodplain sales each in 1957 and 1959, four in 1962, one in 1963, and eight in 1964.

TABLE 9.--Estimated Upland Regression Coefficients and Mean Values for Upland and Floodplain Observations, Upper Wabash Area, 1952-1966.

Item	Upland Regression			Unit	Means	
	Coefficient	Standard Error	Significance Level		Upland	Floodplain
No. of Observations					346	60
R^2	0.66					
$\overline{Y}$	325.39	91.99[a]		$	325.39	221.03
Constant	287.47	71.14	0.005			
Independent Variables:						
Expansion	16.41	10.90	0.129	%	33.2	20.0
Log Acres	-160.56	28.66	0.0005	-	1.87	1.99
Proportion Crop AB	273.43	26.28	0.0005	%	20.2	15.1
Proportion Crop C	178.30	27.12	0.0005	%	37.4	24.4
Proportion Crop DE	85.44	30.80	0.006	%	20.0	22.2
Contract	95.93	14.88	0.0005	%	14.7	8.3
Special	47.84	14.07	0.001	%	16.5	11.7
Improvements:						
Small Farm	0.87	0.09	0.0005	$	24.85	10.82
Medium Farm	0.99	0.13	0.0005	$	31.41	21.08
Large Farm	1.60	0.27	0.0005	$	12.30	13.98
Year of Sale						
1955	52.65	43.77	0.228		56	5
1956	50.66	44.27	0.252		49	9
1957-59	39.70	78.73	0.620		2	4
1960	74.15	44.11	0.090		44	2
1961	57.02	43.91	0.192		50	3
1962-64	97.49	54.73	0.072		7	13
1965	140.12	43.88	0.002		60	10
1966	184.36	43.43	0.0005		73	8

[a]Standard error of estimate.

to index equivalents and plotting these computed indices against the actual land price indices for the State of Indiana for the same years (Figure 6). The indices for the remaining years (1957, 1959, 1962, 1963 and 1964) were then estimated by straight-line interpolation and converted back to estimated price increments equivalent to the values derived from the regression.[1] This procedure yielded an estimate of the influence of year-of-sale on sale price for each year of the period 1955-66. These yearly estimates were then used in the analysis of floodplain sales (below). Data to estimate the trend in value for the six observations sold between 1952 and 1955 were inadequate for estimation purposes.

It may also be noted from Figure 6 that the agreement between the state-wide index and the computed index for the Upper Wabash sales is very close for the beginning and ending years of the period examined. Real estate sales in the four county areas during 1960 and 1961 apparently commanded lower relative prices than the state averages but the computed indices did reflect the state-wide drop in prices for 1961. It was concluded therefore that the estimated price increments attributable to year of sale in the

[1]The estimates were: $55.39 for 1957, $69.72 for 1959, $79.27 for 1962, $98.38 for 1963, and $117.49 for 1964.

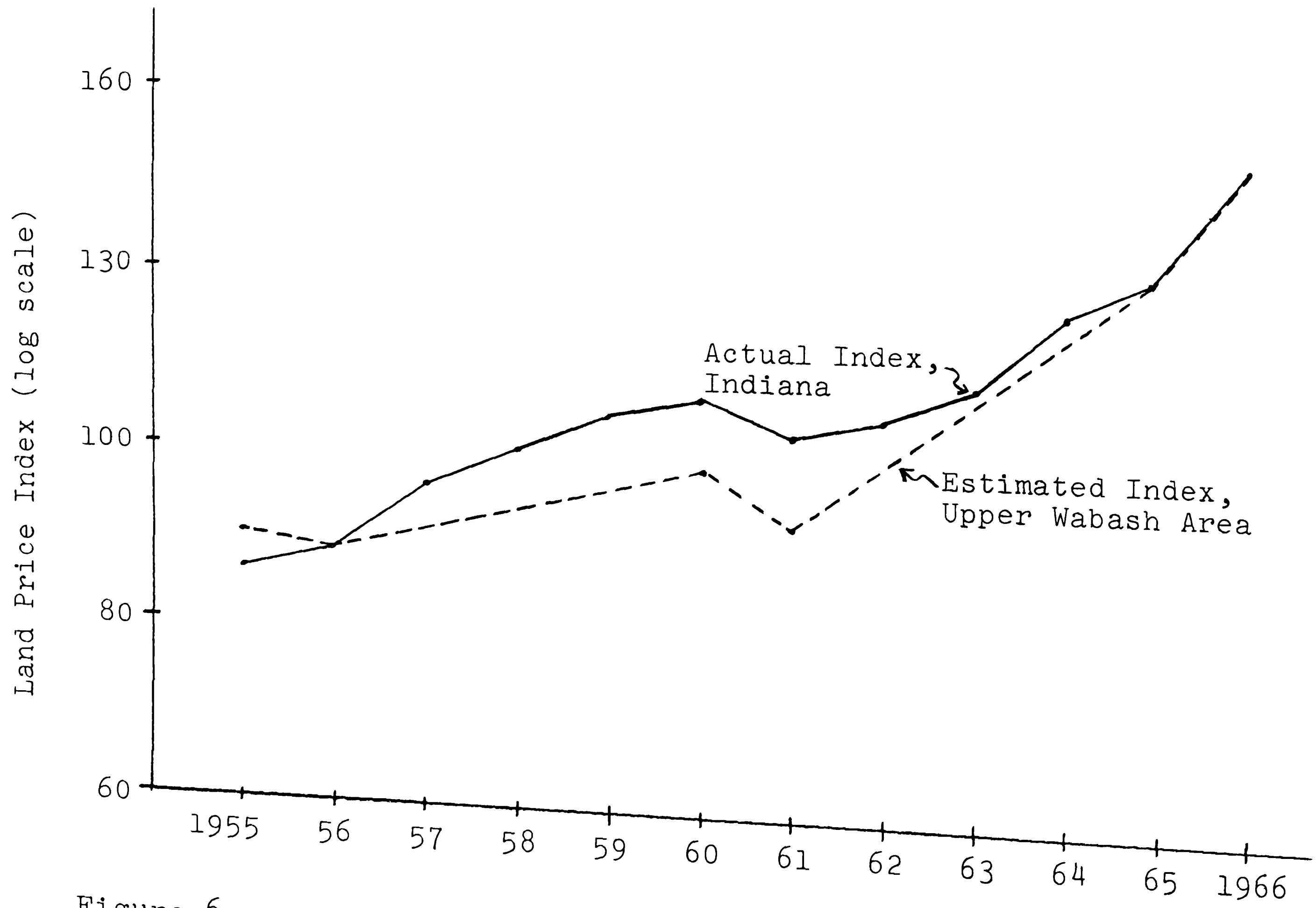


Figure 6.--Actual Land Price Indices, Indiana, and Estimated Indices, Upper Wabash Area, 1955-1966.

regression analysis were reasonably related to average state-wide price changes over the study period.[1]

Price and Flood Risk Adjustments

The average price per acre of the 60 floodplain sales was $221.03. However, part of this difference in price per acre represents quality differences in the average upland and floodplain tract. For example, only 61 per cent of the floodplain tract was in cropland, compared to 77 per cent for the upland sales, and relatively less of this cropland was graded A, B or C. Similarly, building values on the small and medium farms were much lower. If corrections are made for these differences (by assigning estimated upland values to the means for floodplain sales) the estimated price per acre is $231 (Table 10).[2] The assumption implicit in this procedure is that in the absence of flood risk, the factors common to both upland and floodplain sales would influence sale price in the same way. The difference in this estimated price ($231) and the actual sale price ($221) therefore represents the component of floodplain land values attributable to flood risk (see part A, Table 10).

---

[1]A similar check was made for the year-of-sale variables for the Lower Wabash area analysis. Good agreement between the state index and the estimated area index was found.

[2]This figure can be derived by converting the variable means for the floodplain observations in Table 9 to decimal equivalents (except the means for value of improvements) and multiplying by the corresponding coefficients for each variable.

TABLE 10.--Average Land Prices and Flood Risk Calculations, Upper Wabash Area.

A. Average Price per Acre Analysis

1.	Price per acre of average farm, 346 upland sales	$325.39
2.	Price per acre of average farm, 60 floodplain sales	221.03
3.	Unadjusted difference	-104.36
4.	Estimated price of floodplain sales at upland values[a]	231.13
5.	Difference attributable to flood risk (4-2)	-10.10

B. Per Acre Residual Analysis

	Category	Mean Residual[b]	Standard Error	t Value	Significance
54	Floodplain sales after 1954	-16.04	10.23	1.57	0.10
15	SCS streams	+11.92	20.63	< 1	N.S.
39	Wabash River observations	-26.79	11.44	2.34	0.025

[a]Estimated as:

$$\hat{\bar{\bar{Y}}} = \hat{\beta}_0 + \hat{\beta}_1\bar{X}_1 + \cdots + \hat{\beta}_i\bar{X}_i + \cdots + \hat{\beta}_n\bar{X}_n$$

where $\hat{\bar{\bar{Y}}}$ = estimated average price per acre, all floodplain observations. The β_i were obtained from the upland regression analysis and the $\bar{X}_i$ were set equal to the means of the floodplain observations.

[b]A residual (R_i) was calculated for each floodplain observation as:

$$R_i = \bar{Y}_i - \hat{\bar{Y}}_i$$

$$= \bar{Y}_i - (\hat{\beta}_0 + \hat{\beta}_1 X_{1i} + \cdots + \hat{\beta}_n X_{ni})$$

where $\bar{Y}_i$ = average price per acre, ith floodplain observation.

The $10 difference in actual floodplain sales and the estimated price in the absence of flood risk is based on average price per acre for all floodplain sales. In order to facilitate further analysis, the "flood-free" price was estimated for each floodplain observation and subtracted from the actual price in order to estimate the flood risk component for each sale. The analysis based on these residuals is indicated in part B of Table 10. Year of sale data were not available for the six sales occurring before 1955 and these sales were eliminated from the analysis. The variable for flood-risk for tracts located on SCS streams was not significant in any analysis of combined upland and floodplain sales. In this residual analysis the residual for the 15 SCS streams was found to average a positive $12. This value was not significantly different from zero and indicates that these farms were valued by farm buyers about the same as surrounding upland farms.

After deleting the 6 sales that occurred before 1955 and the 15 sales on SCS streams, there were 39 sales representing tracts subject to flooding for the Wabash River. The sales commanded an average of $26.80 less than their estimated value under flood-free conditions. This difference was statistically smaller than zero at better than the three per cent level.

The difference of $26.80 represents the average discount across all flood risk zones and includes some

non-floodplain land, since a number of the farms overlapped the floodplain and uplands (55 per cent of all open land on the average floodplain farm was on the floodplain; of this 34 per cent was subject to flooding once in five years or more frequently). In addition, the sales cover a span of 11 years during which there has been a substantial reduction in flood risk due to reservoir construction. Therefore, additional investigations were made using the residual values. The results may be indicative of general relationships but the statistical reliability is very low because of the large standard errors associated with the residuals used as the dependent variable.

The best estimating equation from the residual analysis was:

$$\text{FP Residual} = 49.16 - \underset{(36.23)}{68.40}\ (\text{HG RISK}) - \underset{(43.78)}{44.81}\ (\text{OTHR FP}) - \underset{(2.77)}{3.68}\ (\text{YEAR})$$

This equation postulates that the residual component is a function of per cent of open land in the high risk zones (recurrance interval of 1 to 5 years), the per cent of open land on the floodplain but outside the high risk zones, and year of sale. The coefficient for HG RISK is significant at the 0.067 level, the remaining coefficients are not significant at the 0.10 level. The R^2 for this equation was 0.14 and the standard error was $69.06.

The signs and the relative magnitude of the two flood risk variables are consistent and indicate, for example, that a 10 per cent increase in land in the high risk zone would increase (make larger negatively) the floodplain location residual by about $7.

One of the reasons for choosing the Upper Wabash area for study was to determine if the effect of reservoir construction in the area was reflected in land values. During the period examined the Salamonie Reservoir was completed, the Mississinewa Reservoir reached operational state and construction on the Huntington Reservoir was begun. Expectations were that this construction activity, and resulting increase in protection levels, would be reflected in sale value. However, the negative coefficient for year of sale indicates that this has not occurred.

The lack of significance for the year of sale variable may indicate either than there are too few observations in any year (and over all years) for a strong trend line to be developed, that capitalization has not yet occurred, or that capitalization occurred before 1955 in anticipation of protection.[1] The latter is at least a possibility because

---

[1]An additional possible explanation is that farmers in Wabash and Miami Counties who were displaced by site acquisition for the Salamonie and Mississinewa Reservoirs in the early sixties bid-up the price of other farmland in the study area in seeking new farmsteads. This might explain the greater rise in the computed land price index for the area, relative to the State of Indiana, between 1960-61 and 1965-66. If this in fact occurred, any rise in floodplain land values attributable to the reduction in flood risk may

authorization for investigation of flood control for the area was approved in 1949; the report recommending the reservoir construction was submitted to the Committee of Public Works in June, 1956;[1] and the Corps was actively buying land in Wabash and Miami County in the early years of this study.

In this study relatively little importance is attached to the fact that the per-acre sale value of farms bordering the upland streams was not significantly different from other upland farms. The study was not designed to investigate the effects of flooding from these streams and the available data are sketchy. Examination of topographic maps and aerial photographs indicate that nearly all the land immediately adjacent to the streams (and therefore presumably in the high risk zones) have been left in woodlands. To the extent conditions in the Upper Wabash are typical of other upland streams this does indicate, however, that the land value check would have little applicability under these conditions.

The implications of the analysis of floodplain land values are discussed further in Chapter IX; where the results of the analysis of all three study areas are related to Corps damage estimates.

---

be obscurred by the general rise in land values in the area which was also related (indirectly) to the reduction in flood risk.

[1]U.S. Congress, House, Committee on Public Works, Headwater Reservoirs, Wabash River, Indiana [Issued as H. Doc. 435], 84th Cong. 2nd sess., 1956.

CHAPTER VII

REGRESSION ANALYSIS: LOWER WABASH AREA

Basically the same analysis was performed for Knox and Sullivan County as in the four county Upper Wabash area. There were 334 observations covering farm sales between the years 1962 and 1966. Of these, 74 were floodplain sales. The results of the combined analysis are presented in Table 11. Variable definitions are the same except that the value of improvements, by size of farm, was entered separately for Knox and Sullivan since the preliminary analysis indicated that buildings had a relatively more important influence on total farm sale price in Sullivan County. The coefficient for value of building on large farms in Knox County was not significant in any equations. "Sand Hill" is a location variable for farms located on the sandy soil areas of the county and had a positive value, as expected. The township variables are additional measures of locational attributes. The signs for these variables are in accord with expected relative price differences over the two counties.

TABLE 11.--Estimated Regression Coefficients, 334 Observations, Lower Wabash Area, 1962-1966.

Item	Regression Coefficient	Standard Error	Significance Level
Number of Observations	334		
R^2	0.61		
$\bar{Y}$	292.76	97.83[a]	
Constant	37.99	32.78	
Independent Variables:			
Proportion Crop ABC	321.99	27.93	0.0005
Proportion Crop D	223.90	26.23	0.0005
Proportion Crop E	201.52	31.18	0.0005
Contract	32.49	15.45	0.034
Special	53.68	16.17	0.0001
Improvements, Sullivan:			
Small Farm	1.02	0.16	0.0005
Medium Farm	0.85	0.30	0.005
Large Farm	1.99	0.60	0.001
Improvements, Knox:			
Small Farm	1.41	0.16	0.0005
Medium Farm	0.89	0.25	0.001
Sand Hill	38.02	14.63	0.010
Townships:			
Fairbanks	-120.97	21.03	0.0005
Gill	-116.38	23.49	0.0005
Hadden	- 59.83	22.86	0.009
Hamilton	- 84.15	27.01	0.002
Turman	-100.48	25.93	0.0005
Busseron	-162.87	26.30	0.0005
Steen	- 42.64	32.17	0.183
Vigo	- 99.40	28.76	0.001
Washington	- 51.03	20.99	0.015
Widner	- 64.82	28.00	0.020
Year of Sale:			
1964	63.52	24.66	0.010
1965	89.74	24.66	0.0005
1966	138.88	24.83	0.0005
Floodplain, no levee	- 74.43	20.07	0.0005

[a]Standard error of estimate.

Again, the coefficients for cropland by grade are consistent in relative magnitude. The coefficient for location on unprotected floodplain land indicates a significant negative value component associated with these sales. The coefficient for location on protected floodplains, on the other hand, did not differ significantly from zero.

Upland and Estimated Floodplain Sales

As in the Upper Wabash analysis, a separate analysis of the 260 upland sales in Knox and Sullivan Counties was made in order to derive estimated coefficients free of the influence of flood risk for those variables common to both upland and floodplain sales. The regression results and average values for the variables on upland and floodplain farms are presented in Table 12. Again, the coefficients for cropland are consistent, although the value difference between cropland graded D and E is small. The coefficients for township are relatively large, and negative, because the township eliminated from the regression to avoid matrix singularity was Curry Township in Sullivan County. Land values in Curry Township were, on the average, the highest for any township in Sullivan County and were about the same as in five of the 10 townships in Knox County.[1] The coefficients for the township variables indicate the

[1]In Table 12, Fairbanks through Turman Townships are in Sullivan; the remainder are in Knox. There were 6 Sullivan townships in the study (Curry plus those listed in Table 12) and 10 Knox County townships.

ABLE 12.--Estimated Upland Regression Coefficients and Mean Values for Upland and Floodplain Observations, Lower Wabash Area, 1962-1966.

Item	Coefficient	Standard Error	Significance Level	Unit	Mean Upland	Mean Floodplain
umber of Observations					260	74
^{2}	0.58					
	303.33	101.32[a]		$	303.33	255.65
onstant	38.20	42.80				
ndependent Variables:						
Proportion Crop ABC	314.88	33.20	0.0005	%	17.0	21.3
Proportion Crop D	207.47	29.85	0.0005	%	36.8	44.4
Proportion Crop E	199.20	35.90	0.0005	%	15.4	19.3
Contract	38.07	17.48	0.030	%	18.5	6.8
Special	54.99	19.52	0.005	%	13.8	14.9
mprovements, Sullivan:						
Small Farm	1.04	0.17	0.0005	$	11.99	--
Medium Farm	0.90	0.32	0.006	$	7.87	0.86
Large Farm	1.98	0.68	0.004	$	2.51	2.69
mprovements, Knox:						
Small Farm	1.23	0.19	0.0005	$	9.48	4.49
Medium Farm	0.86	0.29	0.003	$	10.73	3.81
and Hill	41.96	17.32	0.016	%	24.2	27.0
ear of Sale:						
1964	66.43	35.17	0.060	%	30.8	32.4
1965	35.61	35.17	0.016	%	33.5	35.1
1966	144.76	35.45	0.0005	%	31.9	17.6
ownships:						
Fairbanks	-120.54	24.63	0.0005		30	6
Gill	-124.99	29.94	0.0005		18	11
Hadden	- 63.57	25.88	0.015		32	5
Hamilton	- 82.30	28.98	0.005		19	0
Turman	-105.96	28.94	0.0005		20	2
Busseron	-130.90	35.61	0.0005		12	9
Steen	- 48.92	41.45	0.239		7	4
Vigo	- 52.64	49.81	0.292		6	12
Washington	- 43.16	22.96	0.061		30	2
Widner	- 48.12	30.54	0.116		15	1

[a]Standard error of estimate.

difference, *ceteris paribus*, in average price per acre relative to average prices in Curry Township (and in five of the Knox County townships which were not significantly different from Curry).

The difference in the simple average sale price per acre for the upland and floodplain farms was $47.68 ($303.33-$255.65). However, the floodplain sales had more cropland per tract and therefore had higher percentages of cropland in each grade. The upland sales, on the other hand, had much higher building values per acre and more sales in 1966. If the floodplain sales are adjusted for these differences, the estimated sale price would have been $285.50 per acre. The difference between this price and actual price provides an estimate of an average discounting for flood risk of $29.85 per acre (Table 13).

The 74 floodplain observations include 4 tracts subject to flooding by upland streams. When these four observations are removed, the residual difference between the estimated and actual sale price for the floodplain sales was $31.23. This was significantly smaller than zero at about the one per cent level. However, the 70 observations were composed of 38 observations receiving protection from levees and 32 observations outside or without levee protection. When residuals were calculated separately for these groups, the observations with protection had a positive residual of about $4.00. This residual

TABLE 13.--Average Land Prices and Flood Risk Calculations, Lower Wabash Area.

A. Average Price per Acre Analysis

1.	Price per acre of average farm, 260 upland sales	$303.33
2.	Price per acre of average farm, 74 floodplain sales	255.65
3.	Unadjusted difference	-47.68
4.	Estimated price of floodplain sales at upland values[a]	285.50
5.	Difference attributable to flood risk (4-2)	-29.85

B. Per Acre Residual Analysis

Category	Mean Residual[a]	Standard Error	t Value	Significance
70 Floodplain sales (less SCS)	-31.23	12.01	2.60	0.01
38 Levee protected sales	+ 3.83	16.31	< 1	N.S.
32 No levee sales	-72.86	14.91	4.89	0.0005
15 Frontage	-117.84	16.53	7.13	0.0005
17 No frontage	-33.17	19.74	1.68	0.10

[a]See footnotes, Table 10.

was not significantly different from zero which indicates that, with protection, the floodplains are valued comparably with upland farms.[1]

Correspondingly, the residual for the 32 observations without protection was \$-72.86. This group was further broken into two categories--those with stream frontage (15 observations) and those without (17 observations). The corresponding residuals were \$-117.84 which was highly significant (smaller than zero) and \$-33.17 which was significant at the 10 per cent level. The difference in the residuals for the frontage and no-frontage sales is partly a reflection of differing flood risk and partly the effect of averaging some upland values in the residual for the no frontage observations. For the sales with frontage, an average of 75 per cent of all open land on the farm was in the high risk zone, and 19 per cent was located on the floodplain between the limits of the 5 and 100 year floods. Thus, essentially all of the open land (94 per cent) on these farms was subject to risk. In the case of the tracts without frontage, 62 per cent of the open land

[1]The average price per acre for the 38 protected sales was \$321.26. Theoretically, there may still be some flood damage expectations built into these protected floodplain values. However, the major levees of the area (Gill Township and Brevoort) have not been over-topped since they were completed in 1947 and the upstream reservoir construction since then has probably further strengthened local confidence in the systems. The land value analysis cannot prove that no residual flood risk discounting remains but it seems unlikely that the discount would be very large.

was in the high risk zone and 8 per cent was between the limits of the 5 and 100 year floods.

A regression analysis of the residuals for the Lower Wabash area similar to the analysis in the four Upper Wabash counties was attempted but was plagued by intercorrelation between the variable for frontage and the variable for high risk. When the frontage variable was deleted, the remaining independent variables (per cent of land in high risk zone, per cent in low risk zone) had essentially no explanatory power. However, the estimated residual for the 15 no-levee sales with frontage should be comparable to COE estimates (Chapter IX) because the distribution of floodplain land among the flood risk zones for these observations is about the same as for all floodplain land in the reaches.[1]

[1]According to data supplied by the Louisville District Office, 74 per cent of all floodplain land unprotected by levees is in the high risk zone.

CHAPTER VIII

REGRESSION ANALYSIS: WHITE SUBAREA

Although Bartholomew and Jackson Counties are contiguous, the land market in the two counties differs sufficiently so that they could not be analyzed jointly. There were 81 observations (16 floodplains) in Bartholomew and 118 observations (36 floodplains) in Jackson for the period 1964-1966.[1]

Table 14 presents the separate estimating equations for all observations in each county. The variables are defined in the same manner as in previous equations except for "Farm Improvements." This is a discontinuous variable that takes the value of one if the tract contained buildings and takes the value of zero otherwise. This variable was not significant in any previous equations. The negative coefficient in the Jackson County regression indicates

[1]No effort was made to extend the sample to earlier years as was done in the other areas because the initial sample--which included all sales over 10 acres and in all townships--indicated a very large number of observations would be obtained. However, many of these were sales of less than 20 acres, which were unusable, or were located in several (upland) townships that were later omitted because of comparability problems. Also the county records were much poorer than in the other areas and the culling rate was consequently higher.

TABLE 14.--Estimated Regression Coefficients, All Sales, Bartholomew and Jackson Counties White Subarea, 1964-1966.

Item	Bartholomew			Jackson		
	Regression Coefficient	Standard Error	Significance Level	Regression Coefficient	Standard Error	Significance Level
Number of Observations	81			118		
R^2	0.68			0.66		
$\overline{Y}$	346.16	95.37[a]		261.34	103.96[a]	
Constant	160.64	102.43		-215.29	176.72	
Independent Variables:						
Farm Improvements				-58.68	29.92	0.052
Log Acres	-51.56	44.93	0.255			
Proportion Crop AB	284.95	61.21	0.0005	184.50	72.36	0.012
Proportion Crop C	246.26	68.92	0.001	269.95	54.36	0.0005
Proportion Crop DE	124.65	83.17	0.138	205.65	50.86	0.0005
Proportion Pasture	97.83	72.27	0.180	194.21	64.93	0.003
Improvements:						
Small Farm	1.30	0.16	0.0005	2.02	0.21	0.0005
Medium Farm	1.08	0.26	0.0005	1.67	0.42	0.0005
Large Farm				1.22	0.59	0.042
Special				87.89	32.17	0.007
Floodplain Location				41.30	28.03	0.144
Year of Sale				14.86	15.86	0.179
Year of Sale:						
1965	40.96	27.54	0.141			
1966	70.34	28.50	0.016			

[a]Standard errors of estimate.

that tracts with buildings tended to command lower prices per acre than tracts without buildings. Jackson County is also unique in that it was the only county in the study with a positive coefficient for flooplain location. The coefficient for floodplain location in Bartholomew was not significantly different from zero. Both of these results are consistent with the relative average price per acre for upland and floodplain sales in the two counties.

Proportion of total land in pasture came into the estimating equation for Bartholomew but was of very low statistical significance. Pasture was significant, and highly valued, in Jackson County. It may also be noted that the value estimates for cropland by grade in Jackson County are not consistent with the assumed quality relationships implied in the cropland grade categories.

Upland and Floodplain Values, Bartholomew County

Table 15 presents the results of the analysis of upland farm sales in Bartholomew County. The average price per acre for upland ($349) and floodplain ($335) is quite close. However, as the discussion of Table 5, Chapter IV indicated, the composition of the average upland and floodplain farm differed considerably. Sixty-five per cent for the cropland on the floodplain farms was graded A or B compared to 42 per cent for the upland farms. This is also reflected in the relative percentage of cropland grade A or B of all land in farms in Table 15. When the

TABLE 15.--Estimated Upland Regression Coefficients and Mean Values for Upland and Floodplain Observations, Bartholomew County, 1964-1966.

Item	Upland Regression			Unit	Means	
	Coefficient	Standard Error	Significance Level		Upland	Floodplain
Number of Observations	65				65	16
R^2	0.72					
$\overline{Y}$	348.83	90.34[a]		$	348.83	335.29
Constant	76.98	44.30				
Independent Variables:						
Proportion Crop AB	263.94	52.96	0.0005	%	34.2	42.4
Proportion Crop C	224.51	61.37	0.001	%	16.6	12.8
Proportion Crop DE	119.52	73.59	0.110	%	22.2	14.5
Improvements:						
Small Farm	1.39	0.17	0.0005	$	31.95	23.36
Medium Farm	1.17	0.32	0.0005	$	21.97	39.42
Year of Sale:						
1965	42.69	28.09	0.134	%	43.1	18.8
1966	112.03	30.47	0.001	%	26.2	43.8

[a]Standard error of estimate.

average price of the floodplain sales is corrected for these differences the estimated average price is $370.68 per acre (Table 16). The difference between this estimated price and average sale value per acre for the floodplain sales is $-35.39, or in terms of the average residual, $-35.90.[1] This difference provides an estimate of the discounting for flood risk on these sales, but the residual is not significantly different from zero. Only 56 per cent of the open land on the average floodplain farm was located on the floodplain (19 per cent in the high risk zone) so we would expect the discount for land entirely in the floodplain to be greater. However, the number of observations and the statistical reliability is too low to enable further analysis in this county.

From the viewpoint of the land value approach, however, the problem with the analysis is at least partially attributable to the lack of observations (which might have been remedied by extending the data collection to earlier years). The techniques used do indicate that differences in land values attributable to flood risk exist and can be identified. On the other hand, even with more observations the standard errors would probably be relatively large because the floodplains narrow considerably in Bartholomew County and most of the farms overlap the floodplains.

---

[1]The two measures differ because the first is the difference in averages and the latter is the average of the differences and some difference in weighing is involved.

TABLE 16.--Average Land Prices and Flood Risk Calculations, Bartholomew County.

A. Average Price per Acre Analysis

1.	Price per acre of average farm, 65 upland sales	$348.83
2.	Price per acre of average farm, 16 floodplain sales	335.29
3.	Unadjusted difference	-13.54
4.	Estimated price of floodplain sales at upland values[a]	370.68
5.	Difference attributable to flood risk (4-2)	-35.39

B. Per Acre Residual Analysis

Category	Mean Residual[a]	Standard Error	t Value	Significance
16 Floodplain sales	-35.90	33.39	1.07	N.S.

[a]See footnotes, Table 10.

Upland and Floodplain Values, Jackson County

As pointed out previously, upland farms in Jackson ounty sold for an average price per acre of $110 less han floodplain land. The upland observations in the ample exclude sales from some of the poorest farming ownships in the county but there are still very large ifferences in the upland and floodplain farms. This is llustrated by the fact that 60 per cent of all land was n grade A and B cropland on the floodplain, compared to ess than 2 per cent on the upland farms (Table 17).

A regression analysis was performed (Table 17) for he upland sales alone but the results were unsatisfactory or adjusting floodplain sales for comparability. There as not enough A or B grade cropland on the upland farms o derive a reliable estimate of value and the relative alues for the different grades of cropland were inconsis- ent. The explanation for the high value assigned to asture also is not clear. Basically, however, the prob- ems seem to lie in the heterogeneity of both the area nd the land market in the county. Regression runs were lso made on various combination of sales in townships ith similar characteristics both in Jackson alone and in artholomew-Jackson combinations but were not successful.

With the contrast between the upland and floodplain ales and the limitations of available data, there is no eans of estimating the value of the higher grades of

Item	Upland Regression			Unit	Means	
	Coefficient	Standard Error	Significance Level		Upland	Floodplain
Number of Observations	82				82	36
R^2	0.53					
$\overline{Y}$	227.54	89.36[a]		$	227.54	338.32
Constant	-76.41	99.23				
Independent Variables:						
Farm Improvements	-87.86	32.41	0.008	%	62.2	38.9
Log Acres	56.95	50.60	0.264	-	1.81	1.77
Proportion Crop AB	282.10	208.73	0.181	%	1.6	59.4
Proportion Crop C	187.49	55.98	0.001	%	14.5	23.4
Proportion Crop DE	211.39	47.89	0.0005	%	45.2	3.1
Proportion Pasture	238.54	60.05	0.0005	%	13.0	4.8
Improvements:						
Small Farm	2.17	0.32	0.0005	$	16.56	26.01
Medium Farm	2.21	0.42	0.0005	$	18.65	5.08
Large Farm	1.55	0.60	0.012	$	10.28	6.32
Special Sale	70.88	42.56	0.100		5	8

[a]Standard error of estimate.

cropland under no flood risk conditions or of estimating the price this land would command in the absence of flooding.[1] This does not mean that no discounting for flood risk occurs on the floodplain but simply indicates that in the absence of flood risks, floodplain land prices would probably be even higher.[2] The difficulty, however, is that there is no way to estimate the potential increment from available land price data. If the Corps of Engineers damage estimates are accepted the increment should be substantial since 92 per cent of all open land on the average floodplain farm was located in the floodplain.

---

[1]An attempt was made to estimate flood-free land values in Jackson County on the basis of upland values in Bartholomew County but this still understated expected values. A regression analysis of the 36 floodplain sales was also made to determine if there were differences in the floodplain prices relatable to degree of flood risk. This was also unsuccessful, presumably because of correlations among cropland acres and the various measures of flood risk.

[2]Better estimates from the analysis of Bartholomew County sales would have been useful in estimating probable price increments in the absence of flooding.

CHAPTER IX

COMPARISONS OF LAND VALUE AND FLOOD RISK

In this section we will attempt to relate the dif-erentials in land value attributable to flood risk to he estimates of flood damage developed by the Corps of ngineers for the same areas.[1] The COE estimates for ll reaches in this study were based on 1960 or 1963 value ata. As a part of this study, the three Interim Reports ere reviewed and procedures used by the COE in deriving gricultural damage estimates were checked for accuracy nd reasonableness. On the basis of the review of Corps rocedures, certain adjustments to the estimates of verage annual damages for the reaches in the White sub-rea and for the West Fork of the White River in the Lower abash area were made, as explained below in the discus-ion of these areas. Otherwise, the damage estimates

[1]The primary source of data was computer printouts nd other calculations of estimated average annual damages nder natural and modified conditions for each reach in the udy supplied by the Louisville Office. These data were necked against other published data in the Interim eports and House Document 435, op. cit. In COE termin-logy, "natural" conditions include allowances for levees nd other protective structures already in place.

prepared by the Corps appeared reasonable and were accepted as objective measures of expected flood damages.[1]

Capitalization Rates

The capitalization rate selected for illustrative purposes was 5.0 per cent. Rate of return to land data for the State of Indiana are fragmentary and nearly nonexistent at the county or smaller unit level. However, 5.0-6.0 per cent seems a reasonable estimate of prevailing rates of return, whether calculated by the landlord approach or as a residual payment to capital.

The landlord approach uses actual net cash rent received by the landlord from rented land as an estimate of the income stream from all farm real estate.[2] Data on the landlord's return are available only on a state basis. For Indiana the rate of gross rent to value for whole farms ranged between 6.8 and 7.0 per cent between 1964 and 1966. After deducting landlord expenses, this corresponds to a net yield of about 5.0 per cent a year.[3]

---

[1]This statement must be qualified since it was not possible to completely review all aspects of COE techniques because of the specialized nature of the hydrological and statistical skills required for flood damage estimation. Therefore, the evaluation of estimated agricultural damages is based on the premise that the Corps data for flood frequencies and areas inundated by flood stage are correct.

[2]Harry Bruce Huff, "Land Values and Valuation: A Landlord Approach" (unpublished M.S. dissertation, Michigan State University, 1967).

[3]U.S. Department of Agriculture, Farm Real Estate Market Developments, CD-68 (July, 1966), p. 22, and CD-71 (December, 1968), p. 17.

Purdue University maintains a farm account project which is operated primarily as a research and system development vehicle rather than as a service to farmers.[1] Therefore the number of farm cooperators is limited and generally restricted to less than 10 accounts in any one county. Since the cooperators represent a selected group, statistical inference to a population of Indiana farmers is doubtful but these records are the only practical source of data for estimating a capitalization rate from return-on-investment data. A drawback of this data source is that returns are calculated on total farm investment; however, a major part of this capital is for land. There is probably also a tendency for farm cooperators to be better-than-average farmers. If so, the rate of return earned by the average farmer is overstated by account data.

The rate earned on investment varies widely from year-to-year, depending on weather and price fluctuations. The year 1965 was particularly favorable with some types of farms earning returns of up to 15 per cent. By contrast, 1967 was unfavorable and some account farms had negative returns on investment after imputing returns to operator labor and management. Nevertheless, for all farms in the project, the average rate of return was 4.3 per cent for 1958-62. Over the last five years (1963-67)

---

[1]Data from the Purdue project was supplied by George D. Irwin, Department of Agricultural Economics, by personal correspondence.

returns averaged 5.7 per cent if 1967 is included and 6.6 per cent, if 1967 is excluded (Table 18).

Farms in the northern part of the State (which include the Upper Wabash area) yielded lower rates of return than farms in Central or Southern Indiana. Farms that included hog production as an enterprise best represent the farms in the study areas. The only data on general farms (found in Bartholomew and Jackson Counties) indicate returns of 4.2 and 4.4 per cent in 1965 and 1966 respectively.

Upper Wabash Area

The four counties in the Upper Wabash area include parts of reaches W-8 and W-11 and all of W-9 and W-10. Estimates of crop and non-crop agricultural damages for each reach were obtained from computer printouts and supplemental data supplied by the Louisville District office. The damage estimates, for this report, are reported on a per acre basis and represent a weighted average of expected damages over all reaches or proportion of reaches within the Upper Wabash study area.

Averaged over all reaches, agricultural crop damages were estimated to average $4.83 per acre, based on 1960 price and yield data, under natural conditions (no flood protection). With completion of the three reservoirs, the residual crop damages, under the same price assumptions, would be $1.03. If the losses attributable to non-crop

TABLE 18.--Average Rate Earned on Investment, Indiana Farm Account Cooperators, Selected Years.

Category	1958-1962	1963-1966	1963-1967
All Farms	4.3	6.6	5.7
By Area			
North	4.0	4.9	4.1
Central	4.4	6.7	5.7
South	4.6	8.4	7.6
By Type			
Crop-Hog	4.8	7.4	6.3
Hog-Feeder Cattle-Crop	4.9	5.6	4.6
Crop-Feeder Cattle	4.0	4.4	3.5
Crop	5.0	6.2	5.3

Source: George D. Irwin, Department of Agricultural Economics, Purdue University, by personal correspondence.

agricultural damages are assumed distributed uniformly across the floodplain, total agricultural damages would average $9.72 before protection and $2.01 after protection.

If annual earnings are capitalized into land value at 5.0 per cent, the Corps estimates of average annual agricultural damages from flooding indicate that before the reservoir protection was offered, uplands should have commanded a price premium of $194 over comparable floodplain land. With completion of the three reservoirs, the residual discount should be reduced to an average of $40 per acre over the reaches.

The implication of reservoir construction in the Upper Wabash area is that the construction should be accompanied by an increase in floodplain land values. There is first the question of when the increases would be expected to occur. If price adjustments were discrete phenomena that followed completion of construction, the effects would not be fully reflected in the years sampled because only two of the three reservoirs were fully operational by January, 1967. If the increments in land value accompanied construction starts, land prices should have begun to respond in the early 1960's. Finally, if the capitalization of expected benefits occurs in anticipation of protection, the capitalization process may have been underway at the beginning of the sample period since the reservoir investigations had already occurred by 1955.

Conceptually, one would expect at least some capitalization to occur in anticipation of protection but with full capitalization perhaps delayed until sometime after completion of construction because of uncertainty about the effectiveness of the protection offered. The analysis of land price data is at least not inconsistent with this explanation but the data on the trend in floodplain land prices over time is inadequate for determining actual land price response to the reservoir construction.

The mean residual difference for the 39 sales of property subject to flooding from the Wabash River was \$-26.79. This amount was statistically different from zero at the 0.025 probability level but it probably biased downward because most of the sales overlapped the floodplain and therefore contained some upland. The best estimate of the relationship between floodplain location and the size of the residual can be obtained from the equation:

$$\text{FP Residual} = 49.160 - 68.400\ (\text{HG RISK}) - 55.809\ (\text{OTHR FP}) - 3.680\ (\text{YEAR})$$

The mean value of HG RISK (per cent of open land flooded once in 5 years or more frequently) was 0.336. The value for OTHR FP was 0.207 and mean YEAR was equivalent to 1961. Maintaining the same relationship between HG RISK and OTHR FP but assuming that all land in the average tract was located on the floodplain yields values of 0.619 and

0.381 per cent, respectively, and an estimated residual of $-55.77.

The regression based on the analysis of residual differences is very low in explanatory power and therefore relatively small confidence can be placed in the estimated $56 residual. However, the most difficult problem with the analysis is in determining how this residual relates to the Corps' estimate of expected flood damages. The coefficient for year of sale is not significantly different from zero and at best indicates no strong trend in flood-plain land prices after adjusting for the general rise in land prices over the period. However, the negative sign for the coefficient is inconsistent with the expected positive sign under the assumption that changes in land value are associated to some degree with construction or actual, effective reductions in risk.

The mean year of sale for the sample was 1961 which preceded any effective protection in the area but, as previously noted, the determing factor in the capitalization process may be the time at which land owners first begin to anticipate protection rather than the time construction starts or protection becomes effective. If some capitalization was already occurring during the early years of the sample then the estimated discount of $56 is not inconsistent with the capitalized COE estimate of $40 per acre after protection.

In anticipated *ex post* applications of the land value check (*ex post* to authorization) this problem would not exist because there would be only one conventionally-derived estimate and presumably the investigation would sufficiently precede authorization so that anticipatory capitalization would not be a problem. For this anticipated use, the present analysis indicates (a) a land price differential can be discerned, even on relatively narrow floodplains and (b) prices of land on floodplains apparently do reflect differentials relating to flood risk (as indicated by the negative and significant coefficient for HG RISK in the preceding equation and the smaller, non-significant but still negative coefficient for OTHR FP). However, the standard errors associated with these estimates are large and it required a search of 11 years of sales records over four counties to obtain the 39 floodplain observations on which the analysis is based. It is probably impractical to extend the sample further in time because the quality of the records maintained at the county level (especially assessment records) deteriorates rapidly[1] and because of the possibility of large structural changes in the land market over time. Extending the sample in space would also create problems from heterogeneity of the geographical area to be investigated. Finally, the

[1]Generally, only the records for the assessment preceding current assessments are maintained in the counties selected for this study.

analysis of turnover rates reported above (in Chapter VI) indicates the possibility of significantly increasing the number of observations through Grantor-Grantee interviews to determine the status of questionable transactions eliminated from this sample is low. Therefore, the desirability of applying a land value check to an area with the characteristics of the Upper Wabash area may require a careful weighing of the costs of obtaining the data against the expected reliability of the land price data obtained. A possible cost reduction procedure is suggested in the conclusion of this report.

Lower Wabash Area

Knox County, in the Lower Wabash area, is bordered on three sides by the Wabash, the White and the West Fork of the White River. Sullivan County has a long frontage on the Wabash. Together river frontage in the two counties includes all or the major portion of reaches W-3, W-4, WH-1 and WW-1. The Wabash reaches receive protection from the three upstream reservoirs protecting the Upper Wabash area plus the Mansfield reservoir.[1] The White River reaches receive protection from the Cagles Mill and Monroe Reservoirs. Damage estimates based on the existing

---

[1]Since the downstream effect of the Huntington reservoir alone is small, it was assumed that protection from this reservoir was effective in order to simplify the analysis of COE data.

modifications were used. The Wabash reach data are based on 1960 prices; the White reach data on 1963 prices.

The average annual crop damage estimated by the Corps was $3.59 per acre (weighed over all reaches). Non-crop damage was estimated to average $3.97 per acre, for total estimated average annual agricultural flood damages of $7.56 an acre.[1] At 5.0 per cent an average land price differential of $151 per acre is indicated.

The best indication of the land market's evaluation of the flood risk is the 15 sales of tracts of land with river frontage. These sales were almost completely embraced by the floodplain (94 per cent of all open land on the farms was within the limits of the 100 year flood). The mean residual for these sales was $-117.84 per acre, with a standard error of $17. The standard error indicates that with a confidence interval of slightly over 95 per cent we could not say the COE and the land market estimates are significantly different. With a confidence limit of one standard error (roughly a 66 per cent confidence interval) the range of expected damages, in annual equivalents at 5.0 per cent, is $5.06 to $6.72 per acre, compared to the COE estimate of $7.56.

---

[1]Total damage estimates for WH-1 and WW-1 are about twice the size of the estimates for the Wabash reaches. Part of the difference appears attributable to assumptions made by the Corps for expected damages in the high risk flood zones. This assumption is discussed in the following section on the Bartholomew-Jackson area.

On the basis of the closeness of agreement between the land value and COE analysis there is no strong basis to question the accuracy of the Corps' estimate. However, in attempting to reconcile the wide discrepency found in the Jackson County analysis, a procedural error was noted that could lead to an overestimation of expected damages from frequent or out-of-season flooding.[1] The same procedure appears to have led to an overstatement of damage estimates for reaches WH-1 and WW-1 of the White River. If the computed damages for floods with modified frequencies larger than once a year are ignored, the weighed average agricultural damage for the Knox-Sullivan area would be $6.81 instead of $7.56 per acre. This estimate is very close to being within one standard error, at a 5.0 per cent capitalization rate, of the best land market estimate.[2]

The point damage estimates derived from the land market analysis are $5.89 or $7.07 per acre at 5.0 and 6.0 per cent, respectively. These estimates embrace the corrected COE estimate of $6.81. Beyond this point the anayisis cannot specify which estimate, if any, is the "best" estimate. The decision to accept any of the three

---

[1]See page 190.

[2]The agreement is closer if a 6.0 instead of a 5.0 per cent discount rate is used. At 6.0 per cent, the $-117 differential is equivalent to an annual loss of $7.07 ($6.08 to $8.06 at one standard error limits).

would depend partially on how critically the choice affected the benefit-cost ratio. If the choice were critical, a full-scale review of the entire COE estimating procedure would probably be the logical next step.

White Subarea

Floodplain sales in the White subarea were located on reaches EW-3, EW-4, and EW-5 of the East Fork of the White River and along the first reach each of the Driftwood and Flatrock Rivers. Bartholomew and Jackson Counties were sufficiently different to prevent a joint analysis and consequently there were only 16 floodplain sales in the analysis for Bartholomew County. The unadjusted difference in the mean price per acre for the upland and floodplain sales in this county was only $-13.54 ($348.53 versus $335.29). However, the analysis indicated that, at upland values, the floodplain lands would command a price of $370.68, or $35 over the current per acre price. The indicated residual of $-35 was not statistically significant. This residual probably underestimates the expected price of floodplain land with protection, however, because most of the farms overlapped the floodplain and only about half the open land on the average tract was subject to flooding. Therefore, the expected flood-free price of land located entirely on the floodplain might rise to $400-$410 an acre ($335 plus twice $35) but no statistical reliability can be attached to this estimate.

Jackson County presents even more of a problem because the floodplains are apparently highly desirable farming lands and already command a $110 premium over the average Jackson County upland farm and are comparaby priced relative to upland farms in Bartholomew County. Presumably, land prices on the floodplain would be even higher in the absence of flood risk but sale price data are not available for estimating the expected price.

Jackson and Bartholomew Counties are also unique because the COE estimated annual average flood damages are the highest of the three areas. The weighted agricultural crop damages were estimated at $16.89 per acre. In addition, non-crop agricultural damages were estimated to be about $4.27 per acre.

Considering only the estimated crop damages, a per acre return of $16.89 would support an average value per acre of land of $338 at 5.0 per cent. This is equal to the current price of floodplain in Bartholomew and Jackson Counties and implies that in the absence of flood damages land prices would double. In order to support the current price of $338 per acre while simultaneously incurring an average yearly crop loss of $16.89, the floodplains would have to yield a net return of $33.78 per acre.[1] It can be noted that the floodplain lands in

[1]The available soil productivity data for alluvial soils indicate that the productivity of floodplain soils in the White subarea is no greater than the productivity of typical alluvial soils found in the other study areas.

the two counties already support a higher price per acre than the uplands or adjusted floodplain prices in either of the other two areas.

A possible explanation of the current high flood-plain land prices, assuming that flood damages are as high as the COE estimates, is that some farm operator immobility may exist in the area. Since the uplands are relatively unattractive for farming purposes (at least in Jackson County), farmers may be willing to accept lower returns to their capital and labor than in the other areas and thus they have bid up the price of floodplain land despite the presence of risk. But even if landowners accepted only a 2.0 per cent yield on their current land investment, the floodplains would have to be capable of yielding a net return of nearly $24 a year to cover the estimated flood damages and a 2.0 per cent residual return to the operator. This required return still exceeds the indicated returns in the other study areas and indicates that the explanation of the discrepancy apparently must lie in errors in COE data or procedures.

Corps data for reach EW-4 of the East Fork of the White River were selected for review.[1] Based on revised data supplied by the Louisville District Office, the average annual crop damages in this reach was estimated

---

[1]Interim Report No. 3, Vol. III, Appendix C, Plate 4.

at $1.26 million, or $17.63 per acre over the 71,600 acres in the reach. Non-crop agricultural damages were an additional $4.94 per acre. In reviewing the Corps data, errors were found (1) in transferring crop value data and (2) in estimating the expected damages on frequently flooded land. These two error sources apparently explain a major part of the high crop damage estimates.

In this Interim Report the Louisville Office adopted the use of the Water Resource Council's long-run normalized prices in their computations which would tend to yield slightly higher damage estimates than the 1963 prices used in the Lower Wabash area or in previous investigations of EW-4 (for Interim Report No. 2). However, after correctly computing the value-at-risk (current crop yields times price per unit) on the basis of normalized prices, considerably higher values for several crops were used in computation of the stage-damage curves. For example, the value-at-risk for corn should have been $88 per acre. Instead a value of $100 was used in the first stage of crop damage computations and carried throughout the succeeding computations. Correcting for this error, the crop damage estimate would be $1.13 million for the reach or $15.84 per acre.[1]

---

[1]Since this discrepancy was fairly obvious it may have been corrected in further reviews of the Interim Report; however, a "re-computation" of the data as of January, 1967 (supplied by the Louisville Office) apparently still contained the error.

The second procedural error apparently arose because a high proportion of the floodplains in this reach is flooded more frequently than once a year. The COE calculates that crop damages begin at stage 11.0 which occurs, on the average, 4.22 times per year (Table 19). At stages 16.0 and 17.0 flooding would still occur with a natural frequency of 1.47 and 0.865 times per year, respectively, and would inundate 28,800 and 38,400 acres of the total 71,600 acre floodplain. Assuming that the one year flood occurs at approximately the 16.5 foot stage, nearly half (49 per cent) of all annual crop damages for the reach are assumed to occur on land flooded more frequently than once a year.

Damages of this magnitude for land in the one-year flood zone are unreasonable and indicate either that the frequency data are wrong or that most flooding occurs in the winter when damages should be small. Since flooding at these frequencies should be easily verifiable, the latter explanation appears most reasonable.

If the floods that occur one to four times a year are primarily winter or early spring floods, crop damages should be very low or non-existent. This is recognized by the COE in that very low damage factors are assigned to winter floods. However, the COE also makes an adjustment for seasonality that has the effect of averaging over all floods regardless of seasons, yielding a much higher

ABLE 19.--Flood Stages, Acres Inundated, Natural Frequen-
ies, and Estimated Average Annual Crop Damages; Reach
EW-4, Jackson County, Indiana.

Stage[1]	Acres Inundated[1]	Natural Frequency[2]	Crop Damage by Stage[1] (dollars)	Average Annual Damages by Stage[3] (dollars)
10.0	0	4.75	0	
				5,177
11.0	1,600	4.22	19,535	
				13,734
12.0	3,400	3.77	41,507	
				28,945
13.0	5,700	3.25	69,821	
				50,140
14.0	9,200	2.70	112,504	
				94,713
15.0	19,100	2.15	231,905	
				197,428
16.0	28,800	1.47	348,867	
				246,183
17.0	38,400	0.865	464,961	
				233,644
18.0	47,600	0.415	573,459	
				166,898
19.0	56,000	0.146	667,419	
				72,661
20.0	64,000	0.044	757,307	
				24,795
21.0	71,600	0.013	842,342	
				1,134,318

[1]Interim Report No. 3, III, Appendix C, Plate 4 (The "crop damage by stage" column has been corrected for computational errors).

[2]Supplied by COE, Louisville District, January, 1967 data.

[3]Recomputed from COE data.

average damage factor.[1] If this latter damage factor is applied to the floods which occur primarily in winter, average annual damages will be greatly overestimated.

It was not possible to adjust the Corps estimate of average annual crop damages completely for this apparent source of overestimation; however, if we assume that all the floods of stage 16.5 or less are winter or spring floods causing no crop damages then the damages from the remaining floods (over a 16.5 foot stage) would total $7.82 per acre, after correcting for the errors in crop values-at-risk.

Although this estimate ($7.82) is not precisely computed, it appears to be a more reasonable estimate of expected damages. It may still be biased upward because the damage factors for stages over 16.5 feet were also averaged over all seasons. However, data were not available for checking this possibility.[2]

The non-crop agricultural damage estimate of $4.90 per acre also seems quite high but there were no data from

---

[1]For example, the damage factor for corn land flooded between January 1 and March 31 is only 0.7 per cent, regardless of depth or duration. But the average damage for corn flooded to one foot over all floods of record is equivalent to 17 per cent. See: Interim Report No. 3, III, Appendix C, page C-71 and Plate 3.

[2]It is noted that the corrected crop damage estimate is still about twice the estimate for the Lower Wabash area. Because the floodplains in Jackson County are intensively farmed, damages from a seasonal flood might be expected to be somewhat higher (but not necessarily doubled).

the land value survey that could be used to check, or refute, the estimate derived by the Corps.

Because of the possibility of further bias in COE procedures, the estimates of $7.82 and $12.72 (total agricultural damages) probably should be viewed as upper limits. Assuming for the purpose of illustration that the total agricultural damages are in the neighborhood of $10 an acre, a potential price increment of $200 an acre in the absence of flooding is indicated. Whether this is reasonable or not can only be evaluated subjectively. Thus, in areas with characteristics similar to those of Jackson County, the utility of a land value approach rests ultimately on its function of indicating what is <u>not</u> reasonable rather than what is. In such a situation land values alone can not yield objective estimates of expected flood damages.

CHAPTER X

CONCLUSIONS AND RECOMMENDATIONS

The three areas of the Wabash Basin selected for investigation each provided a different set of conditions for testing the applicability of the land value approach. The results of the investigation in each area, as they relate to the second objective, are summarized briefly below. These summaries are followed by a discussion of the results of the study as they pertain to the first objective--the estimation of the relationships between land values and flood risks in the study areas. Finally, an analysis of the cost of this study and some suggestions for reducing the costs of applications of a land value check are presented in Appendix A.

Although the details of the investigation have not been presented in this report, the procedures and data used by the Corps of Engineers in deriving estimates of expected average annual damages over the river reaches included in this study were reviewed for each area and corrections were made in the Corps' estimates for the Lower Wabash and White subarea. Although the review cannot be considered definitive because of uncertainties regarding the hydrological and statistical aspects of the

COE procedures, it is believed that the corrected COE damage estimates are reasonably close to the actual flood risk in each area, and therefore are relevant for comparisons with the estimates derived from the land value model.

In the Upper Wabash area the investigation of land price relationships was complicated by the narrowness of the floodplains in this area which yielded relatively few floodplain sales in any year. In addition most of the farms "overlapped" the floodplains and the uplands. This latter consideration complicates the determination of the flood risk discounting that may occur because only part of the land in a typical sale is subject to flood risk. The investigation in this area did indicate, however, that it is at least feasible to apply the land value approach to a narrow floodplain area and that there is some evidence of regularity in land price response to flood risk.

The indicated price differentials for floodplain land could not be related to a conventionally derived estimate of expected flood damages because of the change in flood risk over time. In this respect the sub-objective of the investigation in this area--to determine if the effects of flood risk reduction would be observed in floodplain land price data--was not achieved, presumably because the processes associated with the risk reduction (project investigations, local hearings, projection authorization, and construction) were spread over the entire study period and there is no theoretical justification for expecting any one of the processes alone to trigger the capitalization process. In the anticipated applications of the land value check by federal agencies this problem should not exist because the land value investigation could sufficiently precede authorization so that anticipatory capitalization would not be a problem.

The analysis of land price differentials in the Lower Wabash area produced close agreement with the COE damage estimates. Although there were only 32 observations without levee protection (and only 15 of these observations had frontage) the relationship between flood risk and land price differentials was strong. Uncertainty about the appropriate capitalization rate becomes a major limitation in relating damage estimates. Allowing for the possible over-estimation of damages by the COE in the White River reaches, the differences in the COE and the land value-derived damage estimates are not statistically significant.

The fact that the levee-protected sales failed to reflect any residual discounting for flood risk was also consistent with a priori expectations. The fact that the major COE-built levees have not been overtopped since their completion in the 1940's would be expected to generate considerable confidence in the efficacy of the

levees in the minds of the floodplain landowners and the results of this analysis do not contradict this expectation.

The analysis for the White subarea yielded unusable results with respect to the objective of estimating flood damages from land value data. In Bartholomew County the problem was basically a lack of observations. This occurred because Bartholomew and Jackson Counties could not be analyzed jointly and too few years of sale data were taken to provide adequate statistical estimates for Bartholomew County alone. This is not a reflection on the analytical techniques used--except to the extent that it indicates problems likely to be encountered from the large standard errors associated with sales data from overlapping farms--since the analysis does indicate that some price adjustment to flood risk has occurred in the county.

Jackson County is the extreme illustration of the comparability problem in this study. The inferences that can be drawn directly from land value data in this situation are limited by the fact that the contrast between the uplands and floodplains (and the associated land markets) is so great that adjustments for comparability were not possible. The value of a land value check in such a region[1] depends primarily on its utility in detecting only the large errors in conventional agency techniques or data.

---

[1]We would consider that mountaineous or heavily forested upland regions generally would be typical of areas where the comparability problem would be severe.

The statistical limitations of the data for the three study areas did not allow a complete investigation of the relationships between land values and flood risk as proposed in the first objective but the findings of this study are at least indicative of underlying regularities in the land market. Considering the results from the three areas jointly, it is noted that the analysis did not yield results in any area that are inconsistent with a priori expectations based on considerations of land rent theory. The results, particularly between the Upper and Lower Wabash areas and between leveed and nonleveed areas, are consistent in relative magnitude and in relation to degree of flood risk. These considerations are indicative of underlying regularities in the land market and, subjectively, are encouraging for regular applications of a land value check. However, it must also be recognized that land value data is not a precise estimating vehicle and that the standard errors associated with a point estimate of flood risk discounting are apt to be large, particularly in areas of overlapping farms and/or areas with relatively low flooding hazards. The standard errors are not necessarily an indication of wide variance in flood risk discounting but stem from variance in all the factors determining land values--many of which cannot be adequately measured or included in an analytical technique.

The "average price per acre" regression model was chosen for the final estimating equations in each study area because this model gave more consistent estimates of the effect of the discontinuous independent variables on sale price. In addition, the final estimating equations were determined by including only those independent variables that reduced mean square error of the regressions. It was believed that these criteria were more relevant than the frequently used criterion of relative size of the coefficient of determination (R^2). For this reason it is difficult to compare the results of the equations used in this study with other land value models. However, Appendix B may be consulted for some indication of the effect of the choice of variables (specifically, cropland grade variables) on the relative precision of the per-acre price estimates.

On the basis of the results in the Wabash River Basin it appears that further applications and tests of the land value approach in other areas to determine if the same relationships prevail are warranted.[1] As suggested in the

---

[1]In selecting areas for additional study, an analysis of land value-flood risk relationships would be facilitated if an area could be found with extensive acreage of flood-plain land subject to only occasional inundation (say, between the 5 and 100 year flood zones) in order to determine the nature of the price relationships in these flood risk zones. In the Wabash Basin these areas occurred naturally to some extent in Knox and Sullivan Counties but are now largely protected by levees. In the remaining areas investigated in this study, the stream valleys are approximately "U-shaped" in cross section and as a result the total acreage inundated by the 100 year flood is not significantly greater than the area inundated by a flood

specific recommendations made below, considerations should be given to the possibilities of reducing the cost of applying a land value check. Ultimately, if a check is adopted as a part of agency procedure, it should be possible to integrate the land value analysis into the project justification studies as they are made. The goal of such integration would be to bring all available data together to obtain a single estimate of expected flood damages and benefits that draws on the strengths of both the land value and conventional techniques.

Based on the results of this analysis the following recommendations are offered:

1. The application of capitalization principles should be made at the appropriate steps of each project justification study. The results should accompany the project report and any wide divergence justified. This recommendation is intended primarily as a procedural check to catch errors of logic or assumptions at each stage of the benefit estimation procedure before they become embodied (and perhaps hidden) in the next stage. This procedure would not require precise land value data but the values used should be consistent with prevailing land prices. It is noted that estimates of total capital values in the floodplain are now routinely reported in project

---

with approximately a 5 year recurrence interval. For this reason the Wabash Basin was not ideal for testing hypotheses about land price relationships on infrequently flooded land.

investigation reports. These estimates serve no apparent purpose and the time devoted to their preparation could as well be spent in deriving per-acre land value estimates.[1]

2. Further studies of the relationship between land values and flood risk should be made in other areas presenting some variety in topographic, farming and flood risk situations. Additional studies are recommended primarily to determine the transferability of relationships found in the Wabash and to accumulate a store of knowledge of land market-flood risk interrelationships. Further experiences would also be helpful in developing procedural guides.

3. If additional investigations are made in other areas emphasis should be placed on reducing the costs of applying a land value check, especially through systematizing land data collection.[2] For example, assuming that each District Office knows approximately which reservoir or levee projects are likely to be considered over the next decade or so, sample counties could be selected and

---

[1]An Engineering Manual prepared in 1957 required that the procedure recommended above be adopted. However, personnel in the Louisville office reported that the manual had never been distributed to them and were not aware of the land value check requirement. See: U.S. Army, Corps of Engineers, "Examinations and Surveys: Relation of Flood Damages and Flood Control Benefits to Market Value of Land" Engineering Manual EM 1120-2-1-1, 13 June 57 (mimeographed).

[2]A note on the costs of this study may be found in Appendix A.

abstractors or the County Recorder in each county could be contracted to supply the district office with farm sales data relevant to each agricultural sale occurring in a specified area on and bordering the floodplain. By virtue of his knowledge of the conditions surrounding each sale, the abstractor could also provide an editing and informational service. The district office could thus maintain a continuing, current file of data useful for general land price index purposes (see 1, above) and at the time for a land value analysis have available a stock of basic data, including Grantor-Grantee names, on which to base additional data collection. The cost and practicality of this, or a similar plan, should be investigated.

4. In selecting areas for investigation some consideration should be given to improving land value estimates in narrow floodplain areas. Although these areas are basically unfavorable for a land value application, topographical considerations usually dictate reservoir location in such areas. Thus, damage reduction estimates in the areas immediately downstream from the reservoir may contribute in large measure to total benefits stemming from the project and should be subject to an independent check. Since the opportunity of increasing the number of observations in such an area is limited, consideration should be given to reducing the standard errors associated with the land value data through supplemental interviews

or professional appraisals. This would require a careful balance of the costs against the likely improvement in precision of estimates and is probably justified only where the damage estimates in the narrow floodplains significantly affect the benefit-cost ratio. However, some investigation of this question appears warranted.

BIBLIOGRAPHY

BIBLIOGRAPHY

American Insurance Association. Studies of Floods and Flood Damage 1952-1955. New York: American Insurance Association, 1956.

ASCE Subcommittee on Floods. "Review of Flood Frequency Methods," Transactions of American Society of Civil Engineers, 118 (1953), pp. 1220-1230.

Barlowe, Raleigh. Land Resource Economics. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1958.

Boyce, Ronald R., ed. Regional Development and the Wabash Basin. Urbana: University of Illinois Press, 1964.

Burton, Ian. Types of Agricultural Occupance of Flood Plains in the United States. Research Paper No. 75, Department of Geography, University of Chicago, 1962.

Commission on Organization of the Executive Branch of the Government, Task Force Report on Water Resources and Power, Vol. III. Washington D.C.: Government Printing Office, 1954.

Huff, Harry Bruce. "Land Values and Valuation: A Landlord Approach." Unpublished M.S. dissertation, Michigan State University, 1967.

Kates, R. W. Hazard and Choice Perception in Flood Plain Management. Research Paper No. 78, Department of Geography, University of Chicago, 1962.

______. Industrial Flood Losses: Damage Estimation in the Lehigh Valley, Research Paper No. 98, Department of Geography, University of Chicago, 1965.

Knetsch, Jack L. "The Influence of Reservoir Projects on Land Values," Journal of Farm Economics, 46 (February, 1964), pp. 231-243.

Maier, Frank H., James L. Hedrick, and W. L. Gibson, Jr. The Sale Value of Flue-cured Tobacco Allotments. Technical Bulletin 148, Virginia Agricultural Experiment Station, Virginia Polytechnic Institute, Blacksburg, Virginia, April, 1960.

Milliman, J. W. "Land Values as Measures of Primary Irrigation Benefits," Journal of Farm Economics, 41 (May, 1959), pp. 234-243.

Murphy, Francis C. Regulating Flood-Plain Development. Research Paper No. 56, Department of Geography, University of Chicago, 1958.

Penn, J. B., Bill Bolton, and Willard F. Woolf. The Farm Land Market in the Mississippi River Delta Cotton Region 1964-1965. D.A.E. Research Report 372, Louisiana State University Agricultural Experiment Station, Louisiana State University, University Station, Louisianna, April, 1968.

[Pine, Wilfred H., et al.] "Report of Advisory Board on Agricultural Flood Damages to Army Corps of Engineers," April 27, 1956. (Mimeographed.)

Renshaw, Edward F. Toward Responsible Government: An Economic Appraisal of Federal Investment in Water Resource Programs. Chicago: Idyia Press, 1957.

Robertson, Lynn, et al. Types of Farming in Indiana. Bulletin 628, Purdue University Agricultural Experiment Station, Purdue University, Lafayette, Indiana, December, 1955.

Sewell, W. R. Derrick. Water Management and Floods in the Fraser River Basin. Research Paper No. 100, Department of Geography, University of Chicago, 1965.

Sheaffer, John R. Flood Proofing: An Element in a Flood Damage Reduction Program. Research Paper No. 65, Department of Geography, University of Chicago, 1960.

Strohbehn, Roger W. Resource Productivity and Income Distribution With Implications for Farm Tenure Adjustments. Bulletin 720, University of Illinois Agricultural Experiment Station, University of Illinois, Urbana, August, 1966.

Tolley, G. S. "Analytical Techniques in Relation to Watershed Development," Journal of Farm Economics, 60 (August, 1968), pp. 653-665.

U.S. Army, Corps of Engineers. "Examinations and Surveys: Relation of Flood Damages and Flood Control Benefits to Market Value of Land." Engineering Manual EM 1120-2-111, 13 June 57. (Mimeographed.)

______. "Survey Investigations and Reports: General Procedures." Engineering Manual EM 1120-2-101 (includes change 16), 12 October 65. (Mimeographed.)

U.S. Army Engineer District, Kansas City, Corps of Engineers. "Appraisal Analysis on Agricultural Levees 345-330-L and 408-L Ray, Clay, and Platte County, Missouri," prepared by the Real Estate Research Corporation, St. Louis, Missouri, July, 1967. (Mimeographed.)

U.S. Army Engineer District, Louisville, Corps of Engineers. "Wabash River Basin Comprehensive Study." Vols. I-III of Interim Reports No. 1 (March, 1963); No. 2 (January, 1964); and No. 3 (March, 1967). (Mimeographed.)

______, and Cooperating Agencies. The Wabash River Basin: Water Resources Planning. (32 page brochure, no date, number, nor publisher given.)

U.S. Bureau of the Census. Census of Agriculture, 1964. Vol. 1, Statistics for the State and Counties, pt. 11, "Indiana, and pt. 12, "Illinois." Washington, D.C.: Government Printing Office, 1967.

U.S. Congress, House. Wabash River, Ohio, Indiana, and Illinois. H. Doc. 100, 73rd Cong., 1st sess., 1932.

______. Wabash River and Tributaries, Indiana and Illinois. H. Doc. 197, 80th Cong., 1st sess., 1964.

______, Committee on Public Works. Headwater Reservoirs, Wabash River, Indiana. [Issued as H. Doc. 435], 84th Cong., 2nd sess., 1956.

______. Lincoln, Clifty Creek, and Patoka Reservoirs, Wabash River Basin, Indiana and Illinois. H. Doc. 202, 89th Cong., 1st sess., 1965.

______, Task Force on Federal Flood Control Policy. A Unified National Program for Managing Flood Losses. H. Doc. 465, 89th Cong., 2nd sess., 1966.

U.S. Congress, Senate. Lafayette and Big Pine Reservoirs, Wabash River Basin, Indiana. S. Doc. 29, 89th Cong., 1st sess., 1965.

______. A Bill to Amend the Federal Flood Insurance Act of October 1956 to Provide for a National Program of Flood Insurance. S. 1985, 90th Cong., 1st sess., 1967.

U.S. Department of Agriculture. Crop Production: 1968 Annual Summary; Acreage, Yield, Production. S.R.S. Crop Reporting Board CR-PR 2-1 (68), December, 1968.

______. Farm Real Estate Market Developments. CD-66, October, 1964.

______. Farm Real Estate Market Developments. CD-67, August, 1965.

______. Farm Real Estate Market Developments. CD-68, July, 1966.

______. Farm Real Estate Market Developments. CD-70, April, 1968.

______. Farm Real Estate Market Developments. CD-71, December, 1968.

______. "Wabash River Basin Comprehensive Basin Study: Appendix H, Agriculture." WAC Review Draft, September, 1968. (Mimeographed.)

Vaughn, Claude M., Jr. Covariance Analysis of Reservoir Development Effects on Property Tax Base. Research Report No. 4, Water Resources Institute, University of Kentucky, Lexington, Kentucky, 1967.

Vermeer, James. Profitability of Participation in the 1962 Feed Grain Program in the Corn Belt. ERS-362, U.S. Department of Agriculture, Washington, D.C.: Government Printing Office, [n.d.].

Waldrop, John E. and Daniel D. Badger. Effects of Upstream Watershed Development on Prices and Values of Farmland in the Upper Washita River Basin. Processed Series P-529, Oklahoma State University Experiment Station, Oklahoma State University, Stillwater, Oklahoma, March, 1966.

White, Gilbert F. Human Adjustment to Floods: A Geographical Approach to the Flood Problem in the United States. Research Paper No. 29, Department of Geography, University of Chicago, 1945.

_______, et al. Changes in Urban Occupance of Flood Plains in the United States. Research Paper No. 57, Department of Geography, University of Chicago, 1958.

_______, ed. Papers on Flood Problems. Research Paper No. 70, Department of Geography, University of Chicago, 1961.

_______. Choice of Adjustment to Floods. Research Paper No. 93, Department of Geography, University of Chicago, 1964.

APPENDICES

APPENDIX A

COST CONSIDERATIONS

Work on this study began during the early summer of 1967 and was essentially completed by January 1, 1969. Although there was considerable overlap of the phases of the study, an approximate breakdown of the professional time expended was one quarter year for general planning and search of data sources, one-half quarter year for specific familiarization with the Wabash Basin, two quarters for various aspects of data collection and processing, and two quarters for data analysis. Report writing efforts were mainly interspersed with data collection and analysis work.

In chronological time requirements, nearly a year was devoted to data collection and processing. Some of the factors involved here were:

1. The selection of three study areas (eight counties) required individual contact, training and supervision of the eight enumerators.
2. The geographical separation of the three study areas from each other and from the East Lansing office created large demands on travel and data transmission time.

3. Because of the inexperience of the enumerators, wide tolerances were established for the field determination of eligible sales and the editing burdens were passed to the East Lansing office. A two-stage data collection plan was also adopted to reduce the work load of the enumerators and this introduced time lags in the field work.
4. Because of the one-time nature of the study and the turnover rates of part-time clerical help, it was not feasible to train an assistant to assume major responsibility of schedule editing and data processing throughout the study.

Many of these time-lags and requirements on professional time could be reduced or eliminated in routine applications of a land value check, assuming that responsibility for the check would be delegated to the district offices. First, the time spent in general orientation, collection of data from COE sources, and selecting sample areas would be eliminated. Better geographical location with respect to study areas would be probable, and possibly only one area would be investigated at a time.[1] Finally, routines for data editing and processing could be set up to reduce professional time requirements.

---

[1]In balance, the time required for data collection in three separate areas outweighed any economies of time realized in the data analysis stage.

The enumerators were hired from the Statistical Reporting Service of the USDA. They were well trained and experienced in general data collection work and required only about a half day of instruction to begin the first stage of data collection (deed searches). The work required for the second stage of data collection was fairly involved since the enumerators had to correlate records in three county offices but even this task was handled capably. The SRS enumerators proved to be a practical medium for primary data collection and, with more training, could have assumed a larger share of the editing functions.

These professional enumerators are one potential medium for systematic land value data collection.[1] If future study sites could be anticipated, the enumerators could be hired for a one or two week period each year to search county data sources for land transaction data for the preceding year. This scheme, by spreading the data collection process over several years, might prove to be more efficient than a one-time survey.

The collection of schedule I data required a total of 793 hours, including travel time, for the eight counties. Three enumerators expended an additional 679 hours in collecting the schedule II's. The hourly rates for the

---

[1]An alternative scheme would be to contract with county land title abstractors or county recorders for the needed data on an annual basis.

enumerators varied from $2.05 to $2.85 an hour, for a straight-time labor bill of $2,120 for the first stage and $1,670 for the second stage.[1] One enumerator lived in the county to which he was assigned, the others were up to 50 miles from their work. The total payment for travel was $1,230.

About 700 hours of clerical time was required for the study, although not all of this time is directly attributable to data processing needs. Some clerical time was spent on mapping farm location but the work mostly involved schedule checking and collating, simple arithmetic checks, and data coding.

Keypunching and verifying required 37 hours and cost $154. Computer charges were slightly under $500 for about one and a half hours of computer time. A standard least squares program was used but about $400 of professional programming time was required for input preparation.

Assuming clerical time at $2.00 an hour, $1,200 total expenditure on computer services, and data collection costs of $5,000; the total nonprofessional expenditures were around $7,600 (excluding secretarial services).[2] The time

---

[1]The actual expenditures were somewhat higher because overtime was authorized for the enumerators living at distance from their assigned courthouses.

[2]Professional travel directly related to the study was about $865, not including an allowance for government vehicle use.

requirements for each area were about equal, indicating a cost of about $2,500 for a study of any one of the areas (or $3,000, allowing for some economies of time). In total, these costs are small relative to the approximately one and a half professional man years expended.

It is difficult to estimate what the professional time requirements would be if a land value check were adopted as a part of COE procedure since a number of time and cost efficiencies that were not available for this study could be utilized. Potential efficiencies are greatest in data collection and processing, especially if potential study areas can be specified sufficiently in advance of the project justification study. Once data collection is initiated, professional time requirements should be low and could be handled on a part-time basis at the district office level or by one full-time professional over several offices.

The marginal cost of adding a land value check to each project justification study would appear to be relatively low although this can be evaluated only by the COE. However, any comparison of relative costs should be based on the costs required to make a thorough application of presently used techniques. In the Louisville office, at least, much of the area-inundated data is based on out-dated floodplain charts, agricultural production and cost data for the floodplains are not collected in any systematic way, and "standard" damage coefficients or factors (e.g.

for crop damage by season, stage and duration) are applied across the Basin without regard to changing geographical or type of farm conditions. If a land value check is to have validity, it must be based on actual conditions on the land to be protected, as this study illustrates. Therefore the need, and expense, of individual studies for each project must be recognized.

APPENDIX B

SENSITIVITY OF REGRESSION ANALYSIS TO LAND USE AND GRADE DATA AVAILABILITY

If a land value model is to have the widest possible applicability it should be based on data that is available at reasonable cost. The primary data for this study were obtained from public sources and were typical of the types of information routinely available at the county level. Thus, the type of analysis used in this report should be easily repeatable in other states and river basins.

The only data used in this study that might not be generally available are the land use and grade data (specifically, cropland grade data) obtained from the County Assessors' Offices. It is not known how many states follow Indiana's practice of appraising property by grade but if this information were not available, and grade data were critical to the analysis, it would probably be necessary to use some form of on-site appraisal techniques to obtain equivalent information. To test the importance of the cropland grade information, regression analyses for the Upper and Lower Wabash areas were made under the assumption that only gross categories of land use (cropland, pasture, woodland) were available. At least this

information should normally be available in the Assessor's Office but, if not, it could be obtained by planimetering aerial photographs.

When only the variable for percentage of cropland was included in the regression equations for the Upper and Lower Wabash (percentage of pasture was non-significant in both areas) the R^2 were reduced and the standard errors were increased. In the Upper Wabash the R^2 for the upland observations analysis was reduced from 0.66 to 0.56 and the standard error of the regression raised from 92 dollars to 103 dollars. In the Lower Wabash the corresponding R^2, for the upland analysis were 0.58 and 0.54 and the standard errors were 101 and 105 dollars, respectively. Thus, the effectiveness of the analyses in estimating per acre farm sale value was reduced (more so in the Upper Wabash than in the Lower Wabash area).

The effect of the lower precision in the estimating equations was to reduce the effectiveness of the procedure used to adjust floodplain sales for comparability and thus to increase the residual differences attributable to flood risk[1] (Tables B-1 and B-2). The residual differences by categories of flood risk (part B of each table) were also larger for most categories and the standard errors were increased.

---

[1]This is to be expected because if no other information were available only the differences in average price per acre for floodplain and upland sales ($104 in the Upper Wabash and $47 in the Lower Wabash) would be available as an estimate of the flood risk discounting.

TABLE B-1.--Estimated Flood Risk and Land Value Relationships, With and Without Cropland Grade Data, Upper Wabash Area.

Item	Crop Grade	No Crop Grade
A. Average Price per Acre Analysis		
Estimated price of floodplain sales at upland values	$231.13	$239.60
Average price, 60 floodplain sales	221.03	221.03
Difference attributable to flood risk	-10.10	-18.57
B. Per Acre Residual Analysis[1]		
54 Floodplain sales after 1954	-16.04 (10.23)	-22.01 (10.81)
15 SCS streams	+11.92 (20.63)	+ 6.97 (17.50)
39 Wabash River observations	-26.79 (11.44)	-33.16 (13.06)

[1]Figures in parentheses are standard errors.

TABLE B-2.--Estimated Flood Risk and Land Value Relationships, With and Without Cropland Data, Lower Wabash Area.

Item	Crop Grade	No Crop Grade
A. Average Price per Acre Analysis		
Estimated price of floodplain sales at upland values	$285.50	$296.47
Average price, 74 floodplain sales	255.65	255.65
Difference attributable to flood risk	-29.85	-40.82
B. Per Acre Residual Analysis[1]		
70 Floodplain sales (less SCS)	-31.23 (12.01)	-39.88 (13.48)
38 Levee protected sales	+ 3.83 (16.31)	+ 7.66 (16.15)
32 No levee sales	-72.86 (14.91)	-96.33 (18.06)
15 Frontage	-117.84 (16.53)	-151.59 (23.68)
17 No frontage	-33.17 (19.74)	-47.57 (20.99)

[1]Figures in parentheses are standard errors.

It appears that the cropland grade data made an important contribution to the analysis of farm sale value in this study. The larger question is whether the contribution was significant enough to warrant the cost of collecting the data if it had not been available. There is no simple answer to this question since the costs that would be incurred or the importance of the data in an analysis of another area are not known. However, this does illustrate the desirability of integrating a land value analysis into project justification studies at the time they are made. The evaluation could then be made in the context of (a) how the additional data would contribute to the accuracy of the land value estimates and (b) how greater accuracy in the land value estimate would contribute to the accuracy of the final estimate of flood damages or expected flood control benefits.

MICHIGAN STATE UNIV. LIBRARIES
31293010616815