AGRICULTURAL FLOOD CONTROL BENEFITS AND LAND VALUES

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A Report by the
U. S. Army Engineer Institute for Water Resources
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FOREWORD

A. Purpose.

This monograph presents the experience which the Institute for Water Resources has accumulated through two detailed and carefully controlled applications of a land value approach to estimate the benefits accruing to the agricultural sector from flood control projects. In preparing this report the contents have been deliberately tailored to be of maximum utility to Corps of Engineers field personnel, to aid them in future applications of the land value approach to estimation of flood control benefits. To fulfill this goal, treatment of both the theoretical basis and practical applications including their limitations has been attempted.

The report links several distinct pieces of work. The methodological framework developed by the Economic Research Service and the Wabash applications of this framework were the responsibility of Robert F. Boxley. (The results of these efforts were published as IWR Report 69-4, The Relationship Between Land Values and Flood Risk in the Wabash River Basin.) The framework and its application to the Wabash are the subject of Chapters II and III of this monograph and rely heavily on Boxley's original treatment. The second application, to an area of the Missouri River, was done by the author but relied on the Real Estate, Planning, and Hydrologic Branches of the Kansas City District for its successful completion.

B. Findings.

The results of these two applications were reinforcing and suggest the role and usefulness of the land value approach may be more general than heretofore realized. Multiple regression methods offer a viable approach for estimating the value which the land market assigns to flood risks and to their reduction. The issue then turns to whether the land market accurately assesses the effect of flood risks on income. If we define land values as the quotient of annual returns to land (rent) divided by the appropriate rate of interest, $V = \frac{R}{i}$, differential changes in R associated with flooding risk will be reflected in market value V. If there is a significant difference between frequency damage and land value methods of estimating the impacts of flood risks, the differences would come from two sources: (1) difference in the assessment of the changes in annual rent (R) -- the returns to land -- which is directly estimated by the frequency-damage method and indirectly estimated by the land value method, or (2) differences in the imputation of the "proper" interest rate (i) -- a significant source of debate since the planning rate of 3-5% is normally used in Corps of Engineers studies whereas the market rate appropriate to the Missouri analysis was approximately 9%.

With all candor, it appears to the researcher and to the reviewers of the Missouri analysis that both sources accounted for the significant differences between flood losses reported by the frequency damage method and the flood losses imputed by land values. We have referred to the difference in interest rates applied in each analysis, a cause for significant differences. On the other hand, review of the frequency damage analysis indicates that several sensitive assumptions embodied therein are, at best, tenuous. These include the assumptions of elevation of the zero damage point -- related to the projection of rating curves -- the effective protection (in this case solely related to elevation) of non-Federal levees in place and to a lesser extent, the composite acre assumption of land use.

C. Assessment.

The conclusions of this research are clear -- land values are affected significantly by flood risks, the multiple regression analysis does offer a viable way to estimate the impacts of flooding on land values. It is also clear, that for several reasons land values tend to understate the effects of flooding. The perception of hydrologic risks by participants in the land market is often unbalanced and generally biased towards the effect of floods of the type which occur frequently with concurrent underassessment of the damages from infrequent major floods. The interest rate applicable to the land value includes allowances for risk and uncertainty associated with financial strength and managerial skill of participants and the range of uncertain events from other weather, insect and disease phenomenon.

One of the important factors in selecting a methodology is that of study costs. We should point out that the land value method is not inexpensive. Study costs would run at least as much as that required by frequency-damage studies.

The shortcomings of the land value method need to be balanced against the shortcomings of the frequency damage method for estimating agricultural crop damage. On balance, the land value method appears to be appropriate for use as a check on other methods when a significant level of agricultural crop benefits are anticipated from a project or program.

D. Status.

This research represents the findings, conclusions and independent judgment of the researcher. The conclusions are not to be construed to necessarily represent the views of the Corps of Engineers. Policy and procedural changes which may result from this research will be implemented by directives and guidelines by the Chief of Engineers through command channels.

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Chapter I

Summary and Recommendations

A. Introduction

The idea of using land values and the differences in the value of lands comparable except in their flood risk to estimate benefits to agricultural land from flood control projects is not new to the Corps of Engineers as is evidenced in the statements concerning its use in Corps directives.[1/] This report is not designed primarily to reiterate the theoretical justifications of this approach, but rather to present in some detail the results of applying this approach in a statistically rigorous way to two study areas. The bulk of this monograph is not, however, directed to analyzing the utility of the approach *per se*, although the strengths and limitations of the approach are reviewed. The main concern is with a rather detailed exposition of the statistical analyses of the two general study areas. In this respect it is written primarily for use at the field level of the Corps to serve as guide to the use of this approach in terms of the types of data which are required, the form of the data for use in the regression model, and the interpretation of the estimated regression models.

Prior to the analyses reported in this monograph, the land value approach was applied generally by simply comparing the average value per acre of farms in a study area subject to various degrees of flood hazard,

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1/ EM 1120-2-101, "Survey Investigations and Reports: General Procedures."

ranging from very high to none. The simple difference of the means was to give an indication of the capitalized reduction in income in the flood-subject area from this hazard. The results of such analysis were frequently and justifiably held suspect due to the lack of strict comparability of the farms used in the analysis. In an effort to alleviate this problem the Economic Research Service (ERS) was retained under contract with the Corps to determine a more appropriate analytical method of employing land values to reflect flood control benefits. In response to the charges of the contract ERS employed a multiple regression analysis to three sub areas in the Wabash and White River basins. The strongest argument for using the regression technique (described in detail in Chapter II) is that it permits the comparison of farms which do not have the same non-flood-hazard characteristics through the use of a large number of farms and the weighting of each of the non-flood factors to reflect their importance in the explanation of land values. One of the most useful features of this analysis is that it permits the significance of each factor, including flood risk, to be tested statistically as to its importance and reliability. Using the methodology developed by ERS as a base, a second application was performed by the Institute for Water Resources to a levee district on the Missouri River.

B. Summary

<u>The Wabash Application</u>.

The major characteristics of the Wabash study done by the Economic Research Service are the use of sales data to reflect the market value of land and the application of the methodology to three topographically different areas. The sales data were purged insofar as possible for those transactions which may have involved statistically significant extra-market considerations. The three study areas, the Upper Wabash, Lower Wabash, and White River area, represent large variations in the width of the floodplains and homogeneity of topography on and off of the floodplain.

The application of the regression analysis to the Upper and Lower Wabash areas indicated that after controlling for differences in productivity, lay of the land, location, and date of the sale a statistically significant differential was found in the value of land per acre associated with flood risk between farms located on the floodplain and those in the upland area adjacent to the floodplain. Two aspects are of particular interest: the floodplains in the Upper Wabash area were fairly narrow so that most of the farms were partially on and partially off of the floodplain; the Lower Wabash possesses a somewhat broader floodplain but there a number of private levees protecting the floodplain farms. In both cases, it was still possible to establish a meaningful relation between flood hazard and land values.

The White River study area has both a very narrow floodplain and extremely uneven topography near the river. It was also difficult to assemble a large enough sample of sales. The result of this combination of factors was that it was not possible to establish a differential in land values associated with flood risk. It seems probable that some of the problems which prevented reaching a more favorable statistical result could be overcome through use of a better data base; on the other hand, one must question the applicability of this approach to areas with these physical characteristics.

The Missouri Application

In the selection of the study area in the St. Joseph's reach of the Missouri River two considerations were foremost. First that the floodplain be wide enough and the topography of the general study area be homogeneous enough to permit successful application of the land value approach. The second consideration was that the floodplain area subject to flooding be close to another floodplain area which had been protected by a Federal levee system for over fifteen years, i.e., a Federally protected area in which all adjustments to the protection had taken place. This means that three subareas were present: an unprotected floodplain area, a protected floodplain area, and an adjacent upland area.[2/] It was then possible to compare two sets of land values, protected vs. unprotected and uplands vs. unprotected, and thus to test the hypothesis that the uplands vs. unprotected comparison is an inappropriate way to measure the difference in land values associated with flood risk.

A major departure from the Wabash application in the Missouri study was the use of "gross estimates" prepared by appraisers to obtain the value

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2/ The unprotected floodplain is actually largely protected by a private levee system sufficient to protect against a flood with a five year recurrance interval. The protected floodplain is protected by a federal levee constructed in 1951.

of the land. The primary reason for using gross estimates was to avoid a statistical problem which had arisen in the Wabash. Because not enough sales occurred in a given year in a study area in the Wabash, it was necessary to use sales over a number of years. This time series data involves factors such as inflationary trends, variation in perceived and real flood risk, and changes in the demand for land which all tend to distort the basic relationship between flood risk and the value of land. The same potential problem reared its head in the Missouri area, and it was decided to overcome it by getting all of the land values at a single point in time--March 1970--through use of gross estimates.

The results of the Missouri application reinforce those of the Wabash application. A statistically significant differential was established between the difference in land values and flood risk. In addition, the differential indicated by the two sets of comparisons were practically identical. Finally, the reasonableness of the estimated differential was substantiated by a second field investigation aimed explicitly at determining the flood damage experience and its effect on net income over the last two decades.

C. Recommendation

Application of the land value approach using the multiple regression method to the Wabash and Missouri River study areas has indicated that the approach is viable and that it yields realistic estimates of the value that the land market assigns to flood protection in terms of the agricultural productivity of the land. At the same time the flood hydrograph-damage frequency approach offers a tested and generally defensible system for making the same estimates and has the advantage of consistency with procedures used in estimating non-agricultural damages and benefits.

Because of the many variables entering into both methods, it is not unreasonable to anticipate some differences in results given by the two approaches. Given more experience with the land value method it should be possible for operational purposes to define what might be considered acceptable levels or degrees of difference.

It is recommended, therefore, that the land value approach continue to be employed as a check on the benefit estimates made using the flood hydrograph approach in accordance with existing directives but that the land value estimates be made using a multiple linear regression method in the manner described herein.

The Institute for Water Resources stands ready to advise field offices in the implementation of these recommendations to the extent our resources permit.

Chapter II

A Theoretical and Applied Framework for Estimating Flood Control Benefits from Land Values

This chapter is designed to present the background materials necessary for understanding the descriptions of the empirical applications which follow it. The first Part of the chapter begins by setting out the theory of economic rent in simple form. In this formulation of the theory, land is the only fixed factor in a perfectly competitive economy. The following sections relax the initial assumptions as well as investigating the importance of various factors which may tend to hamper the application of this theoretical framework to real world situations. The second Part of this chapter first reviews the previous attempts at implementing the basic theory and then presents the general approach adopted in these studies.

I. The Theoretical Framework

A. Land Rent Theory

Of the traditional classes of factors of production (land, labor and capital) land is unique because it is fixed in supply and lacks mobility. In contrast the other factors, generally, are reproducible and possess mobility. They can transfer to alternative uses and, hence, can command their market value. Land, however, can command only what is left; that is, the residual value of its product after deducting the payments to all other factors. This residual, or rent, determines the real value of land and, when capitalized at interest rates considered to be appropriate to the investment conditions involved, determines the market value of land.

The nature of land rent can be illustrated by considering first a parcel of land free of flooding hazards.[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 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 nonland inputs that we conveniently denote as "capital-labor." We visualize these nonland inputs as being highly divisible so that units of capital-labor can be combined with a 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-labor 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-labor as in Figure 1. Over the relevant range of production decisions the VMP curve is downward sloping to the right. The VMP curve simply indicates that as

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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, Gilbert F. White (ed.). University of Chicago, Department of Geography Research Paper No. 70, 1961.

more of the variable inputs are used with the fixed unit of land the value of total output increases but at a decreasing rate. The total value of the product forthcoming at any level of capital-labor 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-labor.[2/]

The unit cost of the nonland resources ("capital-labor") is assumed to be (P_O). Under conditions of pure competition in factor markets (which implies perfect mobility of all nonland resources), the price of capital-labor is determined by its opportunity cost. Capital-labor 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-labor are available at a constant price we derive a straight-line "cost of capital-labor" function $P_OP'_O$).

Given the VMP and cost of capital-labor functions, returns to the fixed unit of land will be maximized if (X_O) units of capital are combined with each unit of land. The payment to capital-labor is its price (P_O) times the (X_O) units, or the area (J Q X_O 0). The residual (AQJ) is a surplus, or

2/ 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.

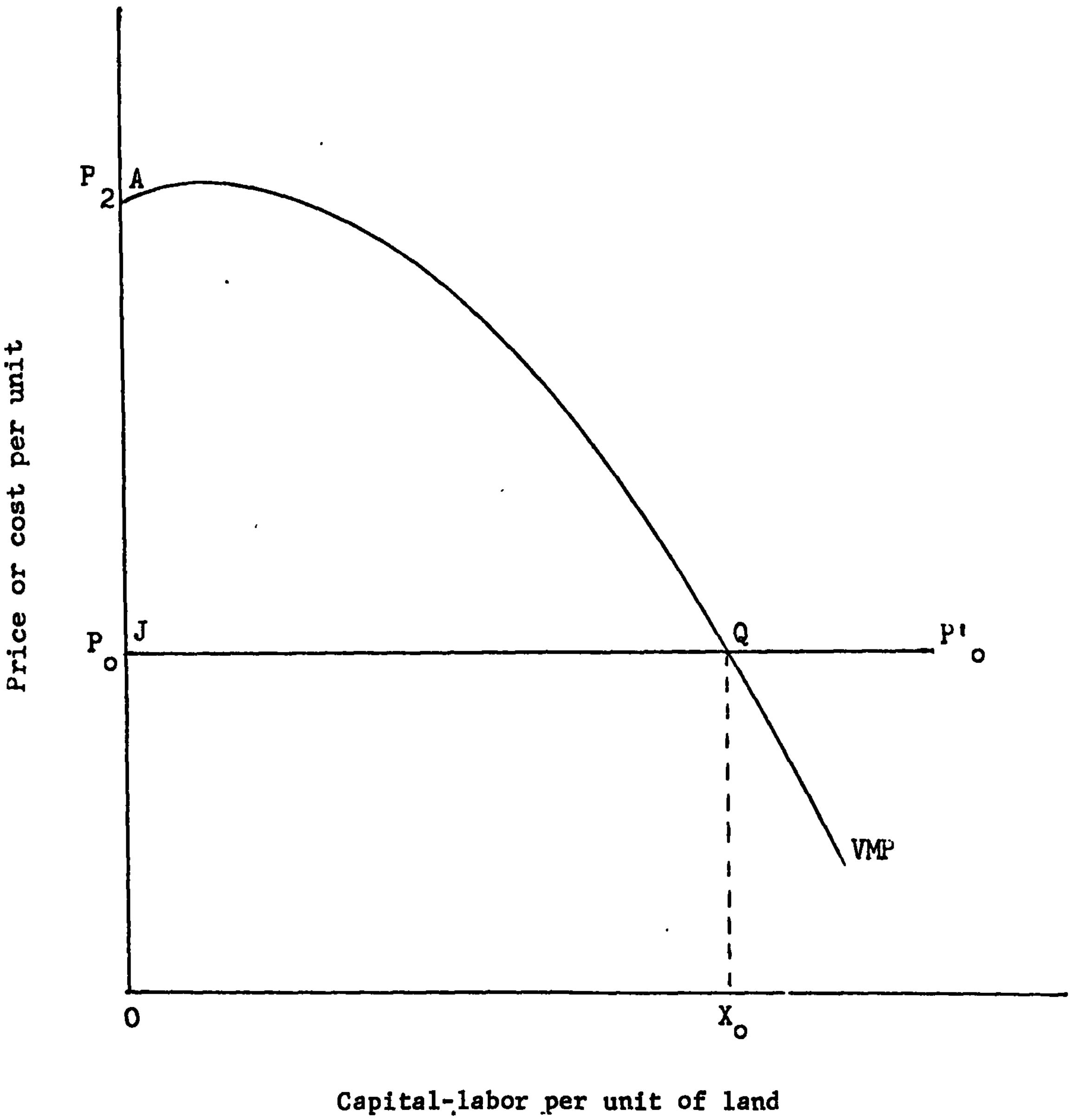

Figure 1-- Capital-labor costs and rent to flood-free land

rent, that accrues to land as the scarce resource.[3/] As we will illustrate below, the market value of this unit of land will be determined by the annual rent it can earn, given an appropriate capitalization rate.

We now drop the assumption of flood-free location. Instead, assume that the unit of land is located on a flood plain 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 and best use (say, truck-farming). The nonland resources might have been combined in other ways to produce other products, such as a cash-crop represented by (VMP_2), but this would represent less-than-optimum use of the land under the postulated flood-free conditions.[4/]

The (VMP_1) and (VMP_2) functions may still be viewed as the VMP curves for truck and cash-crops, respectively, on the flood plain tract in a year when floods do not occur. However, the entrepreneur must now take potential flood losses into account and discount the VMP schedule accordingly.

3/ 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-labor is less than (P_2). For capital-labor costs greater than (P_2) the land will be land in its natural state (and have no market value for productive purposes), until events either lower the cost of capital-labor 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.

4/ For simplicity, we draw the VMP curves as nonintersecting and assume a common cost of capital-labor function regardless of the product produced.

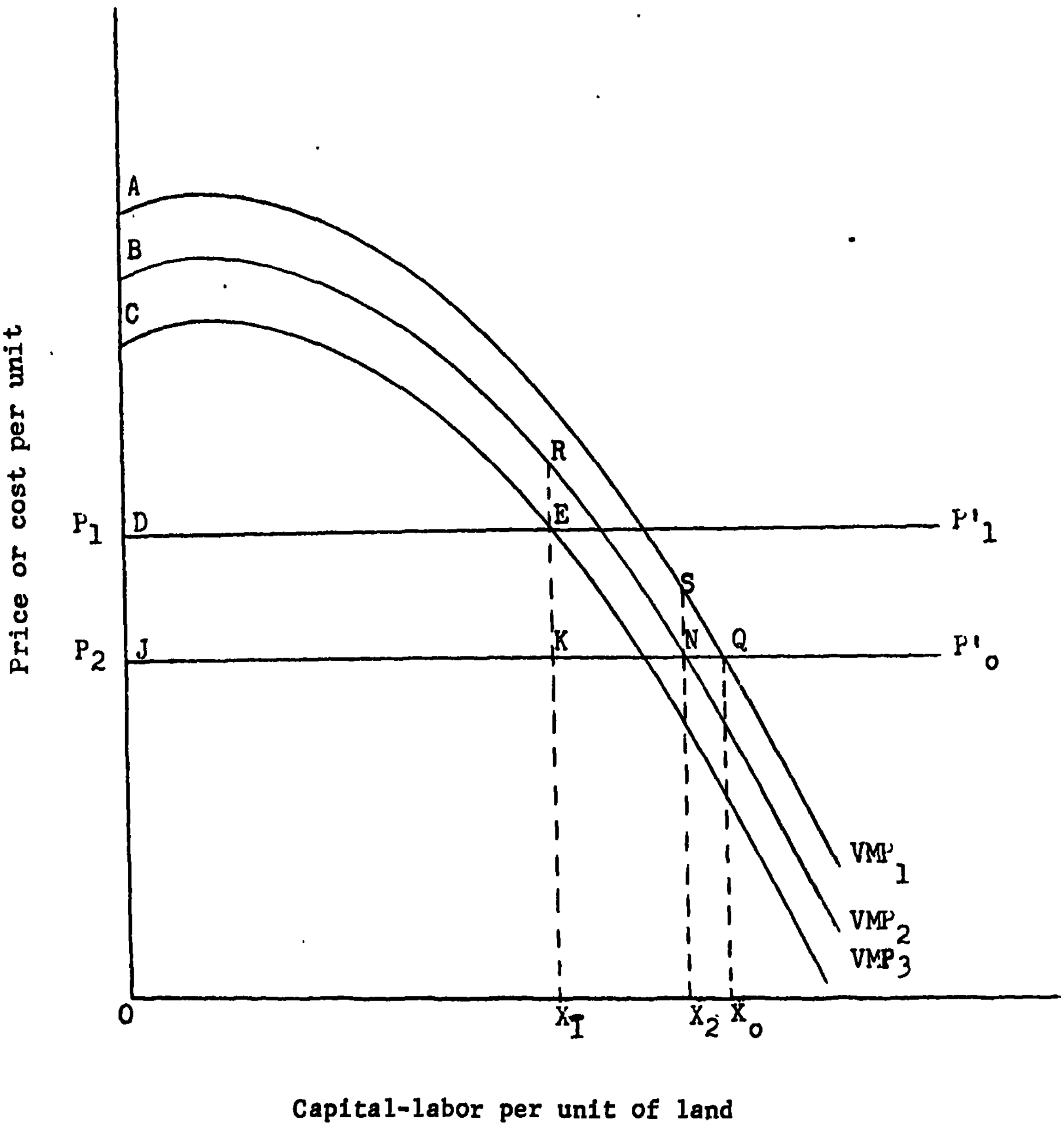

Figure 2.-- Capital-labor costs and rent to flood plain land, beföre and after flood protection

Truck farming may be a land use that is especially vulnerable to flood damages and therefore must be heavily discounted, perhaps to the point that production on the flood plain is uneconomic. On the other hand, while cash-crop farming is not as profitable on a flood-free location, it may also be a use that is better able to withstand inundation and therefore be the preferred flood plain 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 expected value of marginal product curve for a cash-crop enterprise in the flood plain. 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 may be additional capital-labor costs incurred in replanting, replacing leached nutrients, etc., following a flood.[5/] Suppose an entrepreneur can expect to incur, on the average, additional costs equivalent to (P_1-P_0) on each unit of capital-labor employed. Then, in terms of expected costs, the "cost of capital-labor" function is ($P_1P'_1$) and (X_1) units of capital-labor will be used. The expected

5/ Although this exposition is in terms of crop damages, other physical damages (debris deposition, erosion) can be incorporated into the diagram. To include highly localized damages (building, bank cutting), a "farm" could be the fixed unit, or the damages from these sources could be allocated on a per-acre basis over the acres flooded on each farm.

payment to the nonland resources is ($DEX_1 0$) and the residual (CED) is 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-labor on the flood plain land, losses are expected to be incurred from (a) additional capital-labor 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 ($P_oP'_o$). Now, however, (X_1) is not the optimum capital-labor input. Capital-labor 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 inputs will be increased to X_0, yielding a surplus (SNG), 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.[6/]

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 (ADJ) and (CED). However, the general effect of flood control investment will be to lower the expected cost of capital-labor curve and shift the expected value of marginal product curve to the right. The result will be an expansion in the size of the rent triangle and the difference in area between the "old" and "new" triangle will measure the expected benefits.

B. Relationship of Land Rent Theory to Conventional Agency Procedures

The Corps of Engineers classifies the damages from flooding as:[7/]

(1) Tangible flood damages
a. Physical damages, including the cost of cleanup, 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

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6/ 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.

7/ 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.

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 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 or increased utilization benefits.

The Engineering Manual specifies 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 capitalization method. The first two methods are suggested for evaluation of physical damages and emergency costs; the income capitalization method for evaluation of agricultural crop losses. The Manual also specifies 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 is 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 "noncrop" categories. Noncrop 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, 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 best be estimated by the income evaluation method which automatically considers business and financial losses.[8/] Although the application of the income evaluation method can become quite complicated, the principle of the method is simple and basically involves determining the expected increase in net income that would stem from flood alleviation. The income evaluation method essentially counts (a) the direct income loss to the farmer--which is the value of his productive investments in the crop (including expected returns to his labor and land) at the time of flooding, less any harvesting costs foregone or losses recouped through replanting or salvaging a part of the crop, and (b) income foregone where the flood hazard precludes higher valued agricultural use of the land.

8/ 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 noncrop or nonagricultural damages and therefore require special estimating techniques.

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 noncrop 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. These latter benefits are termed "enhancement" or "increased utilization" benefits.[9/]

It should be obvious, however, that the benefits we have labeled as "direct damage reduction," "efficiency," and "higher utilization" benefits in the theoretical model are the same as the Corps' measure of direct damage and enhancement benefits. Thus, if only an isolated tract of raw land were being traded and the only expected damage was to growing crops, the land value approach should give the same estimate of agricultural crop damages as the conventional approach. However, it is necessary to consider that most agricultural land is transferred as "farms" which include fixed capital investments in fences, drainage ditches, and (usually) a set of farm buildings used with the land or as a farm residence. In addition, the land itself may be subject

9/ Since this study is of agricultural land values we will consider that the only enhancement that occurs is from shifts to higher-valued agricultural uses. It is also possible that flood protection may make it feasible to shift the land out of agriculture to residential, commercial or industrial uses. This is especially likely to occur on flood plains in or near urban areas or in extremely mountainous areas where the flood plains are the only feasible areas for development. The land value principles would apply equally here but are not considered in this report.

to physical damages from bank cutting, scouring, silting or debris deposition. We would expect these noncrop damages to also be reflected in the total price of a tract of land and hence in the per acre value of the land and associated capital investments. Thus the appropriate measure of losses that should be reflected in land values will generally be the total agricultural damages (crop plus noncrop) as conventionally computed.[10/]

In order to relate the rent changes to land values and to conventional damage estimates it may be helpful to supply some hypothetical numbers to the diagram in Figure 2. Suppose the land is capable of producing a 100-bushel corn crop in flood free years with a value of $1.00 per bushel at the farm (i.e., after deducting transportation and marketing costs). The gross return to the land would be $100. If the payment to all other factors of production is $80, a residual of $20 per acre would accrue to the land. If an entrepreneur expected a return of 5.0 percent on his investment, he would be willing to pay $400 for the land.[11/] Suppose,

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10/ Theoretically, there are probably grounds for questioning how potential damages to farm residences and contents should be classified or for questioning whether land buyers are this precise in evaluating these potential damages. As a practical matter, however, this is probably an insignificant issue. In the Wabash Basin, for example, there were very few buildings actually located on the flood plain and "property" damage was a very minor component of COE noncrop damages estimates. The major noncrop damage sources were from bank cutting, sanding and ditch damages. See, for example: U.S. Army Engineer District, Louisville, Corps of Engineers, "Wabash River Basin Comprehensive Study," Interim Report No. 3, March 1967.

11/ Assuming the use of the simple capitalization formula $V=R/i$, where $R=$ the annual rent to land and $i=$ the capitalization rate. Landowners may use more complicated formulas, especially if they impose a restraint in terms of a planning horizon of 20 or 30 years, but the difference in however, that the land is regularly inundated by early spring floods which delay planting so that the expected yield is only 95 bushels and that additional costs of $3 an acre are encountered because part of the seedbed preparation must be reworked or debris must be removed from the land. Then the net return to the land would be reduced to $12 an acre ($95-$83) for an indicated market value of $240 an acre.

Finally, it may be likely that, with flood protection, the land would be shifted to, say, melon production with a value of $105 per acre and with production costs of $82 per acre. Then the expected return would be $23 per acre for an indicated land value of $460 per acre.

Using conventional procedures, the expected benefits from flood protection would be estimated by summing the components of the rent change. The direct damage reduction would be $5 from prevention of crop damages (5 bushels of corn) and $3 from savings in production costs. In addition, assuming an immediate shift to melon production, net returns would be further increased by $3 a year, which would be classified as an enhancement benefit. Thus the total expected benefits would be $11 annually.

This same conclusion could have been reached by examining the differences between the price of the flooding land ($240 and the price of comparable land capable of being used for melon production ($460)--assuming that such land could be found nearby, either behind a levee or at an

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capital values would be small (at 5 percent) and this formula is adequate for relative comparisons. For alternative capitalization formulas see: Raleigh Barlowe, Land Resource Economics, (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1963), pp. 186-190.

elevation above the inundation limits. The difference in price of $220 is equivalent, at 5 percent, to an annual return to land of $11 per acre.

In this hypothetical example, the estimated benefits are exactly the same, regardless of how they are derived--as they should be if all the relationships are as specified and with the assumption of full knowledge by both the landowners and the benefit estimator. In practice we would not necessarily expect the landowners or benefit estimators to have full knowledge of the flood risk and potential flood control benefits. However, the principles of rent capitalization provide a potentially powerful analytical aid. Given, for example, a conventionally-derived estimate of total annual benefits of $11 per acre we know that this estimate should be supported by price difference of around $220 an acre (at 5 percent) between the flood plain and comparable flood-free land; i.e., if flood plain land is selling for $240 an acre, comparable uplands should be priced around $460. If this estimate cannot be supported by prevailing price differentials we should at least be alerted to the possibilities of errors in the estimating process.

C. Factors Distorting the Basic Relationship

While the basic theory has been outlined with disarming simplicity, there are a number of factors which in reality serve to distort the basic relationship between the value assigned to land or farms, as the productive unit, and the risk of flood damage. Put differently, the purpose of this section is to enunciate a number of factors which affect the magnitude of the perceived or measured differential between flood plain and flood free land similar in other ways. In terms of Figure 2, the issue is what factors might cause the measured distance between VMP_2 and VMP_3 to differ from the actual, and thus to distort the correspondence between the measured differential and the benefits which actually would accrue to flood protection projects.

The Land Market's Evaluation of Flooding Hazards

The diagrams in Figures 1 and 2 are simplified views of reality based on assumptions of competitive equilibrium, perfect knowledge and mobile resources. In practice, knowledge is not perfect and economic conditions are not static so that equilibrium is not universally achieved. In a well-settled, reasonably homogenous area we can expect land prices to be closely tied to the land's productivity because of the accumulated knowledge by the land market participants. However, most objections to a land-value model are based on the belief that land buyers cannot be assumed to have equal knowledge of the expected returns on flood plain lands because they do not have full knowledge of the flooding hazards. The basic issue here is 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.

Investigation of this issue is one of the purposes of this research. However, before proceeding to discuss what evidence has been uncovered within the course of the two applications of the land value approach, a brief review of the most relevant literature is made in order to provide the necessary background.

The search of literature failed to reveal any studies that have directly examined the land market's effectiveness or that have specifically evaluated the attitudes of agricultural operators of flood plain land. The Department of Geography of the University of Chicago has sponsored a number of papers primarily investigating urban and industrial uses of flood plains.[12/] Although the behaviorial and informational factors involved in human occupancy should apply to some extent to both urban and rural areas we would generally expect agricultural operators of flood plain land to be somewhat better informed than their urban counterparts because of their closer involvement in flood plain activities. Nevertheless, some of the more relevant of the Chicago studies are briefly reviewed below as indications of the factors that may lead flood plain occupants to either under or over-value flood plain lands relative to the actual flood risk.

12/ 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 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).

The Nature of the Flood Hazard.--Probably the most important conclusion arising from these studies affecting the validity of the land-value approach is that flood plain occupants may have little knowledge of the true risks involved. As White notes:

> The flood hazard is underestimated by most flood plain 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....
>
> 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 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. 13/

White's observations indicate that the awareness by flood plain occupants 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 above this 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.

13/ Gilbert F. White: Human Adjustment to Floods, op. cit., pp. 51-52. In connection with White's last point it is interesting that a report issued by the American Insurance Association notes that "the investigations of the engineers strongly indicate that neither the maximum probable loss from floods nor the maximum probable frequency of flood occurances in any given period has yet been experienced in the United States." American Insurance Association, Studies of Floods and Flood Damage, 1952-1955 (New York: American Insurance Association, 1956), p. 4.

In this case, a land-value check applied to the higher elevations will fail to reveal a price differential attributable to flooding.

This possibility creates the problem of defining the relevant flood plain. A general practice among engineers and other flood control specialists is to take the limits of the historical flood of record or the synthetic "100-year" flood as defining the flood plain. In many areas of the Wabash, for example, 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, 100-year flood, or apparent valley limits) are taken as defining the flood plain in an area where land buyers and sellers do not recognize the risk of the larger floods, any differences between land values of this "flood plain" and flood-free land will underestimate the true discounting for flood risk that did occur on the lower elevations of the plain. This possibility does not necessarily rule out the use of land values, since land values could still be used as a check of damage computations over that part of the frequency distribution that flood plain occupants recognize, but this must be known a priori or determined as part of the application of the land-value model.

It seems possible that land buyers and sellers, collectively, may in many cases actually have a better knowledge of expected losses from the more frequent floods than the engineer or hydrologist because of the limited time and data available to these specialists in typical project justification studies. However, land buyers may have little ability to recognize and discount for the hazards of the larger floods and land values may fail to reflect the possibility of catastropic events.[14/] 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 flood plain occupance. This will lead to an "overpricing" of land relative to a price based on more accurate expectations. If the flood plain land is overpriced in view of the flood hazard, a land-value comparison will underestimate a part of the benefits of flood control. In effect, part of the benefit of protection will serve to indemnify current owners of flood plain land for their past mistakes, and the increment in land values following protection will be less than otherwise would have occurred.

White's observations also suggest the hypothesis that the land market tends to reflect the occurrence of the rare flood event in a predictable way. As time passes without a major flood, flood plain land values may

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14/ In a 52-year period ending in 1957, more than 40 percent 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," Ch. III in G. F. White (ed.) Papers on Flood Problems, op. cit. p. 41.

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 reevaluated, 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 model 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,[15/] in a study of the feasibility of flood-proofing structures in Bristol, Tennessee, found other evidence that confirms White's observations. 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 occuring in 1929.

Sheaffer found that many Bristolians believed their city was no longer subject to flooding since nearly 30 years had 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.

15/ John R. Sheaffer, Flood Proofing op. cit.

Sheaffer reported that incomplete and inadequate streamflow 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 vigorous efforts are made to inform them otherwise 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 value of 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 overflow 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 and this 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.

Seasonality.--Another source of underestimation of flood risks may arise from the fact that flooding in the various river basins of the United States tends to follow well-defined, but not perfect, patterns of seasonality.[16/] 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 except for the "out-of-season" flood. In order to realistically appraise the flood risk, the individual needs to know both distributions. If he underestimates the probablity of occurrence of either, the compounding of probabilities involved will lead to even greater underestimation of flood risks and, hence, expected losses.[17/]

In order to test what the perception of the market is with respect to flood risk, two field investigations of the Missouri River study area were carried out. The first investigation, which was conducted to assemble the data base for the analysis, indicated that farmers seem in general to be quite knowledgeable as to the frequency and the extent of flooding on their land. A second investigation, designed to address the question of their perception of flood risk explicitly, reinforced the conclusions of the first

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16/ Robert W. Kates, "Seasonality" In: *Papers on Flood Problems* G.F. White (ed), *op. cit*. pp. 114-131.

17/ For example, if the probability of a flood in a given year is 0.50 and the probability that it will be a damaging spring flood is 0.25, the probability that a loss will be incurred is 0.125. If the probability of spring flooding is mistakenly believed to be only 0.15 the risk will appear to be only 0.075.

effort. The farmers and other knowledgeable people in the area were found to be accurately aware of the extent of flooding and magnitude of losses of the past 20 years and to generally expect the same type of flooding in the future. An interesting aspect of the findings of this effort is the mental attitude of the people in the flood prone area toward floods. They had made as many adjustments as possible in terms of minimizing the damage which would accompany flooding and in general were quite willing to move on and off their farms with flooding with little hesitation.

Discussion with the farmers in the area indicated that they had experienced flooding in four years during the 17 year period ending in 1969: 1952, 1960, 1965, 1967. These floods varied from the flood of record (1952) to quite minor flooding (1965). The people interviewed also had the general feeling that the breeching of the private levee protecting the area had in some of these cases been caused by negligence on the part of the farmers themselves. This implies to some degree that the farmers may overestimate the extent of protection afforded by the levee. On the other hand, the general distribution of flooding events shown by the hydrological data in the 1963 Flood Damage Report (Exhibits 3A and 3B), suggests that the frequency of flooding probably is quite close to that which might be expected by the farmers in general. It is still likely, however, that the frequency and extent of major floods (greater than a 25-year average recurrance interval flood) are underestimated by the market. Because the crop damages associated with any particular flood are not great (relative to non-crop and non-agricultural damages), the extent of the error introduced into the total estimate of the crop damages (and total damages to a greater extent) is quite small. An extreme outside estimate of the bias would be in the neighborhood of 50 percent.

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 flood plain occupants paid, for the most part, 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.[18/] In addition, direct income losses resulting from a flood may be offset by increased off-farm employment opportunities for relief or rehabilitation work.

Speculation.--Under this simple and broad caption there appears a variety of factors which may affect the basic relationship. There are a number of reasons why prices are paid for land which are already in excess of its productive potential, but only some of which have a deleterious effect on our ability to estimate the differential in the productive capacities of flood prone and flood free farms. If the cause of the speculation is such that it applies generally to all land or farms, the effect is simply to raise the intercept of the relation between price and productive capacity equally for all farms regardless of their location thus leaving the estimated differential due to flood risk unchanged. Examples of this type of speculation are

18/ G.F. White, Human Adjustment to Floods, op. cit. pp. 196-199.

purchases made as a hedge against inflation, a week-end retreat, or for retirement purposes. Other types of speculation which fall differentially on sections of land within a given area will distort the estimated differential. A strong example of this type is urban speculation in an area. The value of land closer to the city will naturally be high and an increased differential between flood prone and flood free locations may develop. In the empirical applications reported in this volume the general problem of "differential speculation" has been avoided by including only areas which are basically free from urban or industrial land speculation.

Valuing Noncomparable Lands

The argument for estimating flood damages or expected benefits assumes that flood-free land can be found that is comparable in all respects with flood plain lands except for the flooding hazard or that corrections can be made for the noncomparable elements. 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 flood plain and flood-free tract of land are comparable if they would command the same price in the absence of flood risk. However, the expected price of flood plain land after protection is one of the unknowns in the land-value model. Therefore, the comparisons will generally have to be in terms of land with physical comparability under the assumption that physical comparability is a sufficient condition for value comparability.

Determining that two tracts of land are comparable (except for flooding hazards) will usually involve an element of uncertainty but it is at least theoretically possible to make whatever adjustments are needed to insure valid comparisons by determining the effect of the noncomparable element on the annual returns to land and capitalizing the derived value. However, if a number of adjustments must be made in this manner, the process can become very complicated or yield unreliable 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. Virtually no agricultural data are systematically collected below the county level, and none is specific to flood plains.

Future Growth

In addition to estimating expected current benefits from flood protection stemming from direct damage reduction plus enhancement, the Corps of Engineers projects the prospective "normal" state of development without the project in order to provide a basis for modifying the basic current average annual damages to determine "prospective average annual damages over the life of the project."[19] This provides an estimate of future growth that is expected to occur even in the absence of the project. (This is in addition to enhancement benefits which are realized only with the project.) In the Wabash Basin Interim Reports, future growth is estimated over a 100-year period.

The land market is also forward looking in the sense that current land values are theoretically equal to the present discounted value of the expected

19/ EM 1120-2-101, op. cit. Also see the reference to this publication in the preceding section.

future returns from the land. The question arises, then, of the relationship of land values to the Corps' future growth concept.

The fact that the current value of land is equal to the present value of expected future income streams is expressed by the capitalization formula $V=R/i$, where $R=$ the annual return to land and $i=$ the capitalization rate.[20/] This formula assumes capitalization into perpetuity. An alternative formula would be of the form: $V=R\ (1+i)^n$ where $n=$ a finite number of years. However, beyond approximately 20-30 years both formulas give nearly the same values and the perpetual formula is usually preferred for simplicity. If the returns to land are expected to increase over time, the formula can be modified to accommodate changes in R over time. Theoretically then, the land market is comparable to the Corps' concept with respect to anticipated growth, if market interest rates coincide with the social interest rate implied by Corps discount factors.

In practice, the land market is probably not as far forward looking as these formulas imply. As Barlowe points out, estimates of future net returns are usually weighted quite heavily by knowledge of the returns received in the present and recent past.[21/] The extensive research into the formulation of expected price relationships by farmers reveal a similar tendency to base future expectations on current relationships.[22/] For these reasons we would expect land values to be heavily weighted by current and expected

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20/ Barlowe, op. cit.
21/ Ibid.
22/ See, for example: Earl O. Heady, Economics of Agricultural Production and Resource Use (Englewood Cliffs, N.J.: Prentice Hall, Inc., 1961).

near-term returns with adjustments for expectations of continuing trends such as rates of technological development. For these reasons, land values may be good indicators of expected developments over the near-term future (say, 10 to 20 years). However, if the Corps' estimate is heavily weighted by projections of large increases in the very far-distant future (50 to 100 years), some adjustment in the land value estimate will be required for comparability with the Corps' estimate.[23/]

D. Summary

With currently used procedures, the Corps of Engineers essentially adopts the viewpoint of a private individual in estimating the benefits to be expected from providing flood protection to agricultural land. The primary agricultural benefits are estimated in terms of changes in net income accruing to the individuals directly affected by the protective works.[24/] In this chapter, we argued that these benefits are received by landowners on the flood plain through changes in the net income accruing to their land. The Corps estimates the increase in net income by summing the components of the income change stemming from the alleviation of direct damages and the enhancement benefits made possible or more feasible by virtue of the project.

23/ An important question should be raised, however, about the potential errors embodied in projections this far into the future. In the empirical portion of this study, Corps estimates of current agricultural benefits are used for comparison purposes.

24/ Of course individuals receive other benefits as from the reduction of personal hazards from flooding, and society receives additional benefits from, for example, reduction in relief costs.

However, the land-value approach provides a theoretical means of estimating the same income changes directly from relative land values and therefore is conceptually equivalent to conventional estimating procedures.

The purpose of this research project has been to determine if the theoretical relationships provide a basis for an operational benefit-estimation model based on land-value relationships. The review of literature indicates that the most important questions regarding the model center around the accuracy of the land markets' evaluation of flooding hazards. An important consideration here is the possibility that land buyers and sellers fail to accurately perceive the flood hazard. This may lead to overpriced flood plain lands in absence of recent or frequent flooding but may also result in temporarily depressed flood plain values after severe flooding. It seems likely that the market value is least likely to reflect the expected losses 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 may also be subject to question because of the lack of observations needed to establish the upper end of the frequency distribution.

Another major consideration is the problem of adjusting land values to a comparable price basis. This may create no serious problems in a wide range of cases where the lands are physically similar or where the noncomparable elements can be easily valued. However, if the physical differences are extreme it may be impractical to make the adjustments, or the adjustments may require so much data and be subject to so many uncertainties to render the land-value approach unusable. This also must be decided on a case-by-case basis but an accumulation of experience with the model should provide guides for determining the types of areas in which comparability problems are likely to be significant.

There may be other inherent difficulties in assembling land-value data or in dealing with value-influencing components not directly related to land productivity. Some of these problems are evaluated in the following sections of this report. The Wabash Basin and the selected Missouri River Reach cannot, of course, represent all conditions that may be encountered but to the extent that the conditions found in these areas are typical of other areas the finding should have general relevance with respect to these questions.

II. The Applied Framework

A. Previous Studies

Although numerous references to a land value check based on theoretical considerations can be found in the literature, there have been only a few reported applications of land value principles. Four of these applications are briefly reviewed below, with emphasis on the methods used and the agreement of the results.

Verdigris River, Kansas

One of the earliest reported applications of the principles of a land value check was made by Fred Clarenbach in his contribution to the Task Force Report on Water and Power.[25/] His approach did not involve actual field

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25/ Clarenbach, Task Force Report, op. cit.

determination of either land values or actual flood risk. For six COE and SCS projects examined, Clarenbach found that the discrepancies in the damage estimates and prevailing land prices were so large that it was easily established that the agency estimates could not be supported by economic logic. By applying capitalization principles to the agency estimates Clarenbach showed that if the estimates were correct either flooding land, which was then selling for $94 an acre, should have almost no market value or conversely, if the $94 reflected a fair price for the land with current flooding, it should sell for over $280 an acre with protection and that this was very unlikely to occur.[26/]

The principles used by Clarenbach are valid applications of rent theory and could be used routinely in all project investigations since it requires only a minimum of information about the level of land prices in a given area and is useful in detecting gross errors in logic or data. The techniques may be useful in establishing certain limits for expected benefits but, generally, the procedures may not be particularly useful for detecting errors of smaller magnitudes.

26/ Renshaw used a procedure similar to Clarenbach's in examining the U.S. Department of Agriculture's (SCS) procedures for PL 566 watershed projects. In the SNY watershed in eastern Illinois he found that capitalized benefit estimates ranged from a fraction of a percent of average Census land and building values to 2370.8 percent and averaged 92.2 percent for the entire watershed. Edward F. Renshaw, Toward Responsible Government: An Economic Appraisal of Federal Investment in Water Resource Programs, Chicago: Idyia Press, 1957, pp. 73-75.

Grand River Reach, Missouri

Another review at about the same time took the land value approach further than Clarenbach did in that actual land price differentials were used to estimate experienced flood damages. This study was made in the Grand River Reach of the Missouri River by an "Advisory Board" formed at the request of the Kansas City District COE office.[27/] The Corps had estimated annual crop and pasture damage in the reach to be $25.50 per acre after allowing for the effect of existing protective works. The Board estimated average annual 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 percent) 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

27/ "Report of Advisory Board on Agricultural Flood Damages to Army Corps of Engineers," April 27, 1956, Mimeographed.

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."[28/]

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.

28/ Ibid. Supplement IV, p. 1.

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.[29/] 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. 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.

The RER was not asked to evaluate the land market's response to flooding hazards and the Corps' estimate was not reported. However, in the first levee district investigated (the results were similar for both districts) the RER found a difference of $73 an acre between unflooded cropland and flooding cropland (which included some cropland behind private levees). The RER also estimated the composite risk of loss to be $2.39 per acre behind the private levees and $7.89 in the absence of all protection. These correspond to capitalized values (at an estimated capitalization rate of 5.8 percent) of $41 and $136 per acre, respectively. This cannot be compared to the average discount for the entire sample of $73 per acre without knowing the proportion of land protected by private levees (this was not reported in the study) but,

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29/ Real Estate Research Corporation, Appraisal Analysis on Agricultural Levees 345-330-L and 408-L Ray, Clay, and Platte Counties, Missouri, prepared for U.S. Army Engineer District - Kansas City; Corps of Engineers, Kansas City, Missouri, July 1967 (Mimeographed).

if half the land were privately protected the estimated discount would be \$88 ((136 + 41) ÷ 2) which is close to the actual market difference of \$73.

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 noncomparable 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 noncomparable 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.[30/]

Washita River Basin, Oklahoma

A recent study of six upstream watersheds in Oklahoma[31/] represents the most rigorous technical application of a land value report found in the literature. In the Oklahoma study three of the six watersheds had been 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.

30/ The price data presented in the report enabled a test of differences 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.

31/ John E. Waldrop and Daniel D. Badger, Effects of Upstream Watershed Development on Prices and Values of Farmland in the Upper Ouachita River Basin, Processed Series P-529 (Stillwater: Oklahoma State University Experiment Station, March, 1968.)

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 flood plains 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 flood plain land, acres of upland cropland, assessed value of farm improvements, mineral rights transferred and appropriate variables for time of sale 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 increase 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 percent). The resulting estimated increase in value per acre attributable to protection were:[32/]

Watershed	Regression	Programming	Estimates
Barnitz Creek	$121.28	$319.00	$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-percent rate) two or threefold 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. Unfortunately, Waldrop and Badger did not attempt to reconcile these figures beyond noting some possible sources of the discrepancies.

Conclusions from Previous Studies

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

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32/ Waldrop and Badger, p. 35.

into project evaluation methodology. The other three studies establish that the land market in the areas investigated does recognize and discount for the flood risk. The Advisory Board report indicates close agreement between the land market and the Boards' estimate based on revisions of COE techniques. It is interesting that the Board estimated the flooding damages in terms of a range of values ($5 to $8 an acre) which is probably a fairer representation of the errors and uncertainties that may be involved in both land values and conventional procedures. The RER report did not present enough information to determine the agreement between land values and the estimated flood risk but if the assumption that about half the land is protected by private levees is correct the agreement would appear to be strong. The Waldrop-Badger study illustrates a dilemma that may be encountered in attempting to reconcile estimates of flood benefits derived from different sources. The discrepancy between the land values estimate and the SCS estimate is large and the data presented in the report do not provide a means of determining which estimate is most nearly correct.

B. The Approach

The Advisory Board and RER used relatively simple research methods in their studies. Both worked with average land values on the assumption that the flooding and nonflooding areas of study were comparable and the only major adjustment in the sales data was a "time" adjustment to account for general changes in land values that occurred over the study period. These methods may be entirely adequate in a number of cases but for these studies it was considered important to evaluate as many of the factors that might affect land values in a local market area as possible. The logic of this approach is that a land buyer must evaluate a number of other factors in addition to flood risk in determining the price he will pay for land. It is therefore important to know how these factors affect land values to insure that the flood plain and upland comparisons are between sales that have been adjusted as fully as possible for differences not related to flood risk.

The general methodological approach adopted in both of the empirical applications presented in this report was to use a multiple linear regression model to control for as many factors as possible which enter into determining the value of the land or the farm as a productive unit. Use of the regression technique in general can be expected to yield results which are more precise and in some ways more general than the less sophisticated methods employed in earlier land-value research. The increase in quantitative precision is, however, contingent upon the quality of the data and the results more sensitive to its quality than on those of these other methods. Additionally, the utility of this approach is limited by requiring an adequate sample size and by high levels of linear association among the independent variables. Finally, the strongest argument for using this technique is that it permits the comparison of farms which are not strictly comparable in all factors other than flood risk due to the use of a sufficient sample and the weighting of each of the non-flood factors to reflect their importance in the explanation of land values.

It will be useful in terms of facilitating the discussion of the remainder of this report to set out the regression model formally.

A general statement follows

$$y = a + b_1 X_1 + b_2 X_2 + \ldots + b_n X_n + E$$

where y is a (t X 1) vector of observations on the dependent variable or the variable being explained;

a is a constant or the intercept term;

X is a (t X 1) vector of observations on an independent variable or a variable which is explaining the observed level of the dependent variable y:

b is the coefficient of X which in the estimated model shows the average marginal effect of a change in X on the level of y; it is in about the average dy/dX of all t observations;

E is a vector of error terms containing a random element as well as those variables not explicitly included as independent variables.

In this analysis of this report y is either the total price or value per acre of a farm or the price or value of the farm net of improvements per acre. The price or value of the farm is a function of a number of factors including absolute size of tract, acres in cropland, acres in pasture and woodland, the quality of the soil, the number and quality of farm buildings and other improvements, other physical characteristics, and in the case of sales data the type of instrument used and whether the purchase was for expansionary purposes. To this basic model one or more terms reflecting the risk of flooding to the individual farm are added. It should be noted that the estimated coefficient of a flood risk term will indicate the effect of a unit change in flood risk on the value per acre of the farm after taking into account the influence of all of the other independent variables included in the regression. The exact form of the regression model will depend upon the variables available for inclusion, the inter-relationships among them, and the statistical significance of the association between the independent variables and the dependent variable.

Chapter III

The Wabash Application

A. Introduction

As mentioned in the first chapter of this monograph, the distinguishing characteristic of the implementation of the land-value approach to the Wabash River Basin by the Economic Research Service is the use of actual price data to measure the market value of farms. This chapter will describe the study areas, the data, and the approach employed by ERS and certain modifications which have been adopted for this report.

A general description of the topography and farming operations in the Wabash River Basin is presented in Appendix B. The selection of study areas within the basin were based on the criteria: (a) To represent as wide a range of topographic and flooding conditions as possible; (b) to choose areas that were reasonably favorable to the land value approach given the first criterion; and (c) within each area chosen to include a sufficient number of counties to insure that an adequate number of farm sales would be obtained. Based on these criteria and on consultations with Louisville Corps personnel and other knowledgeable persons, the following study areas were delineated:

(1) Lower Wabash Area - Knox and Sullivan Counties.

(2) Upper Wabash Area - Carrol, Cass, Miami, and Wabash Counties.

(3) White River Area - Bartholomew and Jackson Counties.

In the next several paragraphs some specific comments on each of the study areas are presented. Summary-information on the three areas is presented in Tables 1 and 2.

The Lower Wabash Area

Knox and Sullivan Counties were chosen because they include the reaches of the Wabash and White Rivers with the largest rural flood plains in the basin. The unprotected flood plains of the two counties are subject to considerable flood risk; although not to the degree of the counties in the extreme end of the basin where backwater flooding from the Ohio is also a problem. It was believed that Knox County, especially, would yield a high number of flood plain 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 are part of 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.

The Upper Wabash Area

A tier of counties from Carroll to Wabash along the upper reaches of the Wabash River were chosen to represent an area that has undergone

TABLE 1

FARMS AND FARM CHARACTERISTICS OF SAMPLE AREAS, WABASH LAND VALUE STUDY, 1956 AND 1964

Item	Unit	State	Upper Wabash	Lower Wabash	White subarea
All farms, 1964	No.	108,082	5,163	2,355	2,388
All farms, 1956	do.	128,160	6,195	3,019	2,635
Change, 1956-64	Pct.	-15.6	-16.6	-22.0	-9.0
Proportion of land in farms	do.	77.4	89.0	80.4	69.8
Average size, 1964	Acre	165.9	175.7	212.6	172.7
Average size, 1959	do.	145.2	151.0	174.3	150.0
Value of land and buildings:					
Per farm, 1964	Dol.	51,645	61,854	58,051	48,142
Per acre, 1964	do.	309.84	349.99	270.49	287.24
Per acre, 1956	do.	265.00	316.77	217.90	228.60
Change, 1956-64	Pct.	+16.9	+10.5	+24.1	+25.6
Value of product sold per farm	Dol.	10,227	13,390	13,228	9,359
Commercial farms, 1964:					
Proportion of all farms	Pct.	69.6	80.5	76.0	63.8
Average size	Acre	212.8	207.6	266.9	278.9
Average value per acre	Dol.	312.55	349.08	266.1	283.34

Source: U.S. Bureau of the Census. Census of Agriculture, 1964. "Statistics for the State and Counties, Indiana," Vol. I. Part 11. Govt. Print. Off., Wash. D.C. 1967.

TABLE 2

STUDY AREAS, REACHES, AND FLOOD PLAIN ACRES, WABASH LAND VALUE STUDY

Study area and stream	Reach	Rural flood plains	Flood plain per stream mile
		Acres	Acres
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.	Wh-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 sample area.

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

a significant recent change in flood risk. 1/ One purpose of choosing this area was to determine if land values on the flood plain 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 flood plains (around 500 acres per-stream mile) with respect to the problems likely to be encountered in working with land values on flood plains of this size. Because the flood plains are relatively narrow, four counties were selected to increase the number of observations of farm sales on the flood plains. Only sales of land in townships bordering the river were taken.

The White Sub-area

Bartholomew and Jackson Counties were chosen for the third study area because, being much less homogenous, 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" flood plain size is intermediate to the flood plains 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 flood plains on the tributaries of the East Fork of the White (see Table 2). Most

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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 analysis sections of this study.

of Bartholomew County and the flood plains 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.

Because of the lack of homogeniety and the general narrowness of the flood plains, it was not possible to establish a significant differential between upland and flood plain locations in the statistical analysis of the data. This is, of course, a very useful finding in itself; however, since the work on this study area has been set out in detail in the ERS report we will concentrate our analysis and discussion on the other two areas which possess more favorable characteristics.

B. The Methodology and the Data

The general methodological approach used in both applications was a multiple linear regression model as discussed above. The particular procedure adopted in the ERS report can be informally summarized in the following steps:

(1) Estimation of the regression model for upland farms only.

(2) Substitution of the values of the independent variables of farms located on the flood plain only into the model estimated in (1) in order to obtain an estimated value of the value of the farm.

(3) The difference between the estimated farm value for those with flood plain locations are subtracted from the observed value (i.e. the sale price).

(4) The difference from (3) is used as the dependent variable in a regression on various measures of flood risk.

For theoretical and empirical reasons set out in detail in Appendix A, it is clear that the ERS estimate of the effect of flood risk on the value of farms in the flood plain are subject to specification error and are therefore biased. For this reason a regression model which is estimated using both the flood plain and upland observations has been utilized for these study areas, and it is these results which are reported and discussed in the remainder of this chapter.

The sources of the data used in the analysis of the Wabash Basin are reviewed in Appendix C. Broad descriptions of the variables employed are presented below; the exact form is indicated in each of the applications. The list of variables includes some possible determinants of farm value which were not found to be statistically significant; these are included for the sake of completeness.

Sale Price

Sale price, the dependent variable, is the total sale price of the tract including farm buildings and associated structures. 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. 3/ Since the tax is 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

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3/ Effective January 1, 1968, this tax was repealed. However, most States have imposed similar taxes to capture this revenue.

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.

The Federal tax is not imposed upon that portion of sale price accounted for by the assumption of an existing mortgage. To qualify for this exemption the fact that a mortgage was assumed must be stated in the deed. When a mortgage assumption was found the enumerators were instructed to determine the amount of the unpaid balance from the mortgage file of the county office.

A description of the criteria employed to determine which sales constituted bona fide or "arm's length" sales is provided within Appendix C. After final editing there were a total of 406 usable sales of which 60 contained some flood plain land for the Upper Wabash area over the period 1952-1966. For the Lower Wabash 334 usable sales were found over the period 1962-1967 of which 74 contained flood plain lands.

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 usually stated in the deed but could be 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 country or township assessors. In Indiana, farmland is appraised for tax purposes by determining the categories 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. Several of the county and township assessors were interviewed during the data collection stage. They indicated that they are required 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 judge the accuracy of their work either relatively or against some objective standard. However, a strong judgment can be offered in support of the appraisal work from the fact that the price relationships between grades as determined by the regression analysis were consistent in all counties except Jackson in the White River subarea. In Jackson, part of the difficulties appeared attributable to the wide heterogeneity of land quality in that county.

Acres of Pasture and Acres of Woodland

These acreages were also determined from appraisal worksheets. The grade for these land use categories were not significant in any regression 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 eliminated from the sample.

Acres of Other Land

On tracts sold for agricultural purposes, acreages in this category was typically 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. Information from land contracts was taken if the contract was recorded but it could not be determined if the practice of recording contracts was not universal.

Expansion

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

Percent of Mineral and Oil Rights Sold

The percent 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 percent 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 relativel quality of each building (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, 4/

4/ 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.

The average appraised value of the farm buildings was relatively low 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 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. 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 regression coefficient (beta) for the Value of Improvement variable was equal to $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 was 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 regression runs. House Grade was generally positively related to sale value but the relationships were not strong enough to warrant inclusion of this variable in the final equations.

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. However, 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 insolated 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 analyses. 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 Units Soil 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 and the maps for Knox and Bartholomew Counties were inadequate for relating the soils to LCU groups. In the remaining three counties, the predominant LCU on each tract of land sold was determined by using a calibrated overlay on the soil map and an aerial photograph to locate cropland boundaries.

There were seven LRA/LCU's suitable for cropland in the three Upper Wabash counties, but these variables were not significant in any regression run. 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 homogenous 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 were 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 Hill, and Uplands; and for Bartholomew: River Valley, Sand Hill, Gravel Benchlands, Upland Corn, Wheat and Livestock, and Upland General Farming. The Sand Hill area of Knox and Sullivan counties is a pronounced region between the Wabash River and the Uplands. The soils are especially adapted for truck cropping and orchard production (although the number of orchards are declining and no sales of orchard land were included in the sample). A similar area is found in Bartholomew and Jackson but of much smaller extent.

Flood Risk

The following information was coded for each observation with land on the flood plains: 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 flood frequency zones.

Each tract sold was located on an aerial photograph and 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 always 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. 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 some observations were deleted for the lack of adequate information.

Table 3 presents the flood frequency data available by streams in the sample. Land lying outside levees on tracts receiving partial levee protection was coded according to actual risk. Land inside levees was considered subject to flooding from levee overtopping from floods with a recurrence interval of 20 to 25 years and coded in zones 4 and 5.

C. Empirical Analysis of the Upper Wabash Area

The Upper Wabash study area consisted of the four contigious counties of Wabash, Miami, Cass, and Carroll. The counties are traversed by the Wabash River (reaches W-9 and W-10 and parts of W-8 and W-11) and by the tributary rivers Salamonie and Mississinewa. 5/ The rural flood plains of

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5/ The Eel River also flows through parts of the upper three counties but this area was excluded from the sample because of the almost complete lack of flood data.

TABLE 3

FLOOD FREQUENCY ZONES BY STREAMS, WABASH LAND VALUE STUDY

Stream	Recurrence interval				
	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
	Years	Years	Years	Years	Years
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 1/	1	-	5	10-25	100

1/ The only sales on Clifty Creek were in the backwater area of the East Fork of the White. The recurrence intervals are for the White.

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

the Wabash average 462 to 500 acres per stream mile along reaches W-8 to W-10; narrowing to about 200 acres per mile along reach W-11. The Huntington Dam is located on the Wabash in Huntington County within reach W-11. The Mississinewa and Salamonie dams are located on these streams a few miles above the Wabash River. These streams have no significant amount of flood plains below the dam sites. At the start of this study both the Missinnewa and Salamonie reservoirs were operational, with only detail work to be completed, and construction on the Huntington had progressed to the point that the dam could be used in an emergency. A change in flood protection, then, did occur over the observation period. Because of uncertainty as to when the additional protection was in fact reflected in land values and the sales data, the analysis presented on the following pages has been limited to a certain extent.

The demarcation of the Wabash River Valley is sharp and the valley is roughly U-shaped in cross section. The valley sides are abrupt and have largely been left timbered or in pasture. The streambanks have also been left uncleared for bank erosion control but the remainder of the flood plain has been cleared and is in cultivation. Because the stream valley is narrow and abrupt, a high percentage of the flood plain was inundated by relatively high frequency floods before the reservoirs were installed. About 30 percent of the flood plain would be inundated by a flood with a two-year recurrence interval, 55 percent for the 5-year, and 72 percent by the 10-year flood. By contrast, only 6.4 percent more land would be inundated by a 100-year flood than would be inundated by the 25-year flood.

Because of the narrowness of the flood plains, the majority of the farms in the area "overlap" or are only partly embraced by the flood plains. The farmsteads are generally located on the upland portion of the farm or on the fringe of the flood plain. The fact that the data on soil types described in the previous section was available on a whole farm basis instead of being disaggregated between upland and flood plain acreage within the same farm is a substantial problem in terms of measuring the effect of soil types on the sale price of the farm.

The summary statistics for the variables employed in the regression analysis are presented in Table 4; the estimated regression models are reported in Tables 5, 6 and 7. Two forms of the dependent variable have been used in the estimates: "gross sales price/acre" and "net sales price/acre." The distinction between them is that the gross figure is simply the price actually paid on a per acre basis while the net figure is the price paid less the assessed value of improvements (house, other buildings, and fencing) on a per acre basis. The gross form was used in the original study.

It was felt, however, that because the value of improvments appears as an independent variable the explanatory power of it would be derived from the simple fact that it is a component of the total sale price. In addition, to compare flood plain and upland total sale prices in which the uplands contain consistently greater amounts of improvements is very likely to bias upwards the differential in land values associated with flood damage. It is also probable that in areas such as those being considered here in which farms contain both flood plain and higher land

Table 4

Upper Wabash Summary Statistics

	flood plain		uplands		pooled	
	Mean	std. dev.	Mean	std. dev.	Mean	std. dev.
Warranty deed	.722	.454	.689	.463	.692	.462
Contract deed	.083	.280	.145	.352	.139	.347
fract. crop. Quality A	-	-	.028	.102	.026	.097
" B	.220	.311	.168	.280	.173	.283
" C	.400	.351	.409	.383	.408	.379
" D	.378	.422	.300	.398	.307	.401
" E	.002	.011	.086	.255	.078	.244
total acres	121.5	73.57	88.3	53.4	91.5	56.3
net price/acre ($)	159.8	88.9	255.5	134.5	246.5	133.7
Expansion	.278	.454	.328	.470	.323	.468
Stream frontage	.777	.421	-	-	.084	.278
fract. crop. 1-10 yr flood zone	.341	.266	-	-	.032	.128
fract. crop. 25 yr flood zone	.727	.292	-	-	.074	.240
Av. acre flooded	51.4	134.7	-	-	4.88	43.6
small improv.($)	329.3	843.7	878.5	2192.	826.1	2107.
Med. improv. ($)	1022.6	2293.	2496.	3696.	2356.	3611.
large improv ($)	2771.2	4139.	1939.	4051.	2018.	4061.
yr.-risk ≥ 57	.405	1.50	-	-	.038	.472
yr.-risk ≤ 57	.361	.487	-	-	.034	.182
gross price/acre ($)	197.3	92.2	324.4	152.2	312.4	152.1

that the buildings which constitute the majority of improvements would be located in the higher areas of the farm. For these reasons, net sale price has been preferred, although the original form yields a consistently higher coefficient of determination for the basic model.

Although the variables have already been described in general terms, the particular form of some of the variables require further description and explanation. The "warranty deed" and "contract deed" variables are dummy variables and should be interpreted as being relative to a "special deed."[6/] The "expansion" and "flood plain location" variables are likewise dummy variables taking on the value of one if the purchase was for expansion purposes or the farm sold was located in the flood plain, respectively, and being zero otherwise. All of these dummy variables are formally referred to as additive dummy variables and the effect of one or more of them taking on the value of unity is to shift the entire function by the amount of the coefficient.

A dummy variable technique was also used for the value of improvements variables. The value of improvements variable could not simply be entered as the value present on each farm; to do this would have made it impossible to distinguish between a small farm with a great deal of improvements and a large farm with a small amount. It seems

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6/ The three deeds variables are all dummy variables, but in order to have an invertible matrix of independent variables when a constant term is included, it is necessary that one of the variables not be included in the regression. In this case it is the "special deed." For a further description of the dummy variable technique see J. Johnson Econometric Methods (New York: McGraw-Hill, 1963) pp. 221-28.

probable that the value of the improvements to a buyer of a small farm for purposes of expansion might be considerably different from the value of the same improvements on a slightly larger farm which could be operated efficiently as a productive unit. For these reasons it was decided to divide the observations into three approximately equal groups on the basis of total acres in the farm. The size categories were: less than 50 acres, 50 to 120 acres, and more than 120 acres. For any farm, then, the value of one of the improvements variables is the actual value of the improvements, which one of the variables depending on the size of the farm. The other two variables are zero. The regression coefficient for these variables should be interpreted as the relative contribution of an additional dollar's worth of improvements to the per acre sale price of land or land and improvements, depending on the form of dependent variable. In this case the dummy variables are referred to as "multiplicative" dummy variables, 7/ and they are interpreted as affecting the slope of the function, not merely shifting the entire function to a different intercept like the additive dummies discussed above.

We are now in a position to discuss the estimated regression models for upland and flood plain locations combined presented in Table 5. The variable at the top of each column is the dependent variable, and the variables along the side of the table are the independent variables.

7/ It is termed multiplicative because the value actually entered into the regression estimate is one times the value of the improvements and one times zero for the other two variables.

The numbers appearing in parenthsis under the coefficients are "student t statistics." 8/ For the uplands 343 observations were employed; 37 were used for the flood plains and 308 for the combined or pooled flood plain-upland regressions.

It was expected that farms sold by land contracts will command a price premium over farms by general warranty deeds with conventional financing, and the magnitude of the coefficients bear this out. Recalling that both the contract and warrant deed variables are interpreted relative to sales by special warranty, the sign of the warranty deed variable is surprising, as is the magnitude of the coefficient. One would expect that since special warranty sales are made under conditions approaching public auction that they would command about the same price as general warranty sales or slightly less. The results may indicate that some of the general warranty sales were made at less than full market value. In view of this possibility, the editing procedure for all observations were reviewed but no obvious cases for exclusion were found.

8/ The student t statistic is used to test the significance of the magnitude of a coefficient and is expressed as $(X_i - a)/S_i$ where X_i is the coefficient of the variable i, a is the number in relation to which the coefficient is being tested, and S_i is the standard error of the variable i. Normally in regression analysis the test for X_i is whether it differs significantly from zero, i.e. a = 0. It can also be be used to test if the coefficients of two variables differ significantly from each other, i.e. $a = X_i$. The significance of the coefficient depends on the size of the t statistic derived from the above formula and on the number of degrees of freedom of the regression which is equal to the number of observations minus the number of independent variables quantity minus one or (n - k - 1). Below appears a listing of the value of t - statistics of more than 30 degrees of freedom and the level of significance associated with each for a two-tail test.

The magnitude of the coefficients of the soil quality types deserves some comment. The coefficients for soils of quality A and E seem to be respectively too small and too large compared with the other coefficients. Two reasons for this appear possible. The first is that the classification of the very best and worst soils by the county appraisers may not have been done on a consistent basis, that is the line between classes A and B and D and E may have been inconsistently defined or applied. The second possibility rests with the small function of the soils of all the farms in these clases; only 2.6% is class A and 7.8% class E with a large number of farms containing neither. The result may be a lack of reliability of the coefficients themselves, although both are statistically significant at generally acceptable levels of reliability. The procedure of grouping the soils

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8/ cont'd.

t - statistic	level of significance
2.58	.01
2.33	.02
1.96	.05
1.64	.10
1.28	.20
1.04	.30

The significance level can be informally thought of as probability of the coefficient of the variable being tested taken on its value by accident. Thus a coefficient with a t of 3.0 can be thought of as being non-significant only one time in a hundred.

In the present research, it is felt that in most cases the .20 level is still an acceptable level of significance, although proportionately greater confidence is placed in conclusions based on more significant results. For a more complete discussion of the student t statistic see Chapter 11 in P. G. Hoel Introduction of Mathematical Statistics (New York: John Wiley, 1962).

Table 5

Upper Wasbash Basic Regression Model
(Coefficients are in Dollar Terms; Student t Statistics in Parentheses)

	Gross Price		Net Price			Wet Price	
	Upland	Pooled	Upland	Pooled	Pooled	Pooled	Pooled
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	440.0	424.0	351.7	339.3	313.7	266.4	280.9
	(5.01)	(4.56)	(4.03)	(4.02)	(4.33)	(4.16)	(3.98)
Warranty deed	-63.1	-46.9	-61.2	-45.8	-42.8	-45.9	-34.0
	(4.11)	(3.18)	(4.05)	(3.15)	(3.14)	(3.10)	(2.54)
Fract. cropland Quality A	124.7	149.0	147.9	170.9	76.0		-45.2
	(1.49)	(1.76)	(1.79)	(2.05)	(.95)		(.55)
Fract. cropland Quality B	225.4	204.8	238.1	216.9	286.6		162.2
	(3.57)	(3.22)	(3.84)	(3.46)	(5.61)		(2.91)
Fract. cropland Quality C	95.1	89.3	107.0	101.2	134.9		31.9
	(1.57)	(1.45)	(1.79)	(1.87)	(2.75)		(.61)
Fract. cropland Quality D	28.1	23.3	44.3	37.9	66.0		-26.8
	(.46)	(.38)	(.74)	(.63)	(1.34)		(.52)
Fract. cropland Quality E	76.7	78.8	88.9	90.6	113.0		8.83
	(1.18)	(1.19)	(1.39)	(1.39)	(.91)		(.07)
Small Improv.	.019	.020	-.008	-.007	-.007	-.003	-.005
	(6.07)	(6.40)	(2.71)	(2.36)	(2.48)	(.89)	(1.92)
Med. Improv.	.013	.014	.002	.001	-.0007	.003	.0001
	(6.88)	(7.56)	(101)	(.69)	(.43)	(1.43)	(.04)
Large Improv.	.013	.012	.005	.005	.005	.005	.004
	(6.36)	(6.74)	(2.55)	(2.82)	(3.01)	(2.63)	(2.47)
Log Total Acres	-91.0	-90.4	-73.2	-74.1	-72.4	-70.9	-65.6
	(6.27)	(6.74)	(5.12)	(5.61)	(5.85)	(5.31)	(5.43)
Trend term	11.7	11.7	11.9	11.8	11.0	11.4	11.0
	(9.11)	(9.43)	(9.41)	(9.69)	(9.63)	(9.35)	(9.84)
Expansion	21.2	29.3	22.1	29.8	27.4	21.6	21.2
	(1.77)	(2.51)	(1.88)	(2.60)	(2.56)	(1.87)	(2.03)
Contract deed	33.8	46.5	32.8	45.5	47.4	47.0	54.9
	(1.66)	(2.34)	(1.64)	(2.32)	(2.55)	(2.36)	(3.03)
Fract. farm in crops						223.7	136.4
						(8.35)	(4.88)
Flood plain location					-61.0	-21.7	-42.4
					(3.23)	(-1.06)	(2.27)
R^2	.569	.552	.465	.439	.511	.422	.542

into three classes, AB, C, DE, was used in the ERS study and yielded more consistent results. In cases such as this, this is probably a preferred procedure. All five soil classes are retained in the analysis of the Upper Wabash data to emphasize the potential problem and to allow more detailed analysis of changes in the magnitude of these coefficients with variation in the particular regression form.

There are several procedures available for controlling for the fact that the sales occurred over a fifteen-year period. One is to consider the effect of each year separately by including a separate dummy variable for each year. The second is to include a single "trend" variable which beginning at some value increases by one for each year of the observation period. Because the first procedure uses up degrees of freedom and opens up increased problems of multicollinearity, it is preferred only when its use offers substantial increases in explanatory power over a simple trend variable. Experimentation with forms of the regression which included both a trend term and the individual year term showed that <u>after</u> the secular upward drift in prices had been taken into account the year dummy variables did not contribute significantly to the explanation of sales prices. This fact combined with the marginal significance of some of the year-dummies when included separately argued for the use of the trend variable in the analysis.

The log of total 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 the total size increases, price per acre decrease. Where net sales price is the dependent variable this occurs probably in response to something like a "quantity discount." Where gross sales price is the dependent variable an additional factor is present. Because the value of improvements is included in the total price per acre, one would expect the value of the improvements to exert a greater influence on average price per acre for small farms than larger farms.

There are some major differences between the regressions explaining gross sale price and those explaining net sales price. The most striking is in the value of improvements variables. The coefficients differ significantly between the two forms. In addition, the sign of the coefficient of small improvements in the net regressions is negative and the coefficient of the improvements of farms in the middle size group is insignificant. The reason for these results probably lay in use of improvements on these farms as actual inputs into the productive process. From the results one would conclude that even after taking into account that small farms may have been bought for expansionary purposes, improvements actually have a depressing effect on the sales price. This could be because of the condition of the improvements in general or because they are heavily weighted by the value of the house which only bears indirectly on the productive capacity of the farm. The lack of significance of the improvements on medium sized farms suggests that the improvements are generally expected on such a farm and that they are on average only an adequate input for production. For large farms, on average, the improvements are shown to be a real asset to the productive process. This may be partially because of the type of farming carried out by these units, such as dairy-grain or livestock-grain operations.

Other changes also occur using net sales as the dependent variable. The significance of the soil type variables is increased. Also the size of the log-acres variables is markedly reduced, although on the basis of the above discussion one would have expected a greater reduction. This would seem to indicate that the value of improvements as an input factor is not a very important consideration in the market.

A final note on the basic results displayed in Table 5 concerns the fifth regression in the table. This regression is identical to the fourth regression except for the addition of other "flood plain location" variable, which is a dummy variable taking on a value of one if the farm is simply on the flood plain. The coefficient indicates that after taking all of the other independent variables into account the net price/acre is reduced on average by $61 for a farm being in such a location. This contrasts with a simple average difference in net sales price/acre between upland and flood plain locations of about $96/acre. There is, however, one problem inherent in accepting the $61/acre figure for flood damage. As mentioned earlier, in most cases, the farms along the Upper Wabash contain land both in and out of the flood plain and thus the average figure may understate the actual damages to flood plain locations proper. On the other hand, because farmers do hold land in both areas it is possible for them to adjust their operations in view of flooding and thus considerably mitigate the loss due to the flooding of the low lands. This could mean that the $61/acre figure is quite accurate. In general, the second case probably approximates reality more closely.

The last two regressions in Table 5 have been included largely for methodological purposes. The fifth, sixth, and seventh regressions differ only in their inclusion of soil class variables and a fraction of farm in cropland variable. The seventh includes both of these variables and the high degree of linear association between the fraction of farm in cropland and the soil class variables have caused a major reduction in the significance of the soil class variables. Indeed only the coefficient of the "Quality B" variable remains significantly different from zero. In view of this, one is tempted to use only the framework of cropland variable and omit the soil classification variables from the model; this form of the regression model is the sixth regression in the table. Note that the explanatory power of the model is substantially reduced by following this procedure. Again, the problems encountered in including all of these variables in the model can be mitigated by aggregating the soils classes into three or two groups. 9/

The real reason for discussing these regressions is not, however, to point out these problems. It is rather to demonstrate the sensitivity of the magnitude of the differential between upland and flood plain farms' sale prices to the particular form of the regression model employed. The coefficients of the "flood plain location" variable in the fifth and seventh are not significantly different from each other but they are significantly different from the same coefficient in the sixth regression, the one omitting the soil class variables. In fact that coefficient is

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9/ This is done in the analysis of the Lower Wabash data. The exploratory power of the model is little changed by this aggregation.

only different from zero at a relatively low level of significance. This should serve to underscore the need for considerable experimentation with the form of the regression until that with maximum explanatory power consistent with the underlying theoretical relationships is obtained. In the remaining analysis the relationship between flood risk and land values is explored more fully.

Regressions for farms only with flood plain locations are presented in Table 6. It is immediately evident that the basic form of this model differs substantially from that presented in the previous table. The soil quality variables were insignificant for these forms. It seems likely that this is due more to the methods employed by the assessors in classifying the soils than to conditions in reality. Nevertheless, it was possible to fit the regressions with moderate success. Aside from the measures of flood risk, two other independent variables are new: the year-risk variables. It was mentioned at the beginning of this section that during the first years from which sales data were drawn that the amount of protection offered by upstream reservoirs, particularly by the Huntington Reservoir, was being increased. Because of the uncertainty with respect to the timing of the inclusion of this increased protection into sales some experimentation with flood risk-year variables was carried out. The year-risk variables take on the value of the average annaul fraction of total cropland flooded over a 25 year period if the year of sale falls within the time interval it represents. For example if .25 of the cropland of a farm sold in 1956 floods annually, the year-risk ≤'57 variable would take on the value of .25 while the other year-risk variable is zero. The underlying idea behind these variables is to link the year of sales

Table 6

Upper Wabash - Regressions for Floodplain Farms Only
(Coefficients are in Dollar Terms; Student t Statistics in Parentheses)

net sale price/acre

Constant	132.1 (1.06)	55.2 (.46)	28.1 (.24)
Warranty deed	63.5 (1.73)	56.1 (1.60)	71.4 (2.09)
Contract deed	92.3 (1.61)	59.7 (1.10)	80.9 (1.56)
Expansion	63.8 1.99	50.0 (1.55)	48.6 (1.59)
Trend	94.6 (1.50)	7.26 (1.14)	12.8 (2.11)
log Total Acres	-22.3 (1.08)	-19.7 (.95)	-48.0 (2.32)
Yr-Risk ⩽ '57	8.56 (.70)	-6.15 (.50)	-20.1 (.76)
Stream frontage	-72.4 (2.15)		
Fraction crops in 1-5 yr flood zone		149.5 (2.53)	
Fraction crops in 25 yr flood zone			174.3 (3.12)
R^2	.387	.419	.471

and the extent of flood risk together; this has been done because the preceived risk has changed over time and a simple dummy for the year of sales would not include the risk aspect. At best one would like to be able to enter in the effect which these reservoirs actually did have on each farm's flood risk and when this change was taken into account by the market. Because this data is not available, the year-risk dummy is being employed in an attempt to pick up these influences.

Each of the regressions in Table 6 contains a different measure of flood risk as an independent variable. First observe that among the farms with flood plain locations the value of farms with frontage on the Wabash are discounted on average of $72 per acre. Also farms, with or without a Wabash frontage, bring a premium of about $41 per acre (149.5 x .341) on the average if it contains land in the 1-5 year flood plain. The premium associated with being in the 25-year flood plain is about $126 per acre (174.3 x .727) or a full $85 an acre above land in the 1-10 year zone. This follows our expectations in that that land in the alluvial plain is more valuable the less its flooding risk.

There are several differences between the second and third regressions shown in Table 6 which deserve mention. The first is that the year-risk variable for sales before 1957 is significant. Whereas its lack of significance in the other regressions can be partially accounted for by the presence of multicollinearity between it and the flood risk variables, it also can mean that the higher areas of the flood plains perceived a greater degree of protection as resulting from the construction of the upstream reservoirs than the areas in the 1-10 year flood frequency zone.

The positive sign of the year-risk <'57 variable indicates that only the outer edges of the flood plain were significantly affected by the reservoirs and that they perceived the change prior to 1957. Experiments with other breakdowns of the observation period for year-risk variables did not show any clear pattern of discounting to be evident for the area subject to more frequent flooding. In general the inability to measure such changes with the data available is not surprising and the general lack of success is a strong argument against using sales data for the land value approach in areas in which significant changes in flood risk have occurred over the period necessary to generate an adequate sample.

Several additional regressions relating flood hazard to the net sale price of farms in both the flood plain and uplands are presented in Table 7. The same form of the regression is used for all of the regressions except for the different measures of flood damage, and is the same as that used in the final regression of Table 5. To determine the average differential it is necessary to multiply each of the coefficients by the means of the independent variable. The resulting differentials are:

Differential per Acre	Differential
Fraction of cropland in 1-5 year flood zone	$ 36.6
Fraction of cropland in 25 year flood zone	27.4
Fraction of cropland flooded annually on average over a 25-year period	55.1

These magnitudes are in keeping with our expectations. The smaller differential over the larger, 25 year, flood plain is easily explained by the less frequent flood hazard and the high quality alluvial soils in the

Table 7

Upper Wasbash - Pooled Regressions
Flood Risk and Land Values
(Coefficients are in Dollar Terms; Student t Statistics in Parentheses)
Net sale price/acre

Constant	278.4 3.94	286.9 (4.06)	287.0 (4.06)
Warranty deed	-33.6 (2.51)	-33.1 (2.47)	-33.8 (2.52)
Contract deed	55.2 (3.05)	56.9 (3.14)	56.2 (3.10)
Expansion	21.2 (2.03)	22.2 (2.12)	21.7 (2.07)
Fract. cropland Quality A	-49.3 (.61)	-53.9 (.66)	-46.0 (.56)
Fract. cropland Quality B	160.0 (2.88)	154.8 (2.78)	155.2 (2.78)
Fract. cropland Quality C	30.0 (.58)	24.4 (.50)	26.7 (.51)
Fract. cropland Quality D	-30.2 (.59)	-34.4 (.67)	-30.7 (.59)
Fract. cropland Quality E	(7.63) (.06)	4.42 (.04)	5.79 (.05)
Fract. farm in cropland	139.1 (5.01)	144.4 (5.24)	141.7 (5.10)
Trend term	10.8 (9.76)	10.9 (9.50)	10.9 (9.87)
Small improv.	-.005 (1.93)	-.005 (1.90)	-.005 (1.89)
Med. improv.	.0001 (.06)	.0002 (.15)	.0002 (.14)
Large improv.	.004 (2.46)	.004 (2.57)	.004 (2.48)
Log Acres	-64.9 (5.36)	-67.5 (5.61)	-67.4 (5.59)

Table 7
cont.

Fract. crops in 1-5 yr zone		-83.2 (1.85)	
Fract. cropland in 25 yr zone	-50.1 (2.31)		
Fract. farm annually flooded in 25-yr period			-112.4 (1.81)
R^2	.542	.540	.539

upperreaches of the flood plain. Probably the most comprehensive measure of flood risk employed is the average fraction of cropland flooded annually during a 25 year period. It is preferred because it weights the flood damage (acres flooded) by the frequency of the flood, and to a certain extent should represent more accurately the perception of flood risk by individuals in the market. In general, the several measures of flood risk employed here tend to be consistent. 10/ The annual average flooding measure and the simple flood plain location variable are those in which the greatest confidence might be placed; the first due to its comprehensiveness and the latter due to its ability to capture the idea of the farm unit being on and off the flood plain with what this implies for farm operation. These two combined with the other results suggest an average differential of about $50 per acre between flood free and non flood free land after differences in productivity, size, improvements, and certain sales conditions have been taken into account. 11/

10/ They are also consistent with the findings obtained using the fraction of the farm flooded instead of the fraction of cropland. These results have not been included in order to keep the discussion as clear as possible.

11/ Using two versions of the method outlined and discussed in Appendix A, ERS found an average difference of about $26 per acre associated with flood damage. In both computational methods this amount was roughly doubled to takeaccount of the fact that only about half of the "flood plain" farms were actually located on the flood plain. On the basis of statements in the text with respect to the operation of the farm unit, this procedure seems questionable. If it were followed for the estimates presented, the differential would be raised to around $100 per acre or slightly greater than average difference between the sale price per acre of upland and flood plain farms.

D. Empirical Analysis of the Lower Wabash Area

The Lower Wabash study area includes Knox and Sullivan Counties. The two counties combined have nearly 90 miles of frontage on the Wabash River and Knox County is bordered on two of the remaining sides by the White and West Fork of the White River. The flood plains along the Lower Wabash are the widest in the basin (ranging from 1,700 to 3,357 acres per stream mile). The flood plains along the White River in Knox County are also wide (1,367 acres per-stream mile).

A major portion of the flood plains along the Wabash are within a Federally constructed levee system (Gill, Niblack, and Brevoort). Two levee systems are authorized for the West Fork of 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 River systems.

Both Knox and Sullivan Counties are in a corn, wheat, and truck type of farm area. 12/ The truck farming is restricted to a "sand hill" area, bordering the Wabash River Valley. This was formerly an area of extensive peach and apple orchards but orchard production is declining. The flood plains, particularly behind the levees, are intensively cultivated. Corn, soybeans, and some wheat are the major crops. As previously mentioned, this type of agriculture does not require on-farm residency. Therefore, there are relatively few farmsteads located on the flood plain and the rate of abandonment of existing strutures is high.

The demarcation between the flood plains and uplands is not as sharp as in the Upper Wabash. The demarcation is characterized by gently sloping

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12/ Robertson, Types of Farming in Indiana, op. cit.

benchlands, except for an occasional bluff along river bends. There are several small, prominent hills on the flood plains at the junction of the Wabash and White.

The townships in the north central part of Knox and the eastern part of Sullivan (the areas fartherest from the river) appear to contain less productive soils and the farms are smaller. This area contains several small towns once populated with workers in the coal mines, but coal mining is now restricted to a few large collieries engaged in strip-mining. Land sales in this portion of Sullivan County were excluded from the sample.

The major difference between the Lower Wabash and Upper Wabash for analysis purposes is the presence of an extensive private levee system in the Lower Wabash area. As shown in Table 8 slightly over half of the flood plain farms have levees while slightly less than a third front on the river. In general, one would expect the presence of the levee system to reduce the differential between the upland and flood plain farms and to make it more difficult to establish a statistically significant differential.

Most of the other variables listed with their summary statistics are familiar by now to the reader in both form and substance. A few comments are, however, in order. One concerns the amount of improvements; in the flood plain there is very little difference between the amount present on small and medium size farms, both being very small amounts. In the uplands, however, the values are comparable to those in the Upper Wabash. In addition to the variables listed in the table; dummy variables for each of the sixteen townships were tested in the regressions. 13/

13/ In Knox County the townships are: Busseron, Decker, Harrison, Johnson, Palmyra, Steen, Vigo, Vincennes, Washington, and Widner. In Sullivan County the townships are Curry, Fairbanks, Gill, Hadden, Hamilton, and Thurman.

Table 8

Lower Wabash
Summary Statistics - Selected Variables

	Flood Plain		Upland		Pooled	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Fract. cropland Quality ABC	.193	.350	.208	.375	.205	.369
Fract. of cropland Quality DE	.806	.351	.768	.392	.776	.383
Fract. of farm in pasture	.019	.066	.167	.516	.135	.462
Fract. or farm in woodland	.082	.146	.109	.200	.103	.189
Fract. of farm in cropland	.856	.158	.717	.539	.747	.486
Fract. of farm in 25 yr. flood zone	.825	.293			.180	.367
Fract. of farm in 1-2 yr flood zone	.268	.394			.058	.212
Fract. of farm in 1-5 yr flood zone	.286	.406			.061	.221
Av. Fract. farm annually flooded	.316	.351			.067	.207
Frontage	.314	.467			.067	.251
Sandhill farm	.343	.478	.230	.422	.254	.436
levee	.514	.503			.110	.313
Acres in crops	141.97	126.39	59.6	73.2	77.3	93.46
Gross sale price/ acre ($)	252.17	146.30	303.9	149.1	292.8	149.8
Net sale price/ acre ($)	231.78	135.93	253.2	141.7	248.6	140.6
Small improv. ($)	132.04	654.6	834.8	2330.	683.9	2105.9
Medium improv. ($)	295.17	1110.1	1590.8	4439.	1312.6	4001.9

Table 8
cont.

	Flood Plain		Upland		Pooled	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Large improv. ($)	2950.1	5839.	1479.9	5294.	1795.6	5440.
Expansion	.628	.487	.472	.500	.506	.501

These variables are included to explain differences in sale price associated with particular locations not captured by other independent variables in the models.

One rather critical factor which should be pointed out is that the difference between the average net sale price/acre of upland and flood plain farms is only $21.4. Although it is quite possible that the differential in land values will increase after taking account of variations in soil quality and other productive factors, the average differential is very small. This fact combined with the presence of the private levee system make it difficult to be sanguine about establishing a significant relation between land values and flood damage.

The remainer of this section parallels the previous section; Tables 9, 10, and 11 present selected estimated regressions. A total of 326 sample farms have been used in the pooled regressions; 256 have upland locations and 70 flood plain. The flood plain sample for the Lower Wabash is then almost twice as large as that used in the Upper Wabash Case.

Several forms of the basic regression model employed to analyze the Lower Wabashdata are presented in Table 9. There are few differences between the independent variables included in this case and those used in the Upper Wabash analysis. The soil classes were grouped into two variables, ABC and DE. The reasons for indicating this type of a grouping were generally set out in the previous section. An additional reason, specific to this case, was that many of the farms had all cropland in a single class, probably due to the habits of the appraisers who classed the soils. In any event, it was hoped that grouping those which were not classed in this manner would make the data more consistent internally. Note that only one of these

Table 9

Lower Wabash - Basic Regression Model
(Coefficients are in Dollar Terms; Student t Statistics in Parentheses)

Net sale price/acre

	Upland			Pooled		
	(1)	(2)		(3)	(4)	(5)
Constant	197.6	200.0		221.7	243.2	242.6
	(2.76)	(2.83)		(3.95)	(4.51)	(4.45)
1963	52.2	46.5		51.8	41.3	41.4
	(1.26)	(1.16)		(1.78)	(1.47)	(1.47)
1964	67.0	(5.6)		72.3	73.1	73.2
	(1.62)	(1.64)		(2.47)	(2.60)	(2.61)
1965	111.3	118.0		109.9	114.9	114.9
	(2.70)	(2.94)		(3.70)	(4.00)	(4.00)
1966	135.0	113.0		144.5	159.3	159.3
	(1.00)	(.91)		(2.21)	(2.53)	(2.53)
Johnson Twp.		70.4	Johnson Twp.		92.7	92.6
		(1.82)			(2.73)	(2.71)
Vigo Twp.		97.4	Palymra Twp.		83.6	93.5
		(1.86)			(2.59)	(2.58)
Washington Twp.		-32.9	Vincennes Twp.		88.9	89.0
		(1.30)			(1.84)	(1.84)
Fairbanks Twp.		-62.4	Fairbanks Twp.		-66.0	-66.0
		(2.37)			(2.85)	(2.85)
Truman Twp.		-81.7	Truman Twp.		-61.7	-61.7
		(2.80)			(2.33)	(2.32)
Warranty-deed	-53.8	-46.6		-54.2	-45.3	-45.3
	(3.20)	(2.80)		(3.67)	(3.15)	(3.15)
Fract. cropland Quality ABC	90.8	72.9		89.4	86.4	86.4
	(4.30)	(3.16)		(4.81)	(4.62)	(4.62)
Fract. farm in Woodland	-140.0	-112.1		-149.7	-112.2	-112.2
	(3.57)	(2.76)		(4.20)	(2.98)	(2.98)
Fract. farm in Cropland	62.7	50.0		65.8	52.2	52.2
	(4.16)	(3.32)		(4.52)	(3.64)	(3.64)
Sand Hill Locat.	28.4	24.2		25.6	26.4	26.4
	(1.53)	(1.31)		(1.63)	(1.72)	(1.72)

Table 9
cont.

Small improv.	-.006	-.005	-.004	-.004	-.004
	(1.62)	(1.60)	(1.26)	(1.30)	(1.30)
Med. improv.	-.004	-.005	-.004	-.004	-.004
	(2.28)	(2.71)	(2.23)	(2.68)	(2.68)
Large improv.	-.004	-.003	-.003	-.003	-.003
	(2.15)	(1.85)	(1.94)	(1.91)	(1.91)
Log total Acres	-5.15	-1.21	-12.6	-16.5	-16.5
	(.40)	(.09)	(1.26)	(1.71)	(1.71)
Floodplain Locat.					-.48
					(.087)
R^2	.311	.369	.309	.377	.380

variables was included in the regression model. It is necessary to omit one of the variables because as the two variables are almost always in a one-zero configuration; they are nearly perfectly inversely correlated which is inadmissible if the model is to be estimated. Another major change is the use of individual year dummies instead of a trend team in this model. Most of the sales were taken from the years 1963-1966 but a few were from earlier years. These variables are then to be interpreted with respect to sales in the sample taking place before 1963. The individual dummies have been used in this case because their explanatory power was somewhat greater than the trend term's. Finally, both the fraction of the farms in cropland and the fraction in woodland were found to be significant in this case.

Turning to the regressions themselves several contrasts with the Upper Wabash results are evident. In the regressions for the upland farms alone the coefficients of the value of improvements variables are all negative. The only reasonable explanation for this result seems to lay in the fact that almost half of these sales were made for purposes of expansion. If one assumes that in most cases the purchaser has an adequate farmstead at the time of the purchase, a reason for discounting the value of the buildings appears. This rationale is weakened somewhat, however, when the positive coefficient of the "large improvements" variable in the pooled regression is observed. Given the fact that the large farms have been sold less frequently for expansion, the argument remains basically valid; but even though the coefficients are statistically significant they should be interpreted with caution.

The discount in sale price associated with large tracts is much smaller in the present case; it is only about one fourth as large as that found in the last section; for the uplands alone it is not significantly different from zero. The discount in sale price associated with the use of a warranty deed is of the same magnitude as for the Upper Wabash, although no effect of using a contract deed was apparent in this case.

The addition of the township variables to both the upland and pooled regressions increases the explanatory power of the models substantially. The determination of which township variables to include in each case was made on the basis of preliminary runs of the township variables on both forms of the dependent variable. These variables are in general interpreted relative to the net prices paid for farms in other townships. For example upland farms on average sold for about $33 per acre less than the average farm in the ten townships not explicitly included in the regression. While these variables raise the portion of the variance of the dependent variable explained, they do not significantly change the coefficients of any of the other independent variables. This is interpreted as meaning that they are explaining only local variations in sale price associated with the working of the market and not local variations which are related to the productivity of the farms sold in these areas.

Finally, it is of interest to note that in the final regression presented in Table 9 the coefficient of the dummy variable indicating if the sale was of a farm located in the flood plain is not significantly different from zero. Because it was possible to establish some relation between land value and flooding with other flood risk variables, it seems probable that the insignificance of the simple flood plain dummy can be attributed to the topography of area. As mentioned earlier the demarcation between the flood price areas and areas subject to flooding is characterized by gently sloping benchlands except for an occasional bluff along river bends, which would tend to blur the flood plain - upland distinction.

Regressions for sales of farms located only in the flood plain are presented in Table 10. The general form of these regressions as indicated in the first regression is much more similar to that used for the uplands than was the case in the Upper Wabash. One difference between these and those for the upland farms is the use of a trend term instead of dummy variables for each year. The substitution was made simply because the former offered a slightly greater explanation of the dependent variable. The signs of the value of improvements variables are somewhat different from the uplands. Only the small improvements variable is really significant, and its positive sign is likely due to the presence of very small amounts of improvements necessary for production on these farms. (Average value $132.)

Before examining the performance of the flood damage variable included in Table 10, the reasons for omitting several others are given. The broader measures of flood damage including the fraction of the farm in the 25 year flood zone and the average fraction of the farm annually flooded turned out to be insignificant in the regressions in which they were included. Two explanations seem possible. One is the topography argument presented above. The second rests on the measurement of flood damage. In the description of the data it was pointed out that the fraction of the farm in each flood zone was found by matching Corps flood frequency maps with plat maps. Unfortunately, the Corps frequency maps did not take into account the protection offered by the private levee system. Thus it is quite possible that much of the area shown to be in some of the flood zones is substantially

Table 10

Lower Wabash - Regressions on Floodplain Farms
(Coefficients are in Dollar Terms; Student t Statistics in Parentheses)

Net sale price/acre

Constant	-680.3 (4.07)	-661.9 (4.08)	-573.2 (3.37)	-616.1 (3.57)	-677.0 (4.15)
Harrison Twp.	39.7 (.87)	91.2 (1.80)	21.1 (.47)	56.2 (1.06)	15.2 (1.90)
Johnson Twp.	143.7 (1.55)	147.6 (1.63)	142.6 (1.60)	132.9 (1.47)	137.2 (1.51)
Vigo Twp.	-48.1 (1.08)	-37.1 (.85)	-29.2 (.66)	-27.9 (.63)	-34.9 (.80)
Vincennes Twp.	124.6 (2.45)	139.8 (2.80)	112.7 (2.26)	117.4 (2.36)	134.8 (2.67)
Fairbanks Twp.	-67.0 (1.30)	-39.3 (.76)	-67.8 (1.35)	-50.8 (.98)	-35.2 (.68)
Warranty deed	-42.1 (1.40)	-41.0 (1.40)	-54.2 (1.81)	-45.2 (1.48)	-36.8 (1.24)
Fract. cropland Quality ABC	70.0 (1.57)	38.5 (.04)	48.5 (1.09)	34.3 (.75)	32.1 (.70)
Fract. farm in cropland	343.5 (3.52)	332.9 (3.51)	282.0 (2.85)	246.0 (2.89)	287.8 (2.71)
Small improv.	.045 (1.97)	.044 (1.95)	.040 (1.79)	.043 (1.89)	.045 (2.00)
Medium improv.	-.006 (.48)	-.010 (.85)	-.009 (.84)	-.009 (.83)	-.009 (.80)
Large improv.	-.002 (1.01)	-.003 (1.37)	-.002 (1.13)	-.002 (1.36)	-.003 (1.26)
Trend	43.7 (4.07)	44.6 (4.27)	42.5 (4.06)	44.9 (4.25)	46.0 (4.36)
Fract. farm in 1-5 yr flood zone		-76.6 (2.11)			-47.0 (.98)
Levee present				44.5 (1.25)	39.4 (.95)
Stream frontage			-62.9 (2.11)	-43.0 (1.27)	
R^2	.570	.602	.602	.613	.608

overstated. If this is the case the lack of correlation between land value and flood risk is understandable. Finally, the "fraction of farm in the 1-5 year flood zone" variable appears the best fit of any of the "acres flooded" type of variable. One should bear in mind that this variable may in fact represent the amount of flooding actually resulting from a somewhat larger flood due to the protection offered by the levee system.

There are two aspects of the fitted models shown in Table 10 of which the reader should be aware. The first is that there is significant variation in the coefficients of the township variables with the type of flood risk measure employed. For example, the average premium per acre for a farm in Harrison Township goes from $91 when the "fraction 1-5 year" variable is used to zero when "stream frontage" is used. (The $21 is not significantly different from zero.) These changes are simply caused by the type of flooding damage occurring in the townships. The variation in the coefficient of the Harrison Township cited above means that the premium paid for farms in that area disappears when one controls explicitly for the stream frontage of the sample farms in the area. Second, the coefficients of the quality of cropland and the fraction of farm in cropland variables also vary with the measure of flood damage employed. The explanation for the latter variations is, however, generally one of low level multicollinearity between the amount of flood risk and these other two independent variables. It is easy to see, of course, why the flood hazard would influence cropping patterns, and how the quality of the soil would be influenced by its proximity to the river.

In the table two sets of regressions are presented: one in which the effect of flood risk is measured independently of the effects of the levee system and one which the effects of the levee system are included. The average discount in the sales price per acre indicated by the farm fronting on the stream and the fraction of the farm flooded by the 1-5 year flood is quite different: $63 versus $23 (76.6 x .29). Although taking the presence of levees explicitly into account in the fourth and fifth regression does lower the estimated discounts by about a third for both flood damage variables, they are still quite far apart, $43 vs. $14/per acre. However, since the discount associated with the 1-5 year measure is no longer really significant, one is forced into statement that after taking the effects of private levees into account the only measurable flood hazard is for those farms fronting on the Wabash and here it is about $45/per acre. This conclusion is for flood plain farms only, i.e. among flood plain farms only those river frontage sell at a discount due to flood hazard.

These results contrast quite sharply with those for the Upper Wabash. In that case while it was possible to establish a discount associated with stream frontage, it was also possible to establish a premium being paid for lands in the alluvial plain with less risk on flood damage over time. The difference between the two cases seems to lay in both the presence of the private levee and the nature of the topography in the Lower Wabash area.

The final regression analysis is presented in Table 11. The basic model is the same as that discussed in Table 9. The flood risk variables are again whether the farm fronts on the Wabash and the fraction of the farm in the 1-5 year flood plain. The most interesting aspect of the findings displayed in the table is that when upland and flood plain sales are considered together the effect of the presence of private levees is negligible.

Table 11

Lower Wabash - Pooled Regression
Analysis of Flood Risk
(Coefficients are in Dollar Terms; Student t Statistics in Parentheses)

Net sale pric/acre

	(1)	(2)	(3)	(4)
Constant	229.8 (4.27)	239.5 (4.43)	239.1 (4.44)	228.5 (4.25)
1963	34.7 (1.22)	41.0 (1.44)	39.2 (1.40)	30.9 (1.10)
1964	70.0 (2.44)	71.9 (2.53)	70.3 (2.50)	64.9 (2.31)
1965	109.6 (3.74)	113.8 (3.89)	111.7 (3.88)	104.0 (3.61)
1966	158.1 (2.50)	178.2 (2.78)	176.2 (2.76)	164.5 (2.58)
Johnson Twp.	97.9 (2.90)	94.6 (2.78)	93.5 (2.76)	96.0 (2.85)
Palmyra Twp.	81.9 (2.54)	82.4 (2.53)	81.0 (2.51)	78.0 (2.43)
Vincennes Twp.	68.6 (1.40)	88.4 (1.79)	92.7 (1.92)	82.3 (1.71)
Fairbanks Twp.	-63.5 (2.74)	-62.1 (2.66)	-63.0 (2.72)	-63.7 (2.42)
Turman Twp.	-61.9 (2.35)	-63.9 (2.40)	-64.5 (2.43)	-63.9 (2.76)
Warranty deed	-45.4 (3.14)	-44.4 (3.06)	-43.8 (3.03)	-43.1 (3.01)
Fract. cropland Quality ABC	80.0 (4.24)	81.1 (4.26)	81.5 (4.33)	79.6 (4.23)
Fract. of farm in woodland	-100.8 (2.68)	-111.1 (2.94)	112.7 (3.00)	-105.4 (2.81)
Fract. of farm in cropland	52.7 (3.69)	53.7 (3.72)	54.1 (3.77)	54.5 (3.82)
Sandhill	23.3 (1.50)	22.9 (1.46)	24.0 (1.55)	24.0 (1.56)

Table 11
cont.

Small improv.	-.004	-.004	-.004	-.004
	(1.32)	(1.34)	(1.36)	(1.38)
Med. improv.	-.005	-.004	-.005	
	(2.84)	(2.73)	(2.81)	
Large improv.	-.003	-.003	-.003	-.003
	(2.10)	(2.07)	(2.08)	(2.17)
Log total acres	-11.5	-15.0	-14.4	-9.80
	(1.14)	(1.52)	(1.48)	(.99)
Stream frontage	-81.8			-65.6
	(2.61)			(2.22)
Levee present	.85	9.18		
	(.03)	(.40)		
Fract. farm in 1-5 yr flood zone		-42.9	-44.9	-15.1
		(1.36)	(1.44)	(.45)
R^2	.392	.381	.380	.391

The discount associated with flood risk after taking account of minor effects of the levees differs markedly between regressions (1) and (2). The discount found using the stream frontage variable is $65/ acre greater than that indicated in the 1-5 year flood zone variable. Both of these variables are included in the fourth regression and the results are that the risk associated with having a farm front on the Wabash clearly dominates being in the 1-5 year flood zone. Interestingly the extent of the linear relation between these two measure of flood risk is quite low (R^2 = .20), so that this finding cannot be attributed to simply measuring the same risk two ways; apparently at least the perception of flood hazard differs significantly between the two.

This brings us to the ultimate issue of which measure of flood risk is the appropriate one to use in this case. Before addressing this issue directly it may be worthwhile to consider what the results of Table 11 have shown. First, it was shown that average per acre discount of a farm fronting the Wabash in this area is about $65, after taking account of the fact that it is in the 1-5 flood plain. Second, it was shown that an average for all farms treated in the 1-5 year flood plain, including those with river frontages, the average per acre discount was about $15. Finally, it was shown that no flood hazard for larger floods has been reflected in the prices paid for the sample farms. The determination of which number is the appropriate number depends quite clearly on the type of project and protection which is being considered. If, as would normally be the case, the project were to benefit the flood plain in general, then the $15 per acre figure should be employed. If the protection is to benefit those farms with stream frontages differentially, than the $65 per acre for these farms is appropriate. 14/

14/ These estimates are about one-half of the similar estimates made in the ERS report following the first two steps of the procedure outlined in Appendix A. The differential associated with flood plain locations estimated was $31. It seems likely that much of the discrepancy between the two sets of estimates can be attributed to the use of gross sales per acre as the dependent variable. This increased the average difference in sales price per acre to almost $50 from the $20 for net sales price per acre between farms located in the uplands and flood plain. The problems associated with using the gross sales price have already been set out at the beginning of Section C of this chapter.

CHAPTER IV
The Missouri River Application

A. Introduction

As indicated in the first chapter of this monograph, the land value study using areas along the Missouri River was undertaken after the completion of the study on the Wabash River and in response to some of the findings resulting from that study. To set the stage, the elements of the Wabash study which caused some problems in establishing the land value differential associated with flood risk as accurately as possible are listed below. Following this the steps taken in the Missouri application to overcome these problems are outlined.

Three principal problems surfaced within the course of the Wabash application. The problem which limited the results most seriously was the use of sales occurring over a considerable time period. As noted earlier the use of extended times series data means that several different factors which influence the value of land over time became intertwined and extremely difficult to separate from each other. In addition to the general upward drift of prices and productivity, the extent of flooding and the increase in protection resulting from the construction of upstream reservoirs all have potentially significant influence on land prices at various points over an extended time period. The second major problem is closely related to the first; the need for a sample of adequate size to permit the "netting-out" of various random elements in the sales data is in fact the reason for the use of sales occurring over a period of several years. It is quite clear that if a sample, not based on actual sales data, could be assembled, the number of observations needed to place the random elements resulting from extra-market considerations in prospective might be substantially reduced. A final major problem in the Wabash application was the question of the appropriateness of comparing flood plain and upland located farms. Despite the fact that production and location factors were standardized for, a potential source of criticism is that in the final analysis the two areas are strictly not comparable.

In attempting to overcome these problems and to lend greater support to the use of the land value approach to measure benefits accruing to agriculture from flood protection, several departures from the methodology established by the Economic Research Service were initiated. In order to obtain a sample of sufficient size at a single point in time with a minimum amount of random elements affecting the data, it was decided to employ "gross estimates" of the value of the land and the farm unit prepared by real estate appraisers. (The "gross estimates" differ from bonafide appraisals only in terms of legal description.) Further, in order to test the hypothesis that upland and flood plain locations are not comparable, three areas of study were employed: an area on the flood plain protected by Federal levees, another area on the flood plain which was not so protected, and an upland area near the other two areas. It was then possible to test the hypothesis by examining the land value differentials indicated by protected-unprotected area and upland-unprotected area comparisons. It is these two features --

the use of appraisal data and comparison of the unprotected area with a protected area located in the flood plain as well as with an upland area -- which characterize the Missouri River application.

The general area of study is the St. Joseph reach of the Missouri River, and more specifically Levee Units Nos. 448-443L and 419-426L and the flood free upland area adjacent to these units. Three areas form the three subareas which are of explicit interest to this study: a flood plain area protected by a Federal levee (Levee Unit No. 448-443L), a flood plain area not protected by Federal levees (Levee Unit No. 419-426L), and an upland area near these other two areas. A general description of these areas and the reasons underlying their selection are presented in Appendix D. In the remainder of this section only those characteristics of these areas which bear most strongly on the comparisons of land values and flood risk made later in this report are described.

Both of the flood plain areas are extremely level; in fact there are only one or two five-foot contours from the Missouri River to the steep hills which mark the limit of the flood plain. The Federal levees protecting the "protected" area were completed in 1951, and the other levee district has been in an inactive status for a number of years so that the land market should not reflect any speculation of possible future construction of Federal levees in the "unprotected" area. One characteristic of the unprotected area should be emphasized: the area is protected by a private levee which is approximately six feet in height and generally thought to be strong enough to withstand a flood of five year frequency. This means that whatever differential in land value associated with flood risk is found will be the marginal difference between the protection afforded by the existing private levee and a Federal levee, other factors being held constant.

Several characteristics of the upland area need to be pointed out. First, the topography of this area ranges from rolling to hilly and as such contrasts sharply with the extreme levelness of the flood plain areas. In an effort to diminish the amount of topographical variance among the areas, the upland farms immediately adjacent to the flood plain which generally contain extremely uneven terrain were excluded from the study area in favor of more rolling terrain slightly beyond the initial range of hills. There were two other factors which had to be taken into account in delineating the upland area which were potential sources of speculative or non-agricultural influences in the land market. These are the presence of Interstate Highway 29 running along the western edge of the upland area and the construction of the new Kansas City International Airport to the south. The procedure adopted in both cases was to draw the sample from farms thought to be far enough away from the source of potential speculation to be relatively free of these influences.[1/]

B. The Data and the Methodology

The use of appraisers to assemble the basic data set is one of the hallmarks of the Missouri application. Six Corps of Engineers appraisers

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1/ The determination of how far this influence extended from each source was determined by studying recent sales data.

actually made the estimates.[2/] They were instructed to evaluate each farm at its current market value. The fact that the data was to be used to measure the extent of flood damage was not emphasized, and the appraisers were told not to deviate from their normal work method. Only one constraint was placed on the group as a whole -- that each appraiser make estimates in each of the three study areas. This was done to insure that systematic differentials would not occur owing to particular appraisers being consistently higher or lower than others. In order to establish the current level of the market, a total of fifty-one sales which occurred in the two years prior to the study were studied by the appraisers.[3/] On this basis gross estimates were made on 50 farms in the protected and upland areas and on 64 farms in the privately protected area. An idea of the type of data gathered by the appraiser, partially by interviewing the farmer or tenant, is available by examining the form used by the appraisers in the field as shown in Appendix F.

Table 1 contains the sample means of a number of the variables for each of the three study areas. From these data it is possible to observe some important differences among the study areas. Interestingly the value of the land without improvements for the protected and unprotected areas are practically identical, although the value of improvements is considerably greater in the protected area. This similarity in the

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2/ The qualifications of these appraisers are given in Appendix E.

3/ The distribution of the sales among the study areas was: protected area, 15; unprotected area, 11; upland area, 25. It should be noted that most of these sales were included in the sample at sale price of the farm.

Table 1

Mean Values of Selected Variables Based on Estimate Data for Missouri River Study

	Protected Area (443-448L)	Unprotected Area (419-426L)	Upland Area
Distance from St. Joseph, Missouri	5.08	16.9	5.62
Distance from Kansas City International Airport	25.4	16.7	14.1
Total Acres per acre	149.7	204.5	149.4
Fraction farm in Soil Class I	.314	.407	.002
Fraction farm in Soil Class II	.499	.430	.105
Fraction farm in Soil Class III	.136	.100	.580
Fraction farm in Soil Class IV	.017	.018	.208
Fraction farm in Soil Class V	.059	.047	.113
Fraction of farm in cropland	.893	.921	.618
Fraction of farm in grassland & woodland	.013	.028	.359
Topography			
Fraction of total farms dominantly level	.980	.968	-
Fraction of total farms dominantly rolling	.020	.032	.604
Fraction of total farms dominantly steeply rolling	-	-	.167
Fraction of total farms dominantly hilly	-	-	.208
Size distribution			
Less than 50 acres	.280	.306	.062
Between 50 and 150 acres	.260	.306	.497
Greater than 150 acres	.460	.387	.458

Table 1 (cont'd)

Mean Values of Selected Variables Based on Estimate Data for Missouri River Study

	Protected Area (443-448L)	Unprotected Area (419-426L)	Upland Area
Valuation			
Acres of tobacco base	-	.375	1.47
Assessed value for tax purposes	4984.	7683.	8261.
Total "estimated" values in dollars	59801.	81698.	48300.
Value of house	4312.	2836.	5630.
Value of buildings	1968.	1753.	2774.
Value of house + buildings per acre - all farms	59.3	37.3	75.9
Farms of less than 50 acres	31.6	16.2	21.4
Farms between 50 and 150 acres	11.9	13.8	31.8
Farms greater than 150 acres	15.7	7.4	23.0
Value per acre without improvements	386.	387.	271.
Total value per acre	445.3	424.3	346.9
Fraction of farms appraised by			
Appraiser 1	.160	.290	.062
Appraiser 2	.080	.306	.104
Appraiser 3	.200	.081	.125
Appraiser 4	.160	.065	.292
Appraiser 5	.220	.177	.083
Appraiser 6	.180	.065	.333

value of the land between the two areas is partially explainable in terms of the larger fraction of the unprotected farms being in the best two soil classes. In this regard it should be noted that there is a considerable overlap in the soil qualities of flood plain farms and those with upland locations, suggesting that the two sets should be comparable.

In the next several paragraphs some of these variables are described in greater detail. Because the data gathered and used in this analysis are in many respects the same as those used in the Wabash case, only those which are felt to be particularly important or different will be discussed here.

Value of land without improvements: This variable has been used as the dependent variable in this analysis, largely for the reasons advanced in the previous chapter and on the basis of the empirical findings there. The appraisers did evaluate the land on a strictly productive basis and estimated the average value per acre of the land without improvements.

Value of improvements: Improvements in this case include both houses and other buildings and the cost of drainage improvements, although it excludes the cost of levees both Federal and private incurred by the farmers. The larger value of improvements for farm in the upland area is caused by the additional buildings needed for livestock operations and by the presence of large tobacco barns in this area; both the livestock and tobacco operations are more extensive in the upland than in the flood plain area. In this analysis the farms have also been divided into three size classes (less than 50 acres, 50-150 acres, greater than 150 acres) and the improvements enter the regression analysis on a per acre basis as multiplicative dummy variables.

Soil Classes: Soils have been broken down into five soil classes, I through V. The classification of the soils was done by the appraisers using the "Soil and Capability Legend" prepared by the Soil Conservation Service as a guide.[4/] In general the classification of soils is based on a combination of the actual quality of the soil and the extent to which conservation practices must be employed in farming the land. The fact that the appraisers had to make this determination (the SCS classification not having been made as of yet in the study area counties) raised the possibility that the soil classes and who classified the soils might be highly correlated. Table 2 presents simple correlation coefficients for several of the independent variables including the appraiser variables and soil classes. The coefficients are based on all of the observations in the unprotected and upland areas (112 farms); the extent of the linear association among these variables is greater for those areas than for the area protected by Federal levees. The coefficients indicate that the extent of interrelationship among the soil class and appraiser variables is quite small.

One improvement in the basic data which was made in this case was the division of the land by soil class and use (crops, grass, timber)

4/ A copy of the Legend appears as Appendix G. Note that classes V-VIII, all unsuited for crop production, have been aggregated into a single class, V, for this study.

Table 2

Missouri River Analysis
Simple Correlation Coefficients of Selected Variables
Combined Upland and Unprotected Area Observations

	Fraction of Farm in Soil Classes			Dominant Topography of Farm		
	I & II	III	IV & V	Rolling	Steep Rolling	Hilly
Appraiser 1	.33	-.29	-.20	-.23	.19	-.16
" 2	-.02	-.05	.13	.26	-.10	-.13
" 3	-.32	.18	.35	-.06	-.03	.63
" 4	.09	.20	-.07	-.19	.09	-.03
" 5	-.12	.32	.09	.43	-.04	-.14
Fraction of farm in cropland	.56	-.35	-.55	-.39	-.21	-.30
Fraction of farm in grass-land and timber	-.57	.42	.63	.45	.16	.32

between those located in flood prone and flood free areas. Since all land in the unprotected area is flood prone and that in the upland is flood free, the only area which contained both types of land was the protected area; the flood prone land in this area is the few hundred acres outside of the Federal levee.

Topography: The appraisers as part of their evaluation of each farm classified the topography of the farm as being dominantly in one of four classes: level, rolling, steeply rolling, or hilly. In other words for each farm one of these variables takes on a value of unity and the other three a value of zero. In the regressions, variables for the last three classes appear, and their coefficients are interpreted relative to farms which are dominantly level. An inverse relationship between the three included topographic variables and the dependent variable is expected as a level farm ceteris paribus should be less costly to cultivate and/or more productive than others.

Distance from Urban Centers: As mentioned in the description of the study area, the study area is bounded to the north and south by St. Joseph, Missouri and the new Kansas City International Airport. Although it was attempted to sample far enough north of the airport in the upland subarea to avoid speculative influences, distance variables from both of these centers have been used in the regression analysis. If an urban or speculative influence were present in either case, one would expect an inverse relationship between the air distance from the centers and the average value of the land per acre.

Appraisers: The statistics in Table 1 indicate that all six appraisers did work in each of the three subareas involved in the study. Also, the simple correlation coefficients presented in Table 2 show that in general the extent of linear association between who appraised the farm and the productivity and topography assigned to the farm is quite limited. It is still possible, however, that the value assigned to the land may vary systematically with who appraised it. To account for the variance in the value of the land attributable to the particular biases of the individual making the estimate, five additive dummy variables have been employed. These variables should, of course, be interpreted as adjusting the constant term of the regression relative to the estimates made by the first appraiser.

Flood Risk: Six measures of flood risk have been dominantly used in the analysis; these variables along with their means can be listed as follows:

FLOOD RISK VARIABLES	Mean
1. Fraction farm in 1-5 year flood zone.	.091
2. Fraction farm in 5-25 year flood zone.	.885
3. Average fraction of farm flooded annually over 25 year period.	.226
4. Average fraction of farm flooded 1965 & 1967	.334
5. Fraction of farm protected by private levee	.797
6. Farm has Missouri River frontage	.194

It should be emphasized that these variables take on non-zero values only for farms in the area protected by the private levee system. It follows, then, that in the regression models, presented later in this Chapter which are based on the pooled observations of this area and one of the other areas, the first five of these variables enter the regression as multiplicative dummy variables. The final variable, Missouri River frontage, enters as an additive dummy variable since it takes on a value of one for those farms having such frontage and is zero otherwise.

Two distinct types of information underlay the construction of these variables. Because in both 1965 and 1967 floods of slightly greater than that of a five year frequency occurred in the study area, it was possible to determine directly the extent of the flood damage to each of the sample farms by asking the owners or tenants about the damage which took place. The second source of flood damage data was the Hydrologic Division of the Corps' Kansas City District office which estimated the amount of flooding on each farm for the 1-5 year, 5-25 year, and 100 year floods by matching topographic and plat maps and the height of the river rise associated with these various floods. It was not possible to measure the flood damage on a more disaggregated basis (10 year, 20 year, etc.) because of the extreme levelness of the flood plains.[5/]

The amount of flood damage shown by the variable (4) based on the interview information is considerably greater than that indicated by the hydrologic data. There are two reasons for this discrepancy. One is that the '65 and '67 floods were slightly greater than the five year

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5/ There are only one or two five foot contours from the river edge to the strip embankments which mark the end of the flood plains.

flood, so that the difference might be simply attributed to differences in the size of the flood. A second and possibly more important explanation of this difference is that during periods of high water this area is troubled by river water "boiling up" and covering the land. Thus this measure might be considered to be slightly more general than that based solely on the matching of contours and river stages.

The third measure, the average fraction of farm flooded annually over a 25 year period, was hoped to provide a somewhat more general indication of the overall flood risk to each farm. This variable was constructed by weighting the fraction of the farm flooded by a flood of given frequency by the number of times it would occur over the 25 year period, summing over all frequencies and dividing by 25. There were two reasons for limiting the period to 25 years. This was thought to be about the maximum period that those in market would take into account in estimating the value of the property. In addition, because the difference between the amount of land flooded by the 25 and 100 year floods is only about 10% of the total, the difference in the weights between the two cases would be minimal.

The data upon which to construct the fifth and a sixth variable was gathered by the appraisers. Regarding the fraction of the farm protected by a private levee, because the entire "unprotected" area has a private levee running parallel to, although at varying distance from the Missouri River, those farm units separated from the river by a farm across which the private levee runs were considered to be wholly protected by the levee.

As one might expect, these various measures of flood risk are related to each other to a fairly large extent. To demonstrate this the simple correlation coefficient matrix for these variables is presented in Table 3. In addition to simply demonstrating the degree of linear association, the information in the table might be recalled when the various regressions are presented; the high correlations between some of these variables preclude using them together in the same regression.

C. Empirical Analysis

In presenting the results of the regression analysis, we deviate from the procedure of the previous chapter of presenting a separate analysis for each area and then the results of the pooled regressions. Here separate analysis of the unprotected area only is presented along with the comparative analysis. There are two reasons for this. One is that the analysis of the last chapter demonstrated in general the type information which can be derived from this work. Second, and more important, is the fact that the analysis of the protected flood plain and the upland areas together demonstrated clearly that after accounting for differences in productivity, improvements, topography, and location, there was no significant difference between the value of the land in the two areas. This leaves us free to concentrate on the analysis of the unprotected area both by itself and relative to the two areas.

Table 4 presents selected regressions for the sample farms in the unprotected area only. The first regression is the basic model, and the

Table 3

Missouri River Analysis
Simple Correlation Coefficients of Selected Flood Risk Variables
For Unprotected Floodplain Area

		(1)	(2)	(3)	(4)	(5)	(6)
(1)	Missouri River Frontage Unprotected Area	1.0					
(2)	Fraction of Farm Protected by Leeves	.183	1.0				
(3)	Fraction of Farm in 1-5 Year Flood Zone	.440	-.025	1.0			
(4)	Fraction of Farm in 5-25 Year Flood Zone	.343	.890	.332	1.0		
(5)	Average Fraction of Farm Flooded Annually over 25 Year Period	.344	.890	.332	.940	1.0	
(6)	Average Fraction of Farm Flooded '65 and '67	.443	.429	.410	.611	.612	1.0

variables included in it are included in the other four regressions along with various measures of flood risk. There are only a few aspects of the basic model which require comment. One obvious factor is the omission of a variable for the fraction of the farm in the best two soil classes. This variable was omitted because of the substantial multicollinearity between it and the other two soil class variables. Interpretatively, because the bulk of the soils in the area are in classes I and II (82%), the other soils are discounted relative to these. The value of improvements enters significantly into the analysis only for larger farms, those containing more than 150 acres. This finding, consistent with our experience in the Wabash analysis, can be explained in the following way. Since the dependent variable is the value of land without improvements, the significance of improvements as an independent variable indicates that they add significantly to the productivity of the land. That the improvements variable is statistically significant only for large farms implies that it is only for units of this minimum size that these facilities enhance the productive process. One reason for this might be simply that as the size of the farm increases the ratio of the value of the home to the value of other improvements decline sharply.

Finally, it is significant that the dummy variables for the appraisers are generally insignificant or significant at low levels of confidence. This indicates that very little of the variance in land values is explained by who made the estimates and thus offers support to the hypothesis that in general estimates made in this manner are subject to fewer systematic extra-market or random influences.

Table 4

Missouri River Analysis
Regression Analysis of Land Differential Associated with Flood Risk
Unprotected Area Only
(Coefficients are in Dollar Terms; Student t Statistics in Parentheses)

Dependent variable: per acre value of land without improvements

	(1)	(2)	(3)	(4)	(5)
Constant	479.0 (8.00)	492.4 (7.55)	524.4 (8.17)	482.2 (6.81)	473.4 (7.86)
Fraction farm in Soil Class III	-104.3 (5.27)	-96.2 (4.92)	-110.7 (5.89)	-109.4 (5.87)	-108.7 (5.96)
Fraction farm in Soil Class IV & V	-306.7 (5.47)	-280.2 (4.83)	-232.0 (4.10)	-246.5 (4.23)	-250.8 (4.57)
Log Total Acres	-13.5 (2.50)	-5.47 (.85)	-10.3 (1.90)	-9.90 (1.65)	-9.70 (1.65)
Distance from K. C. Int'l Airport	-.45 (.16)	-1.14 (.39)	-1.68 (.61)	-1.81 (.66)	-1.72 (.64)
Improvements on Large Farms	.703 (2.45)	.525 (1.81)	.497 (1.79)	.477 (1.73)	.476 (1.74)
Appraiser 1	19.5 (1.20)	12.8 (.80)	13.9 (.92)	12.4 (.82)	12.2 (.82)
Appraiser 2	4.72 (.21)	8.86 (.39)	9.27 (.44)	8.86 (.42)	8.40 (.40)
Appraiser 3	2.67 (.13)	-23.9 (1.02)	-28.3 (1.26)	-17.3 (.73)	-15.2 (.70)
Appraiser 4	22.3 (1.25)	16.2 (1.00)	18.2 (1.16)	17.2 (1.11)	17.0 (1.11)
Appraiser 5	6.51 (.30)	5.36 (.25)	22.0 (1.01)	18.3 (.85)	16.7 (.82)
Missouri River Frontage		-13.4 (1.00)	-1.69 (.12)	-1.27 (.09)	-2.02 (.15)
Fract. farm in 1-5 yr. flood zone			-66.7 (2.56)	-11.7 (.24)	
Fract. farm in 5-25 yr. flood zone		-29.8 (1.14)	-37.7 (1.56)	-49.1 (1.94)	-50.8 (2.12)

Table 4 (Cont'd)

Fract. farm flooded Av. '65 & '67		-24.0 (1.40)			
Fract. farm protected by private levee				54.3 (1.36)	62.4 (2.94)
R^2	.659	.698	.723	.734	.734
F	9.86	8.53	9.66	9.26	10.2

The remaining four regressions fall clearly into two groups, those which give explicit consideration to the effects of the private levees on land values (Nos. 4 and 5) and those which do not (Nos. 2 and 3). In evaluating these variables, a .20 level significance (i.e. a t-statistic of 1.25 or greater) is required in order for the coefficient to be treated as being significantly different from zero. Using this criteria the effect of a farm fronting on the Missouri was found to be of negligible importance, after taking the fractions of the farm subject to flooding into account.[6/]

The low levels of significance of the flood risk variables other than river frontage in regression (2) should not be taken too seriously. The large simple correlation (shown in Table 3) between these two variables increases the standard errors of these variables beyond what they would be in the absence of this linear dependency and consequently lowers the value of the t-statistics. Discounting these t-statistics somewhat, the combined effect of the flood risk variables in regressions (2) and (3) indicate a differential evaluated at the mean in land value between those farms in the unprotected area which are subject to flooding by storms of 25 year frequency or less and those which are not of about $30 per acre.[7/] This result is dramatically reversed when the effects of the private

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6/ The addition of the river frontage variable only to the basic model showed the variable to be of marginal significance indicating about a $6 per acre differential associated with such locations.

7/ In reality the distinction is not this clear. Only 18 of the 62 sample farms are not completely covered by the 25 year flood, so that the differential is between those which flood completely and those which only partially flood.

levees are taken explicitly into account by adding a variable for the fraction of the farm protected by the levee system. Again use of the combined effect of the flood risk variables evaluated at their means for regressions (4) and (5) indicates that the value of land per acre for farms with an average amount of levee protection (80%) is at a slight premium of $2-5 compared to those with less protection. Taking the results of this analysis on balance one would have to conclude that there is very little difference in the land value among farms within the unprotected area. Given the general nature of the flood damage resulting from relatively minor floods, this result was to be anticipated.

We are now ready to examine the differential between land values between the flood free areas and the flood subject area. To do this two comparisons are made using the pooled observations from the two areas in the same type of regression analysis as that employed in the last chapter. The two comparisons carried out using the Missouri data are: one between the value of the land in the flood plain area protected by the Federal levee and the land in the flood plain area protected only by a private levee (the "unprotected" area); and one between the value of the land in the flood free upland area near the flood plain and that of the flood plain area protected by the private levee. These two comparisons are discussed in order in the following paragraphs.

Selected estimated regression models using the combined protected and unprotected area observations are presented in Table 5. The first model presented is again the basic model, and the remaining five add measures of flood risk to the basic model. The variables included in

Table 5

Missouri River Analysis
Regression Analysis of Land Value Differential Associated With
Flood Risk Combined Protected and Unprotected Areas
(Coefficients are in Dollar Terms; Student t Statistics in Parentheses)

	Dependent variable: per acre value of land without improvements					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	486.9 (12.5)	554.8 (10.2)	482.8 (9.03)	546.6 (10.4)	514.6 (9.41)	540.8 (9.88)
Fraction farm in Soil Classes I & II	.50 (.20)	3.72 (.22)	4.02 (.24)	5.20 (.31)	4.21 (.25)	3.02 (.18)
Fraction farm in Soil Class III	-102.0 (4.47)	-102.7 (4.12)	-94.8 (4.12)	-94.2 (4.15)	-100.9 (4.51)	-99.1 (4.34)
Fraction farm in Soil Classes IV & V	-352.9 (7.95)	-322.0 (7.20)	-346.9 (7.88)	-337.9 (-7.67)	-322.7 (7.27)	-340.4 (7.61)
Log Total Acres	-13.3 (2.75)	-12.6 (2.44)	-8.52 (1.58)	-9.96 (1.95)	-10.8 (2.09)	-12.1 (2.30)
Value per acre of improvements on large farms	.374 (1.92)	.281 (1.45)	.294 (1.49)	.276 (1.41)	.242 (1.25)	.315 (1.60)
Distance from Kansas City International Airport	-.58 (.55)	-3.40 (-1.94)	-1.40 (.79)	-3.55 (2.01)	-2.13 (1.22)	-2.82 (1.63)
Appraiser 1	21.1 (1.68)	10.3 (.74)	18.5 (1.34)	9.41 (.68)	11.9 (.86)	9.34 (.66)
Appraiser 2	21.8 (1.52)	26.7 (1.88)	24.1 (1.66)	28.2 (1.98)	23.4 (1.65)	25.9 (1.79)
Appraiser 3	-8.89 (.59)	-22.0 (1.39)	-14.7 (.94)	-22.4 (1.40)	-21.5 (1.36)	-19.4 (-1.20)
Appraiser 4	15.8 (1.31)	13.9 (1.18)	13.0 (1.08)	12.9 (1.09)	11.4 (.97)	14.9 (1.25)
Appraiser 5	12.0 (.82)	15.8 (1.09)	10.5 (.72)	10.7 (.74)	11.6 (.81)	10.6 (.73)

Table 5 (cont'd)

Missouri River Analysis
Regression Analysis of Land Value Differential Associated With
Flood Risk Combined Protected and Unprotected Areas
(Coefficients are in Dollar Terms; Student t Statistics in Parentheses)

	Dependent variable:	per acre value of land without improvements				
	(1)	(2)	(3)	(4)	(5)	(6)
Missouri River frontage unprotected area		3.62 (.24)	-6.40 (.45)		-.93 (.06)	-8.78 (.62)
Fraction farm in 1-5 year flood zone		-5.93 (2.12)				
Fraction farm in 5-25 year flood zone		-24.9 (1.56)		-20.3 (1.27)		
Fraction farm protected by private levee			5.29 (.39)		44.4 (2.34)	
Fraction farm flooded on average '65 & '67			-33.0 (1.85)	-31.0 (1.70)		
Average fraction farm flooded annually over 25-year period					-242.0 (2.34)	-93.8 (1.48)
R^2	.632	.660	.649	.654	.644	.644
F	15.6	13.4	12.8	14.2	13.6	13.6

the first regression are, with one exception, the same as those in the basic model estimated for the unprotected area only; there are, however, some important differences. The exception is the addition of the variables "Fraction of farm in Soil Classes I and II" which was able to be included because of the reduction in linear dependency among the soil class variables. Its insignificance still reflects the implicit use of the soils in these two classes as the guide against which to judge the others. One important feature of this basic model is the significance of the variable for the distance from the Kansas City International Airport. In addition, none of the appraiser dummy variables are significant in the present analysis. This probably stems from the different sampling rates of the appraisers between the two areas. Finally, over 60% of the variance of the dependent variable is explained by the basic model, suggesting that most of the important factors have been taken into account.

Turning to the other regressions, it is observed that the flood risk variables are in general significant at high levels and that their inclusion raises the explanatory power of the model markedly. Interpretations of the flood risk variables are presented in Table 6. The summary information for each variable includes the coefficient evaluated at the mean of the sample of unprotected farms only. Intuitively, this mean is used in order to compare the two subsamples, that is the differential between the value of the protected and unprotected lands. Use of the mean of the whole sample would produce a comparison between the whole sample (combined protected and unprotected) and the unprotected

Table 6

Estimates of the Average Marginal Difference in Land Values Per Acre Between an Area Protected by Federal Levees and an Area Protected by Private Levees*

Regression No.	Flood Risk Variable b/	Coefficient (Evaluated at the Mean a/)	90% Confidence Interval (Evaluated at the Mean a/)
2	Fraction farm in 1-5 year flood zone	$ - 5.2	$ - 2.7 to - 7.7
	Fraction farm in 5-25 year flood zone	-22.0	1.2 to -45.2
		-27.2	- 1.5 to -52.9
3	Average fraction farm flooded in '65 & '67	-11.0	- 1.2 to -20.8
4	Fraction farm in 5-25 year flood zone	-17.9	5.3 to -41.1
	Average fraction farm flooded in '65 & '67	-10.3	- .9 to -19.7
		-28.2	4.4 to -60.8
5	Fraction farm protected by private levee	35.4	20.2 to 40.6
	Average fraction of farm flooded annually, 25 year period	-54.7	-16.4 to -93.0
		-19.3	3.8 to -52.4
6	Average fraction of farm flooded annually, 25 year period	-24.1	4.7 to -52.9

*The complete estimated regression models are displayed in Table 5.

a/ Because the flood risk variables enter as multiplicative dummy variables, the mean used in the evaluation is that for the subsample of unprotected farms only.

b/ All flood risk variables included are significant at a .20 level or higher.

subsample. The other information for each variable is a "90% confidence interval." This interval is the range within which the true value of the coefficient can be expected to fall nine out of the ten times (or 90% of the time). In those regressions which include more than one flood risk variable, it is appropriate to add the mean-evaluated coefficients to obtain the total effects of the flood risk variables and approximate accurately to add the bounds of the confidence intervals.

The results displayed in the table contrast rather sharply with those presented for the unprotected area only with respect to the effect on the per acre differential of including a variable for the fraction of the unprotected farm behind the private levee. It was seen earlier that when examining the sample of unprotected farms alone the inclusion of the "fraction leveed" variable had the effect of essentially eliminating any average differential among these farms due to flood damage. On the other hand the interpretation of regression 5 presented in Table 6 (and other similar regressions not shown here) shows that even after taking this protection into account the value of land per acre is about $17 lower in the unprotected area than in the protected area due to flood damage in the farms.

Examining the magnitude of the differential indicated by these various variables, the average differential is found to be about $25 with a confidence interval ranging from about zero to $50. It is emphasized that these are average values per acre across the whole of the unprotected area. The discount associated with flood damage for any given farm within the area depends on the fraction of the farm in the various flood zones and the extent of the protection afforded it by the private levee.

Representative regressions comparing the land values of the flood free upland area adjacent to the flood plain study areas and those of the unprotected flood plain area are shown in Table 7. The table has the same general format as the previous ones, and sample size is again 112. In general the fraction of the variance of the dependent variable explained in this case is somewhat larger than in the first comparison: approximately .81 vs. .65. The better fit in the present case is attributable to the greater variance in both the dependent and independent variables which results from the heterogeneity of the two areas.

There are several major differences between the basic models used in the two comparisons. One major difference is the addition of the topography dummy variables in the uplands - unprotected regression. As mentioned earlier these variables should be interpreted relative to a farm being dominantly level. The magnitude of the discounts associated with the increasing degrees of roughness are in keeping with our expectations. The other, additional variable in this model is the fraction of the farm in crops. This variable was not significant in the protected-unprotected comparisons probably owing to the very small variance in the variable for farms located in these areas. There is, however, a considerable variance among the farms in the upland area and between the two areas. Evaluated at the mean, the coefficient indicates a premium of around $20 per acre for a farm having the average of 78% of its land in crops.

Table 7

Missouri River Analysis
Regression Analysis of Land Value Differential Associated With
Flood Risk Combined Upland and Unprotected Areas
(Coefficients are in Dollar Terms; Student t Statistics in Parentheses)

	Dependent variable: per acre value of land without improvements					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	331.4	338.0	338.3	352.6	325.1	314.9
	(5.96)	(6.23)	(5.91)	(6.32)	(5.72)	(5.72)
Rolling	-16.8	-41.1	-43.6	-44.8	-23.3	-18.1
	(1.10)	(2.06)	(2.11)	(2.18)	(.92)	(.83)
Steeply Rolling	-30.9	-58.0	-61.7	-61.5	-37.0	-32.2
	(1.51)	(2.35)	(2.43)	(2.42)	(1.28)	(1.22)
Hilly	-78.0	-101.6	-102.6	-104.4	-83.6	-79.0
	(3.33)	(3.94)	(3.85)	(3.92)	(2.89)	(2.93)
Fraction farm in crops	30.5	31.3	35.1	33.4	33.5	33.9
	(1.36)	(1.46)	(1.58)	(1.51)	(1.56)	(1.60)
Fraction farm in Soil Classes I & II	133.8	137.0	137.8	138.4	127.8	127.9
	(2.79)	(2.99)	(2.92)	(2.92)	(2.76)	(2.80)
Fraction farm in Soil Classes III	39.5	37.2	43.6	40.6	32.8	35.4
	(.88)	(.86)	(.98)	(.92)	(.76)	(.83)
Fraction farm in Soil Classes IV & V	-50.5	-42.8	-46.3	-47.5	-44.9	-44.4
	(1.27)	(1.13	(1.18)	(1.21)	(1.18)	(1.18)
Log Total Acres	-19.0	-14.6	-14.6	-17.1	-15.2	-14.1
	(3.72)	(2.90)	(2.61)	(3.33)	(2.75)	(2.80)
Improvement on large farms	.430	.332	.355	.390	.308	.300
	(2.42)	(1.93)	(1.98)	(2.21	(1.77)	(1.74)
Appraiser 1	25.4	27.0	25.3	24.0	25.8	23.2
	(2.08)	(2.30)	(2.09)	(1.98)	(2.12)	(2.00)

Table 7 (cont'd)

Missouri River Analysis
Regression Analysis of Land Value Differential Associated With
Flood Risk Combined Upland and Unprotected Areas

(Coefficients are in Dollar Terms; Student t Statistics in Parentheses)

	Dependent variable:	per acre value of land without improvements				
	(1)	(2)	(3)	(4)	(5)	(6)
Appraiser 2	1.24 (.08)	-2.81 (.19)	-2.67 (.18)	-2.07 (.14)	-3.17 (.22)	-3.30 (.22)
Appraiser 3	11.0 (.68)	4.20 (.26)	1.22 (.07)	3.31 (.20)	4.63 (.29)	3.37 (.21)
Appraiser 4	-2.88 (.19)	-5.59 (.39)	-7.12 (.47)	-4.42 (.30)	-9.95 .67)	-11.2 .77)
Appraiser 5	23.3 (1.62)	24.7 (1.76)	17.6 (1.22)	18.7 (1.30)	25.7 (1.81)	23.8 (1.71)
Fraction farm in 1-5 year zone		-68.8 (2.73)			-29.9 (.70)	
Fraction farm in 5-25 year zone		-27.3 (1.37)	-31.2 (1.44)		-53.9 (1.89)	
Average fraction farm flooded '65 & '67			-19.2 (1.07)			
Fraction farm annually flooded 25-year period				-155.8 (2.84)		-255.0 (3.09)
Fraction farm protected by levee					46.6 (1.32)	62.8 (2.98)
R^2	.808	.829	.818	.816	.833	.832
F	29.2	28.8	26.7	28.4	25.7	29.3

With respect to the soil class variables, there is a marked contrast between the two comparisons. In the present case there is a substantial premium assigned to farms with better soils and a substantial discount assigned to those with the poorer soil, with soils of average quality having no real influence on the value of the land. Heuristically, the situation again appears to be one of using the Class III soil as a benchmark from which to value better or worse soils. The remaining variables in the basic model have already been discussed.

The addition of the flood risk variables to the basic model increases the explanatory power of the model significantly. Note that in this case the dummy variable indicating Missouri River frontage has been omitted because in the analysis of the unprotected sample farms alone and the protected-unprotected area comparison was insignificant. Interpretations of the flood risk variables are presented in Table 8. Probably the most striking feature about these results in their consistency with those for the protected-unprotected comparison. On balance the average per acre differential in the value of land between the flood plain area protected by a private levee and the flood free upland area associated with flood damage after having taken account of differences in productivity, topography, and location is about $25.

Table 8

Estimates of the Average Marginal Difference in Land Values Per Acre Between a Non-Floodplain Flood-Free Area and an Area on the Floodplain Protected by a Private Levee*

Regression No.	Flood Risk Variable b/	Coefficient	90% Confidence Interval		
		Evaluated at the Mean a/			
2	Fraction farm in 1-5 year flood zone	$ - 6.2	$ - 2.5	to	$ -10.1
	Fraction farm in 5-25 year flood zone	-24.1	4.7	to	-52.9
		-30.3	2.2	to	-63.0
3	Fraction farm in 5-25 year flood zone	-27.6	3.9	to	-59.1
4	Average fraction farm flooded annually, 25 year period	-35.2	-13.9	to	-56.5
5	Fraction farm in 5-25 year flood zone	-47.6	- 1.9	to	-93.3
	Fraction farm protected by private levee	37.3	- 9.0	to	83.0
		-10.3	-10.9	to	-10.3
6	Average fraction farm flooded annually, 25 year period	-57.3	-27.2	to	-87.4
	Fraction farm protected by private levee	55.5	36.9	to	74.1
		1.8	9.7	to	-13.3

*The complete estimated regression models are displayed in Table 7.

a/ Because the flood risk variables enter as multiplicative dummy variables, the mean used in the evaluation is that for the subsample of unprotected farms only.

b/ All flood risk variables included are significant at a .20 level or higher.

APPENDIX A

The Problem of Specification Error and the E.R.S. Estimation Procedure

APPENDIX A

The Problem of Specification Error and the E.R.S. Estimation Procedure

The purpose of this appendix is to discuss the procedure adopted by E.R.S. in conducting their regression analysis in light of the general issue of specification error. The discussion which follows is based rather explicitly on the treatment of this topic by Goldberger, and the notation is the same as his in his treatment of the classical linear regression model.* We will begin by briefly describing the procedure actually used and then shall discuss the several points at which specification error might occur and the probable seriousness of the problems.

It is useful to think of the E.R.S. procedure as consisting of three steps, the third of which produces an estimate of the extent of the association between flood risk and land value. The first step consists of the estimation of a model of the following form for farms located in upland (flood free) areas.

$$Y = X_1 \beta_1 + \varepsilon$$

where

Y is the $(T \times 1)$ vector of observations on the regressand,

X is the $T \times (I + H)$ matrix of observations on the regressors,

β is the $(I + H) \times 1$ vector of coefficients,

ε is the $(T \times 1)$ vector of residuals,

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* Arthur S. Goldberger, Econometric Theory (New York: John Wiley and Sons, 1966).

T is the number of observations,

H is the number of regressors.

The second step involves substituting the values of the same independent variables of flood plain farms (X_1^{11}) into the resultant regression and obtaining an estimated value of the farm per acre, Y. In the third step the difference between the estimated and actual dependent variable was regressed on flood risk variables (X_2) or

$$\hat{\hat{Y}} = (Y - \hat{Y}) = X_2 B_2 + \varepsilon^1$$

The next several statements set out a standard specification error framework. Following this various implications for the E.R.S. procedure are discussed.

Assume that the complete model to be estimated is of the form

(1) $Y = X_1 \beta_1 + X_2 \beta_2 + \varepsilon$

where X_1 includes H regressors and X_2 contains K-H regressors. Then

(2) $Y - X_1 \beta_1 = X_2 \beta_2 + \varepsilon$

which suggests that an estimate of β_2 could be obtained by regressing the residuals from the regression of Y on X_1. Computationally, b_1 is estimated as

(3) $b_1 = (X_1^1 X_1)^{-1} X_1^1 Y$

so that

(4) $\tilde{Y} = Y - X_1 \tilde{b}_1 = Y - X_1 (X_1^1 X_1)^{-1} X_1^1 Y = M_1 Y$

where $M_1 = I - X_1 (X_1^1 X_1)^{-1} X_1^1$

then regressing these on X_2 to estimate β_2

(5) $\tilde{b}_2 = (X_2^1 X_2)^{-1} X_2^1 M_1 Y)$

Now then the estimate of β_2 from a full regression of Y on X_1 and X_2 together is

$$(6) \quad b_2 = (X_2^1 M X_2)^{-1} (X_2^1 M_1 Y)$$

Thus comparing (5) and (6) it is seen that

$$(7) \quad \tilde{b}_2 = (X_2^1 X_2)^{-1} (X_2^1 M_1 X_2) b_2$$

$$= [I - (X_2^1 X_2)^{-1} X_2^1 X_1 (X_1^1 X)^{-1} X_1^1 X_2] b_2$$

Therefore $\tilde{b}_2 \neq b_2$ unless $X_1^1 X_2 = 0$ or $b_2 = 0$.

It is also clear that the estimator of β_1 obtained in (3) would not be identical to that obtained from a full model; specifically

$$(8) \quad b_1 = b_1 + Bb_2$$

$$\text{where } B = (X_1^1 X_1)^{-1} X_1^1 X_2$$

With specific reference to the E.R.S. procedure, it is possible that there exists a systematic relationship between some of the X_1 variables which include soil qualities and fraction of the farm in various uses with X_2 which are various measures of flood risk including simply being on the flood plain. This problem probably does not affect the first step of the analysis significantly, but the use of the upland coefficients for the flood plain farms for which are would assume $X_1^1 X_2 \neq 0$ is a problem of greater significance and one which is discussed in greater detail.

To see this more clearly assume that the model actually estimated is of the form

$$(9) \quad Y = X_1 \beta_1 + \varepsilon^*$$

$$(10) \quad \text{where } \varepsilon^* = X_2 \beta_2 + \varepsilon$$

This assumption is being based on the presence of the approximately 30% unexplained variance in Y resulting from the estimation of (9).

From (8) above it is clear that

$$(11) \quad E\ \tilde{b}_1 = E\ b_1 + B\ E\ b_2 = \beta_1 + \beta\ B_2$$

so that the estimates of β_1 will in general be biased.

Further, in the second step, that of regressing Y on β_2 or in the E.R.S. case, a rather special case of the residuals on the flood frequency and probability variables.

It is also evident that the regression

$$(12) \quad \tilde{Y} = X_2\ \beta_2 + \epsilon^{**}$$

$$(13) \quad \text{where } \epsilon^{**} = -\ X_1\ (b_1 - \beta_1) +$$

is generally biased. That is from (7) above

$$(14) \quad E\ \tilde{b}_2 = [\ I - (X_2^1\ X_2)^{-1}\ X_2\ X_1\ (X_1^1\ X_1)^{-1}\ X_1^1\ X_2\ ]\ E\ b_2$$

$$= \beta_2 - (X_2^1\ X_2)^{-1}\ X_2^1\ X_1\ B\ B_2$$

In short this bias is attributable to the fact that there is specification error; a generalized linear regression model and not the classical is appropriate in this case since the disturbance term ϵ^{**} does not have a zero expectation.

Having gone this far we pause to question the importance of each of the several points raised above. The first point is the extent to which important variables have been omitted from the analysis or more exactly from regressions of flood plain farms, upland farms, and combinations of the two (step 1 of the E.R.S. analysis). It is difficult to specify variables of major importance which might have been omitted, although the specification and measurement of some of those included are certainly weak. In brief, this is a general problem confronted in the estimation of this type of a model and are not particular to this case nor particularly strong here. The second point concerns the use of upland coefficients to determine a calculated price/acre of flood plain farms. There are two aspects of this question which deserve careful consideration. The first is whether or not the coefficients of only the variables included in the regression for upland farms are significantly different from the coefficients of the same variables estimated in a regression of flood plain farms only. The second aspect deals with the question of whether or not the coefficients of the flood plain farms estimated as indicated in the previous sentence are significantly altered by the introduction of flood plain variables into the regression; put differently, the question is whether or not $X_1^{1} X_2 \neq 0$ for flood plain farms. It should be noted that significant differences between the coefficients in either case are sufficient to show that the ultimate estimates of the effect of flood risk on land prices is biased.

The statistical evidence on these points is quite conclusive. First concerning the issue of whether the coefficients of the same regression run separately for upland and flood plain farms are the same, it is clear that they are not. In regressions using sale price per acre (gross price per acre) which was the same as that estimated by E.R.S. for the Upper Wabash except that a year trend variable was substituted for the separate year dummies and multiplicative dummies were employed for the value of improvements variables instead of additive dummies, and a variable for the fraction of farm in crops was added, the quality of soil variables and fraction of farm devoted to crops variable were significantly different from zero for the upland farms.* These same variables, however, were not significantly different from zero for flood plain farms; but they were significantly different from the same upland coefficients. The fact that these extremely important variables have such markedly different effects between the two locations argues strongly against the employment of one set of coefficients to represent the other.

With respect to the effect of adding flood risk or flood damage variables to the regression of sale price/acre of flood plain farms, Table A-1 shows that the changes in other coefficients are significant. A description of most of the independent variables is provided in the text. Net price per acre is the sale price less the value of improvements. The year-risk variables are multiplicative dummy variables one of which takes on the value of the average annual fraction of cropland flood over a 25 year period if the sale was made between 1952 and 1957 and zero otherwise; the other takes on non-zero values if the farm was sold after 1956. The positive sign of year-risk before 1957 indicates that a premium was paid during this period, after accounting for simple trend considerations. This reflects presumably the increase in protection which was afforded this reach of the Wabash in the early fifties. The positive sign of the final independent variable was anticipated, as it reflects a bonus paid for flood plain land subject to less flood risk. This compares, for example, with a discount of about $70 per acre for farms which front on the Wabash. These points are only incidental to the thrust of this discussion. Of the

* For a description of the original form see the E.R.S. report, Vol. 1, Part II, p. 137.

seven independent variables included in both regressions, three differ significantly between the form which does not include the flood risk variable and that which does.

In summary, on the basis of the empirical evidence just presented it seems quite clear that the statistical procedure adopted by E.R.S. has led to bias estimates of the effect of flood risk on land values in the Upper Wabash area.

TABLE A-1

REGRESSIONS FOR UPPER WABASH FLOOD PLAIN FARMS

	Net Price Per Acre	Net Price Per Acre	Test for Difference of Coefficients
Constant	92.2 .70	28.1 .24	
Warrant	4.50 1.19	71.4 2.09	significantly different at 1% level [a]
Contract	59.8 1.01	80.9 1.56	
Expansion	74.2 2.20	48.6 1.59	
Year of Sale	9.68 1.41	12.8 2.11	
Log of Total Acres	-23.6 1.08	-48.0 2.32	significantly different at 20% level [a]
Yr-Risk Before '57	7.26 .70	20.1 2.01	significantly different at 20% level [a]
Yr-Risk '57 or After	47.9 .70	45.0 .76	
Fraction of Crops in 25 Year Flood Zone		174.3 3.12	
R^2	.281	.471	

[a] Two-tail Test

Student t statistics appear under the coefficients.

A P P E N D I X B

General Characteristics of the Wabash River Basin and the Selection of the Study Areas

Appendix B
General Characteristics of the Wabash River Basin
and the
Selection of the Study Areas

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. 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 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. Natural drainage is frequently poor in the level areas. Coal, interbedded with Pennsylvania shales and sandstone, is found in the southwestern part of the basin in the Wabash Lowlands, Mount Vernon Hill

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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). The Wabash River Basin: Water Resources Planning (Brochure prepared by the U. S. Army Corps of Engineers and cooperating agencies; no date, number of publisher given). Ronald R. Boyce (ed.), Regional Development and the Wabash Basin, Urbana: University of Illinois Press, 1964.

Country, and Springfield Plain areas. It is currently strip mined 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.

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 6.

Flood Problems

The major portion of the Wabash and many of its tributaries flow through flat terrain with relatively poor natural drainage. Streambeds have relatively little slope and shallow streambank. The gradient of the Wabash River, for example, averages approximately 1½ feet per mile, ranging from approximately 4 feet per mile in the headwaters to about 0.6 feet per mile near the mouth.[2/] The nature of the terrain precludes extensive major impoundments of water.

The flood plains comprise something over a million acres, one-half of which is leveed. The major flood damages occur on the exposed flood plains located primarily in the southern one-third of the basin.[3/] There have been 15 major floods on the Wabash since 1875. Estimated flood damage from the 1913 flood was $30 million; from the 1943 flood, $21 million; and from the 1950 flood, $6 million, all in 1953 dollar terms.[4/]

The "Water Resources Planning" brochure states that "... the average annual damages in the basin, as reduced by the limited flood control works build to date, presently amount to about $35,000,000."[5/] 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 mainstem of the Wabash River (reaches W-1 through W-9) places the average annual damages at $3.8 million after allowing for

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2/ Ronald R. Boyce, Regional Development, op. cit., p. 43.

3/ Ibid.

4/ Ibid.

5/ The Wabash River Basin: Water Resources Planning, op. cit., p. 5.

protective works now in place.[6/] Nearly half (49.4 percent) of this damage amount is attributed to agricultural crop damage and another 42.2 percent to noncrop agricultural damages. The remaining damages are distributed about equally between damages to transportation facilities, levees and urban areas.[7/]

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, in his study of seasonality of flooding in the Ohio River Basin,[8/] 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 percent until the month of May, and the mode of occurrence was March-April.[9/] 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 requested study of portions or all of the

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6/ Data supplied by the Louisville District Office, U. S. Army Corps of Engineers.

7/ The COE data for urban damages are residual to all local protection in place or authorized.

8/ Robert W. Kates, "Seasonality," In: Gilbert F. White (ed.) Papers on Flood Problems, op. cit., pp. 115-128.

9/ Modes were March for the northeast and northcentral portions of the Ohio Basin and along the mainstem of the Ohio River and January-February for the southern tributaries of the Ohio.

Wabash River Basin.[10/] The earliest comprehensive report of survey scope dealing with water resources of the Wabash Basin was completed in 1932.[11/] This survey found that improvements of the Wabash River by the Federal Government were not advisable at that time. A subsequent report in 1944 concluded that flood control by levees would be the most attractive improvement from a financial viewpoint.[12/] Since the 1944 report, which lead to the authorization of several Federally-financed levee projects, emphasis was switched to construction of multipurpose reservoirs as the primary flood control medium. The reservoirs are operated primarily for flood control purposes but also fulfill 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.[13/] In addition, the Third Interim Report found favorably for five additional reservoirs.[14/]

10/ U. S. Army Engineer District, Louisville, "Wabash River Basin Comprehensive Study," Interim Report No. 3, Vol. III, p. 2.

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

12/ U. S. Congress, House, Wabash River and Tributaries, Indiana and Illinois, H. Doc. 197, 80th Cong., 1st Sess., 1944.

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

14/ Interim Report No. 3, op. cit., The Interim Reports are so called because they are part of a Wabash River Basin Comprehensive Study scheduled for completion in 1969. Originally four Interim Reports were planned.

Prior to Federal assumption of the financial responsibility for flood control work, reliance for flood 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 built 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.[15/]

In the process of this study essentially all the flood plains in the Indiana portion of the basin that were accessible by automobile were examined. The general impression one receives is that the flood risk is recognized by the majority of the flood plain inhabitants and adjustments have been taken to minimize risk. Where topography permits, farmsteads have been located off the flood plain or to take advantage of higher elevations within the flood plain. In the areas of extensive flood plains (Knox and Sullivan Counties), the type of agriculture is such that on-farm residency is not required and the rate of abandonment of existing structures appears high. In this area, there are some low-grade summer

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15/ 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 named or enumerated. Source: Map #1, Existing Levees, Wabash River Basin Emergency Flood Control Activities, January 1966. Obtained from Louisville District, U. S. Army, Corps of Engineers.

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 cultivated. Corn, soybeans, some wheat and an occasional field of alfalfa were observed in the summer of 1967 and 1968. In unprotected areas, crop production appeared restricted primarily to corn. The acreage of idle and uncleared land was proportionately greater. There is little fencing in the flood plains, apparently because the types of farming undertaken do not require extensive fencing.

Selection of Areas for Investigation

The primary criteria for selecting areas for investigation of the land value approach within the Wabash Basin were (a) to represent as wide a range of topographic and flooding conditions within the basin as possible, (b) to choose areas that were reasonably favorable to a land value approach, given the first criterion, and (c) within each area chosen, to include a sufficient number of counties to insure that an adequate number of farm sales would be obtained. The areas were chosen after consulting with personnel in the Louisville COE office, after making a reconnaissance tour of the major parts of the basin, and after conducting a pre-test of planned data collection activities in Knox County, Indiana to determine the number of observations that could be expected over a given time period. The counties selected for this study are not necessarily representative of all agricultural areas in the basin or portions of the basin affected by flood control projects. However, conclusions about techniques and principles should have relevance to similar agricultural areas both within and outside the Wabash Basin.

Since the purpose of the investigation was to determine the relationship between agricultural land values and flood risk, areas with large urban centers were excluded because urban site values may unduly affect the price of agricultural land 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 were also considered unfavorable 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 flood plains appears to be of subsistance nature.

The regression analysis planned for the study depended importantly on being able to locate tracts of land on topographical maps to facilitate determination of flood risk. United States Geological Survey (USGS) topographic maps for the Indiana portion of the basin were available in 7½-minute quadrangles (scale of 1:24,000). The mapping of the 7½-minute quadrangles was much less advanced in Illinois and only 15 minute maps were available for most areas of Illinois. The greater scale of the 7½-minute maps favored the choice of counties in Indiana. Since working in 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 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.

Brief descriptions of each of these areas is presented at the beginning of Chapter III and are not, therefore, repeated here.

A P P E N D I X   C

Data Sources and Collection for Wabash River Application

Appendix C
Data Sources and Collection for
Wabash Basin Application

Data Sources

The general sources of data utilized in 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 Offices of the County Assessors and County Auditors.

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 include:

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

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 and if the sale was a bona fide transaction between a willing buyer and seller dealing at arms length. 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.[1/] Real property is assessed at one-third of 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; 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 the other data sources (deeds, maps, and aerial photographs).

Maps and Photographs

A complete set of USGS topographic maps were assembled for each area. They were taken to Louisville where they were matched to COE

1/ 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.

flood plain charts. The inundation limits of natural or synthetic floods for a range of exceedence frequencies was transferred to the maps and provided the basis for flood risk determination for flood plain sales. In the editing process the boundaries of each flood plain tract sold were 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.[2/] 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 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.

Soil maps were available for Miami, Cass, Carroll, Knox and Bartholomew Counties. Wabash, Sullivan and Jackson Counties 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.

2/ Rockford Map Publishers, 4525 Forest View Avenue, Rockford, Ill. 61108.

Data Collection

Farm sales data were collected from county records in the eight study counties by enumerators hired from the Statistical Reporting Service, USDA. 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 flood plain 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 of flood plain land values. Inadequacies in earlier assessment records determined the starting date of 1955.

The enumerators were instructed to record all real estate transactions in their assigned counties that could be considered bona fide sales of agricultural land. The enumerators were instructed to consider all sales of sizable[3/] tracts of land to be sales of agricultural lands if the tract was located in an open agricultural area of the county, and if

3/ The enumerators were instructed to record only sales of 10 acres or more. This 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 analysis was based only on sales of 20 acres or more.

it was carried on the assessment records as a farm. Sales within corporate limits or sub-divisions as well as sales to which one of the parties was a business or corporation not clearly identified with farming were not taken. Each tract was checked further in the office by examining aerial photographs for locational attributes that might affect sale price.

The enumerators were not asked to determine if the sale could be considered bona fide. Instead they were given a set of criteria defining ineligible sales (i.e., sales that *prima facie* could not be considered bona fide). Transactions were considered eligible if (1) they were general or special warranty deeds or land contracts, (2) they carried tax stamps or a statement of price paid, and (3) they were not disqualified for any of the following reasons:

(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 or divorce settlement, 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).

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

Most deeds between private interests are general warranty deeds. These are "strong" deeds because the grantor warrants the title to be free of defects. In the case of sales by court-appointed trustees or administrators, it is common to give a special warranty deed that limits the personal liability of the administrator. If the special warranty was given to settle an estate (the most common use) the sale was considered bona fide but special warranty deeds given for other reasons (rule 1) were eliminated because of the forced sale element.

One common method of transferring property between generations within a family is to convey the land by transferring partial interest (as between father and son). Since an element of gift may be involved, these transfers were ruled ineligible (rule 6). Sales for reconveyance (rule 3) are frequently used to clear a defect in title because of errors in the original instrument or to change the way in which the property is held (to joint tenancy, for example). In this process the title to the property is first transferred to a third party who promptly reconveys it to the original party. The consideration is nominal and these are not true sales.

The other rules were similarly designed to eliminate sales unlikely to reflect full market value for agricultural purposes. The sales were further checked in the office and all sales between parties of the same surname were eliminated as possible kinship sales unless the enumerator or other local officials knew that this was not the case. The criteria for determining bona fide sales were made restrictive because the anticipated sample size, geographic distribution, and time requirements made follow-up interviews with land buyers and sellers impractical and therefore more reliance had to be placed on the pre-specified criteria.

The schedules from this stage of data collection 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.

The search for additional sales was decided upon after the initial returns from the first data collection stage indicated that fewer flood plain sales than expected had occurred in the Upper Wabash area. The number of flood plain 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 flood plain 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 flood plain observations were 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 a total of 406 sales recorded, of which 60 contained some flood plain 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 8-W were selected. This eliminated three civil townships and parts of two others that contained no flood plains. The final count yielded 334 sales covering the period 1962 through 1967. There were 74 sales containing some flood plain 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 flood plain sales. The sales covered the period of 1964-66 only.

A P P E N D I X   D

Description of the Missouri River Study Area

Appendix D
Description of the Missouri River Study Area

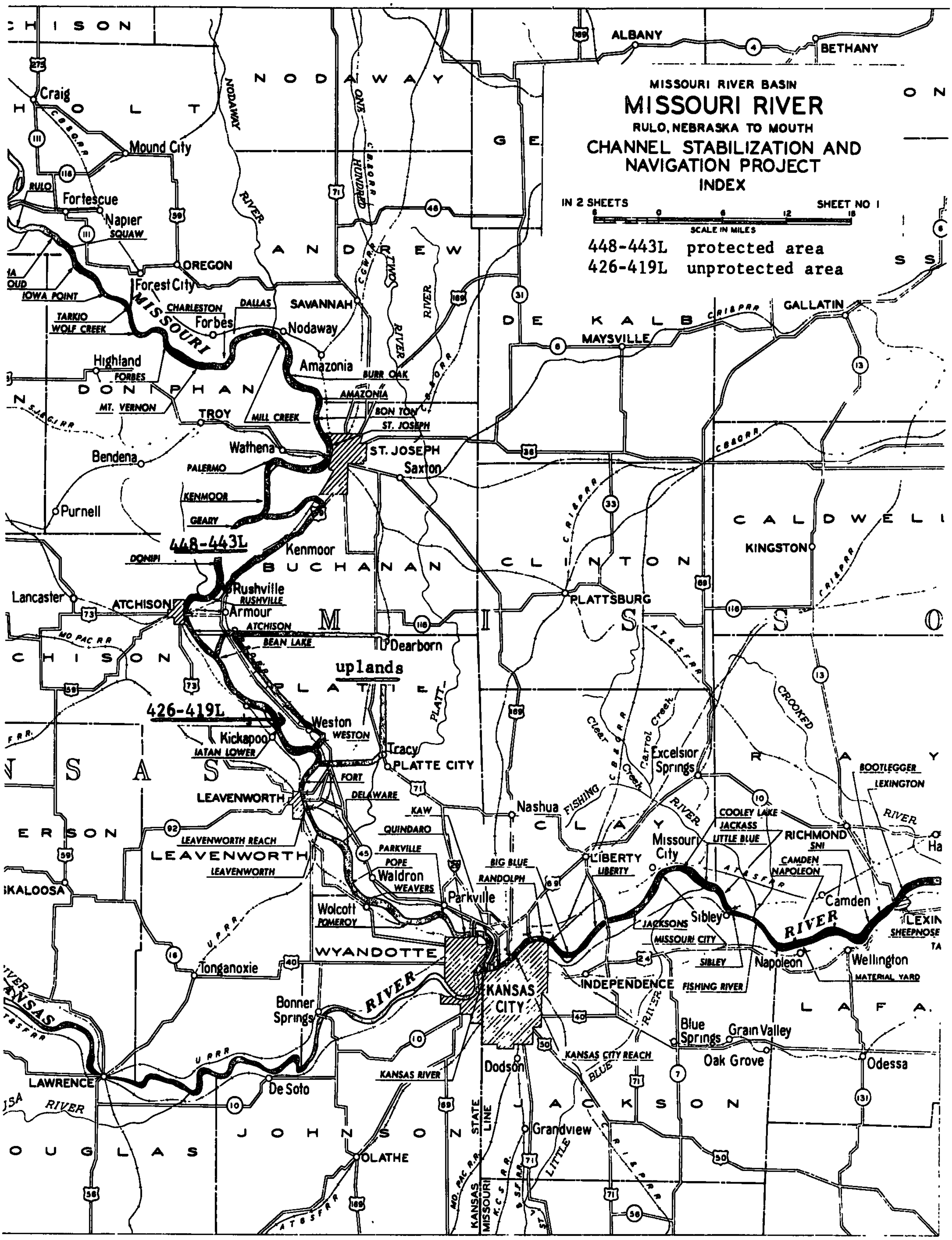
Three areas were selected to test the concept of changes in land value as an indication of flood benefits. These three areas are: an upland area where no threat of flood exists -- consequently no impaired land value, protected area, levee unit 448-443L, and an unprotected area, levee unit 426-419L (a unit that was proposed for construction but not constructed). These two levee units are very similar; there being only some 14 river miles between them. Both are agricultural, row-crop areas. These three study areas are located between St. Joseph and Kansas City, Missouri. The upland area is between Interstate 29 and the Missouri River. The upstream end of unit 448-443L is about seven miles south of St. Joseph. Leavenworth, Kansas, is about 11 miles south of unit 426-419L. Kansas City is some 30 miles downstream.

Farming operations in the protected, unprotected, and upland area are primarily corn, wheat and soybeans. Returns per acre average from \$80 to \$125 for the various type of crops reported. Almost without exception all the agricultural operations were row crop. There were no large feed lots observed. Tobacco is a very significant income-generating crop but uses only small land area. A tobacco allotment was generally reported to be worth about \$3,000 per acre. Several of the farms in this study area, and in most of the upland area, curing barns. Tobacco acreages were in Platte County and not in Buchannan. Most of the acreage is located in the upland.

The upland area is located in Platte County, Missouri. Approximate boundaries of the study area are: Interstate 29 on the east, Missouri Route 45 on the west and south, and the county line on the north. Data from 25 sales covering approximately 3,200 acres were utilized as a base. A major influence on land value is the proximity of the Kansas City International Airport. This facility has been used by TWA as an overhaul base for the past few years. Current plans are to move the operations of the Kansas City Municipal Airport to the site by the end of 1970. Influence of this proposed change was fairly obvious and changes in land values far above those normally expected to occur were observed. Action was taken to allow for this influence in the estimates prepared for this area.

Using the 25 sales as data, the appraisers prepared 50 estimates in the upland area. These estimates contained 7,342 acres, which is approximately 25 percent of the total area. Some 12 of the estimates contained land that was also part of one of the sales used. Size of tracts ranged from 39 acres to 478.

The unprotected area levee unit No. 426-419L contains some 13,440 acres of land that would have been protected. A report, Missouri River Agricultural Levees, Sioux City, Iowa, to the Mouth (Rulo, Nebraska, to mouth), Design Memorandum No. 1 - Levee Unit 426-419L, dated 29 May 1957, was prepared as definite project report by the Kansas City District of the Missouri River Division. This levee unit was part of the comprehensive plan for the Missouri River Basin authorized by the Flood Control Act of 1944 (Public Law 534, 78th Congress, 2nd Session).


MISSOURI RIVER BASIN
MISSOURI RIVER
RULO, NEBRASKA TO MOUTH
CHANNEL STABILIZATION AND
NAVIGATION PROJECT
INDEX
IN 2 SHEETS
SHEET NO 1
SCALE IN MILES
448-443L protected area
426-419L unprotected area
448-443L
426-419L
uplands
NODAWAY
ANDREW
DE KALB
DONIPHAN
BUCHANAN
CLINTON
CALDWELL
PLATTE
CLAY
RAY
LEAVENWORTH
WYANDOTTE
JOHNSON
JACKSON
MISSOURI
KANSAS
MISSOURI RIVER
KANSAS RIVER
ALBANY
BETHANY
Craig
Mound City
Fortescue
Napier
OREGON
Forest City
Forbes
Nodaway
SAVANNAH
Amazonia
GALLATIN
MAYSVILLE
Highland
TROY
Wathena
ST. JOSEPH
Saxton
Bendena
Purnell
Kenmoor
KINGSTON
Lancaster
ATCHISON
Rushville
Armour
PLATTSBURG
Dearborn
Weston
Kickapoo
Tracy
PLATTE CITY
Excelsior Springs
LEAVENWORTH
Nashua
LIBERTY
Missouri City
RICHMOND
Waldron
Parkville
Wolcott
Camden
Sibley
Tonganoxie
KANSAS CITY
INDEPENDENCE
Napoleon
Wellington
Bonner Springs
Blue Springs
Grain Valley
Oak Grove
Odessa
Dodson
LAWRENCE
De Soto
Grandview
OLATHE

The overall levee program was described in "Definite Project Report, Missouri River Agricultural Levees, Sioux City, Iowa, to Mouth" dated 17 March 1947. Proposed protective works included 24.6 miles of levees and appurtenant structures with provisions for stability berms and underseepage control where necessary. Approximately 13.7 miles of levees would be along the Missouri River, and 10.9 miles would be tributary tieback levees; 0.7 miles of tieback tributary levee would have been to provide protection to the town of Weston.

These proposed works were estimated to cost $3,720,000. The local sponsor would have provided $320,000 of this cost. The Weston-Iatan District was organized 9 October 1952 as the local sponsoring agency to provide the necessary lands. This District was disbanned by an order of the Circuit Court of Platte County dated 21 December 1963.

At the time of the 1957 report the only levees available to protect against flooding were some 11.1 miles of privately-constructed levees. These levees have been repaired periodically under emergency levee repair programs. A high degree of protection is provided by the upstream reservoir system constructed by the Corps of Engineers. These upstream structures have reduced the threat of flooding and consequently provide protection to the area. The local people have in part of the area constructed levees to protect against the small frequent floods. The last serious flooding occurred in 1965.

As previously mentioned the unprotected area contained some 13,440 acres that would have been protected by the levee program. This present analysis covered a slightly larger area. Data used as a base was compiled from 11 sales covering almost 1,200 acres. Sixty-four estimates covering 12,553 acres were prepared. These estimates ranged in size from 20 acres to 1,435.

Property around Bean Lake was excluded from the analysis because of its primarly recreational use. Records indicate that recreational use of the lake, an oxbow of the Missouri River, has been occurring for the past 90 years. The number and value of structures observed during preparation of the 1957 report have increased during the intervening time period. Property around Bean Lake suffered damage estimated at $141,000 in the 1952 flood.

The protected area levee unit No. 448-443L contains 16,180 acres of land. "Missouri River Agricultural Levees, Sioux City, Iowa, to Mouth (Rulo, Nebraska, to mouth), Supplemental Definite Project Report, Levee Unit 448-443L, Part I," dated 6 December 1947 and "Supplemental Definite Project Report, Levee Unit 448-443L, Part II," dated 11 June 1948 by the Kansas City District comprise the basic reports for the levee unit. There are 14.2 miles of main stem levee and 2.7 miles of tributary tiebacks constructed.

Cost of these works was $2,919,200 of which the Federal government paid $2,740,000 and the local districts furnished the lands, easements, and rights-of-way. Hall Levee District was organized to provide these local requirements and perform the routine maintenance. This district was organized in December 1947.

Reasons for selecting the protected and unprotected areas are principally location, land use, and condition relative to the Agricultural Levee

Program. The upland area was selected to provide a check against the changes identified in the protected and unprotected areas. Efforts were made to limit the analysis to land used for agriculture presently and for the immediate future. Land use and farming practices are similar, there being no outstanding difference in size of farming operations in land use. The main difference between the protected and unprotected areas is the recreational use of Bean Lake in the unprotected area. These two levee units were proposed for construction very early in the program.

A P P E N D I X E

Qualifications of Appraisers

QUALIFICATIONS AND EXPERIENCE
(As of January 1970)

NAME : James P. Landreth

DATE OF BIRTH: 24 November 1910

PLACE OF BIRTH: Aldrich, Missouri, Dade County

EDUCATION : Graduated Dadeville High School 1929, Dadeville, Missouri

Graduated Springfield State Teachers College 1933, B. S. Education, Springfield, Missouri

Graduated Missouri College of Agriculture 1939, B. S. Agriculture, Columbia, Missouri

Successfully completed American Institute Appraisal Course I, 1958, Notre Dame University, South Bend, Indiana.

Successfully completed American Institute Appraisal Course III, 1961, University of Wisconsin, Madison, Wisconsin.

Successfully completed a course in Soil Conservation 1954, Coshocton, Ohio.

Successfully completed a course in Salesmanship Principles 1959, Rockhurst College, Kansas City, Missouri.

Successfully completed a course in Radiological Monitoring Training, 1963, given by U. S. Army Engineer District, Kansas City, Missouri.

Successfully completed a Management Institute Course 1963, given by the St. Louis U. S. Civil Service Commission.

GENERAL EXPERIENCE IN REAL ESTATE: (23 years)

Have a general knowledge of all the real estate problems, e.g., acquisition, condemnation, disposal, management, planning and control.

Employed as a farm planner with U. S. Soil Conservation Service from March 1953 to September 1956, in Clay County, Missouri. Instructed on-the-farm training to veterans from 1947 to 1953 for the Dadeville School District, Dadeville, Missouri.

Have purchased and sold farmland and city property.

APPRAISAL EXPERIENCE WITH CORPS OF ENGINEERS:

As staff appraiser from 1956 to 1957 GS-7

As staff appraiser from 1957 to 1959 GS-9

As staff appraiser from 1959 to 1963 GS-11

As a Supervisory Appraiser, GS-12, Stockton Reservoir Project from February 1963 to March 1966

As a staff appraiser from March 1966 to present GS-11

My appraisal experience with the U. S. Army Corps of Engineers, Kansas City District, has been in Missouri, Kansas, Nebraska, and Colorado, making military and civil appraisals consisting of fee, flowage easements, safety area easements, waterline easements, azimuth marker easements, clearance easements, cable line easements, approach lighting easements, inleasing and outleasing of buildings, inleasing and outleasing of agricultural lands, salvage of government buildings, siting team member, real estate requirement estimates, real estate planning reports and secured army maneuver permits.

COURT TESTIMONY EXPERIENCE:

Federal Court Commission, Salina, Kansas, 1962

Federal Court Commission, Topeka, Kansas, 1963

Federal Court Condemnation, Springfield, Missouri, 1964 and 1965

SPECIAL EXPERIENCE:

Employed as a farm planner with the U. S. Soil Conservation Service from March 1953 to September 1956, in Clay County, Missouri.

Instructed on-the-farm training to veterans from 1947 to 1953.

In the grocery business for myself from 1946 to 1947.

In the military service from 1941 to 1946 and overseas for two years.

Employed by the Moorman Manufacturing Company and traveled in 18 central states from 1940 to 1941.

Employed by the Missouri Relief Commission from 1934 to 1938 as a County Relief Director.

Owns and operates two farms in Dade and Cedar Counties, Missouri.

MEMBER IN PROFESSIONAL ORGANIZATIONS:

Member of the Missouri Society of Farm Managers and Rural Appraisers; past member of the Liberty Zoning Board; Past president of the Greenfield Chamber of Commerce; member of the Stockton Lions Club; past president of the American Legion. Superintendent of Sunday School 5 years; Elder in the Christian Church.

QUALIFICATIONS OF APPRAISER

Harry D. Word
4994 Lochinvar Road
Memphis, Tennessee 38116

Date and place of birth: October 25, 1932 - Rison, Arkansas

Education:

a. 1950 - High school diploma, Rison, Arkansas.

b. 1959 - BS degree in Agriculture, University of Arkansas, Fayetteville, Arkansas.

c. 1961 - Appraisal seminar sponsored by the Arkansas Highway Department and the Bureau of Public Roads.

d. 1968 - Completed Course I, American Institute of Real Estate Appraisers

Experience:

a. 1959 - 1960 In charge of rice, wheat and barley fertilization experimental plots at the Kelso, Stuttgart and Keiser, Arkansas, agricultural experimental stations of the University of Arkansas. This was part-time work while a student at the University of Arkansas and was done under the direction of a professor in the Agronomy Department.

b. 1961 - 1965 Employed by the Arkansas Highway Department as a staff appraiser for over four years. More than one-half of my appraisal experience with the Highway Department was on the interstate highway system in rural and farmland areas. Also had appraisal experience on both interstate and federal primary roads in both rural and urban areas.

c. 1965 - 1970 Employed as a staff appraiser by the Memphis District Corps of Engineers for approximately four and one-half years. In Missouri, I have been involved in appraisal or related real estate work in the counties of Butler, Stoddard, Scott, Mississippi, New Madrid, Pemiscot and Dunklin.

On April 4, 1966, I was on TDY to the Economics Section, Project Planning Branch, Engineering Division, New Orleans District, for approximately 75 days. This work consisted of collecting and developing certain technical data for the Department of Housing and Urban Development to be used to study the feasibility of establishing a Government-sponsored flood insurance program. The study area was in the citrus area of New Orleans, an area heavily damaged by Hurricane Betsy.

In October 1968, I was on TDY to the Appraisal Branch, Real Estate Division, Seattle District. Work consisted of making real estate validation reports and securing right of entry permits.

On August 25, 1969, I was on TDY to the Economics Section, Project Planning Branch, Engineering Division, New Orleans District. Made estimates of damages to real estate and personalty and related costs due to Hurricane Camille, and assisted in preparation of report of damages.

Have appeared as an appraisal witness in Federal District Courts at Jonesboro, Arkansas, in 1968 and Cape Girardeau, Missouri, in 1969.

QUALIFICATIONS OF ERIC P. SCRUGGS, JR.

Appraiser
Real Estate Division
Little Rock District, U. S. Army Corps of Engineers

1. Born: 29 January 1922, Humnoke, Arkansas.

2. Public Schools:
   a. Humnoke School, Humnoke, Arkansas (Grades 1 thru 11)
   b. England High School, England, Arkansas (Graduated 1939)
   c. University of Arkansas, Fayetteville, Arkansas
      BS in Business Administration, January 1954

3. Business College: Chillicothe Business College, Chillicothe, Missouri (Commercial courses)

4. Professional Courses:
   a. General and Special Appraisal Problems - Arkansas Appraisal Institute: Sponsored by Arkansas Public Service Commission and Arkansas Assessors' Association. This was an annual three-day seminar. Four of these seminars were attended by this appraiser.
   b. "Principles of Real Estate" - University of Arkansas Graduate Institute, Little Rock, Arkansas (January-May 1958). This was a 16-week course, meeting three hours per week. This course is now required by law to be taken by real estate brokers and salesmen within one year after obtaining their licenses.
   c. "The Appraisal of Real Estate" - Southern Methodist University, Dallas, Texas (June 1968). This was a two-week (8 hours per day) course offered periodically by the American Institute of Real Estate Appraisers and is a prerequisite to membership in the organization.

5. Appraisal Experience:
   a. Arkansas Public Service Commission
      (1) Statistical Clerk, November 1957 - June 1958. Assisted statistician in compiling appraisal data.
      (2) Statistician, June 1958 - June 1959. Compiled and analyzed appraisal data.

(3) Appraiser, June 1959 - February 1962. Made appraisals on residential, commercial, industrial, and rural properties for the purpose of determining ratios between assessed valuation and market value. Properties were appraised by this appraiser during this assignment in various incorporated cities and school districts in 63 counties in Arkansas.

b. Arkansas State Highway Department. Staff Appraiser, March 1962 - April 1966. Appraised properties for right-of-way division for acquisition. Properties appraised included rural and urban, both residential and commercial, also farm and timberlands, and special purpose properties. Various assignments included properties located in 33 counties in Arkansas.

c. U. S. Army Corps of Engineers. May 1966 to present time. Appraiser - Appraisals of various interests including fee simple title and estates of less than fee simple, including several types of easements, leases, and other interests required for acquisition and disposal of properties by the agency.

6. Court Experience: This appraiser has offered expert testimony before circuit courts in six counties in Arkansas, which includes Crawford, Johnson, Logan, Little River, Van Buren, and Independence and in Chancery Court in Cross County, Arkansas. Expert testimony has also been offered by this appraiser before the Federal Court in Little Rock, Arkansas.

QUALIFICATIONS OF APPRAISER

Harry L. Hargrove, Jr.
156 Palisade Street
Memphis, Tennessee

1. Birth: March 26, 1911 (age 59) Mobile, Alabama.

2. Education:

   a. Elementary and high school, Mobile, Alabama.

   b. BS in Commerce - Spring Hill College, Spring Hill, Alabama May 20, 1932.

   c. Completed course and exams for Chartered Life Underwriter degree, 1937.

   d. Courses in Real Estate Law, Finance and Appraising, University of Alabama - 1956 and 1957.

   e. Civil Service Examination - February 1959.

   f. Completed Course I, American Institute of Real Estate Appraisers, Vanderbilt University - September 1968.

3. Employment relative to real estate.

   a. 1952 - 54 Noble-Mustin Real Estate - Salesman and management of rental housing project.

   b. 1955 - 59 Real Estate Broker license in State of Alabama. Member of National Association of Real Estate Boards (Realtor).

   c. March 16, 1959, employed in Management and Disposal Branch, Real Estate Division, Corps of Engineers.

   d. October 30, 1966, appointed as appraiser, Real Estate Division, Memphis District, Corps of Engineers (present position).

4. Appraisal Experience.

a. 1955 - 56. By appointment of Probate Court, Mobile, Alabama, served as a commissioner on three occasions to appraise damages and compensation for U. S. Highway 43 and city of Chickasaw sewage line easements, involving commercial residential and farm property.

b. 1966 - 69 Appraisals for Corps of Engineers on rural properties in Arkansas and Missouri, (Missouri counties: Wayne, Butler, Dunklin, Stoddard, New Madrid and Mississippi); and for commercial and residential leases, sale of government land, pipeline, power line and road easements, and harbor facilities.

c. Federal Court - Condemnation
May Term - Judge Harper - Cape Girardeau, Missouri.
May 12 - 14 and May 18 - 21, 1969

d. August - September 1969 - 5 weeks in New Orleans District as a member of 4-man team, estimated damages and economic loss due to Hurricane "Camille".

23 March 1970

QUALIFICATIONS AND EXPERIENCE

NAME: Henry R. Hudgens

DATE OF BIRTH: 7 November 1921

1. Education:

Graduated from High School	1940
Attended Kansas State University	1940-1942
U.S. Air Force	1942-1946
Graduated from Kansas State University	1948

2. Experience:

Veteran's "on the farm" instructor	1948-1950
County Supervisor for Farmer's Home Administration	1950-1955
Appraiser for the Federal Land Bank Farms and ranches, also irrigation. Training of managers to be appraiser.	1955-1961
Appraiser with the Corps of Engineers Appraising land to be purchased or for imposition of easements when required for Dam and Missile projects; appraising for leases, and collecting data on farm sales for the use in estimating fair market value for above-mentioned item, and the cost estimate of Reservoirs. Served as expert witness in Federal Court cases.	1961 to date
Appraisal experience with the New York, Seattle and Minneapolis-St. Paul Districts.	

3. Appraisal schools attended:

American Inst. of R.E. Appr (Bloomington, Ind.) Course 1 — 1961

Appraisal training in Federal Land Bank

4. Professional organizations:

Member American Society of Farm Managers and Rural Appraisers

QUALIFICATIONS

GUS R. CLIFTON
APPRAISER
REAL ESTATE DIVISION
LITTLE ROCK DISTRICT, CORPS OF ENGINEERS

1. Date of birth - 29 December 1911

2. Place of birth - Western Grove, Arkansas

3. Formal education:

   a. Western Grove High School, Western Grove, Arkansas - Diploma - 1929
   b. University of Arkansas, Fayetteville, Arkansas - B.S.A. Degree - 1934
   c. University of Arkansas, Fayetteville, Arkansas - Graduate Shool - 18 Semester Hours - 1950

4. Specialized education:

   a. Arkansas Highway Department, Little Rock, Arkansas - Appraisal Course - 30 Weeks, 1 Hour Sessions - 1961
   b. Weaver School of Real Estate, Kansas City, Missouri - Diploma - 1962
   c. Arkansas Real Estate Commission, Little Rock, Arkansas - License - 1962
   d. General Service Administration, Memphis, Tennessee - Report Writing Certificate - 1964
   e. University of Oklahoma, Norman, Oklahoma - S.R.E.A. Appraisal Course - 1964
   f. University of Missouri, Columbia, Missouri - Real Estate Appraisal Course - 1968
   g. Society of Real Estate Appraisers - Vice President Central Arkansas, Chapter No. 108 (1969-1970)
   h. Charter Member - Arkansas Chapter, American Right-of-Way Association, Executive Committee, 1969-1970.

5. Experience:

From July 1935 to November 1943 employed by the Farmer's Home Administration as County Supervisor and Project Manager. During this period I was responsible for the administration of the program at different times in various locations, namely Pulaski, Lawrence, Randolph, Prairie Counties and the Biscoe Farms Project.

My duties included the making of production loans and the supervision of the borrowers in their farming program. I was responsible for the screening and reviewing loan applications for real property loans. After land purchase by the borrower, I supervised the improvement program, such as new building construction, renovation of existing buildings, fence building, terracing, drainage, etc.

From November 1943 to August 1960 I was owner-operator of the Clifton Lumber Company at West Fork, Arkansas. This was a retail building supply and appliance business. During this period I appraised many customers' property for the purpose of building loans and insurance. Also, I estimated material requirements for new construction and repairs. I constructed about 100 buildings by contract, including new houses, barns, garages, and small commercial buildings. During this period I also bought and sold about 20 urban and rural properties.

From August 1960 to August 1963, I was employed by the Arkansas Highway Department as an appraiser and a reviewing appraiser. The appraisals prepared were for the purpose of estimating market value for the taking and damages to the remainder in acquisition for highway right-of-way requirements. Commercial, agricultural, residential, industrial, and special purpose properties were appraised. During this period I made 267 appraisals and reviewed 1,120 made by other appraisers.

From August 1963 to March 1965 I was employed as an appraiser for the Memphis District, Corps of Engineers. My duties were to prepare tract and gross appraisals of rural, recreational, commercial, and urban properties for acquisition and disposal purposes with the flood control mission of the Memphis District. Total appraisals prepared - 210, consisting of fee and less than fee takings.

From March 1965 to October 1965 I was a right-of-way officer with the Bureau of Public Roads, Ohio Division. My duties were to review all right-of-way activities of the Ohio State Highway Department including appraisals, negotiations, property management, clearing improvements from right-of-way and other related matters.

From October 1965 to the present I have been employed by the Little Rock District, Corps of Engineers as an appraiser. My duties are the appraisal of real and personal property for acquisition and disposal purposes. The estate taken is fee and less than fee. I have prepared 400 appraisals for the Little Rock District of which the majority are an estimate of value for imposition of flowage easements.

Appendix F

Form Used by Appraisers in Making Gross Estimates

[illegible]

Average yields (list by crop)

[illegible] ____________________

105 County Average ____________________

		Present Use	Highest and Best Use
107-108	Grain	( )	( )
109-110	Livestock	( )	( )
111-112	Dairy	( )	( )
113-114	Dairy and Grain	( )	( )
115-116	Livestock and Grain	( )	( )

Flood Payments: Amount Received

117-120 1968, __________; 1967, __________; 1966, __________; 1965, __________

121 How High was the Flood Water on This Farm in 1952? ____________________

122-123 Acres Flooded in 1965: Total Acres __________ Crop Acres __________

124-125 Acres Flooded in 1967: Total Acres __________ Crop Acres __________

126-127 Have Levees or Berms Been Constructed Since 1965? Yes_____ No_____ When_____

Valuation:

Tobacco base ______ acres

128-129 House (In Flood Plain Yes_____ No_____) $__________

130-131 Other Bldgs (In Flood Plain Yes_____ No_____) $__________

132-133 Acres fenced __________ Value of fencing $__________

134-135 Land w/o Improvements $______ P/A x ______ Acres = $__________

136 Cost of Drainage Improvement $__________

137 Total Value $__________

REMARKS:

138 Quality of Operation: Good__________ Medium__________ Poor__________

Did the 1965 or 1967 Floods Cause the Farmer to Alter His Operations? If so, explain in what manner.

139 ____________________
Appraiser
Date: ____________________

To be completed by ED-H

Acres Flooded

140 ____________________ 1-5 yrs.

141 ____________________ 5-25 yrs.

142 ____________________ 25-100 yrs.

ESTIMATE SHEET FOR MISSOURI RIVER LAND VALUE STUDY

1 Farm Number ____________________

2-3 Owner ____________________________________ Address ___________________________

4-5 Owner Operated ______________________ Tenant Operated ________________

6-7 Rental Basis: Share Crop ______________________ Cash Rent ______________

8-12 Location: __________________ Acres in Sec. ____ Twp ____ Rng ___ County ______

13-14 Distance from St. Joseph ___________________ K.C. Int'l Airport ___________________

15-18 General Topography: Level _____________ Rolling _______________

Steeply Rolling _____________ Hilly ______________

19 Missouri River Frontage: Yes _____________ No __________________

20-21 Other Streams Fronting or Affecting _________________ ____________________

22 Is The Farm Subject to Sidehill Drainage Problems? Yes _____ No ________

☆ 23-24 Is Levee Present? Private Yes _____ No _____ Federal Yes ____ No _____

25-28 Average Height _____ Construction: Earth _____ Combination Earth & Stone _____

Other (Specify) _________________

29 Acres protected by levee ____

☆☆ 30 Is it Adequate for Minor Flood (1-5 yr Flood) Yes ________ No __________

LAND:

	ACRES	USE	FLOOD FREE CLASS I	II	III	IV	V	FLOOD PLAIN CLASS (subject to flooding) I	II	III	IV	V	GROSS INCOME PER ACRE
31-42		Bot. Crop.											
43-54		Upl. Crop.											
55-66		Grassland											
67-78		Timber Past.											
79-90		Timber											
91-101		Rd Riv. & Waste											
102		Total											

103 Income From Recreational Use Per Year $ ____________________

☆ Appraiser Note: If property protected by Federal Levee, omit 23 thru 30; and for 31-102 consider all land flood free, except for land outside of the levee.

☆☆ Based on Appraisers Judgment

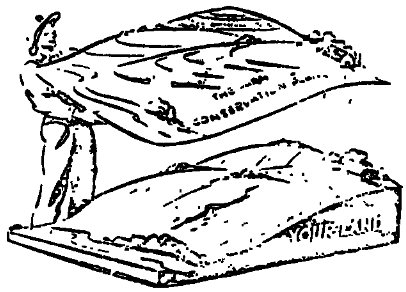
Appendix G

Soil and Capability Legend

U. S. DEPARTMENT OF AGRICULTURE · SOIL CONSERVATION SERVICE · COLUMBIA, MISSOURI

Mo-107
(Rev. 8/67)

SOIL AND CAPABILITY LEGEND



The colored map tells the land capabilities and the potential problems of the soils on your land.

THE SYMBOL TELLS THE STORY. (Example IIIe1)

The Romon numeral (III) tells the capability class.
The small letter (e) indicates the potential problem.
The small number (1) tells the general physical characteristics of the soil.

THE FIRST NUMBER TELLS THE CAPABILITY CLASS--

LAND SUITABLE FOR REGULAR CULTIVATION

Class I — Soils in Class I have few limitations that restrict their use.

Class II — Soils in Class II have some limitations that reduce the choice of plants or require moderate conservation practices.

Class III — Soils in Class III have severe limitations that reduce the choice of plants or require special conservation practices - or both

Class IV — Soils in Class IV have very severe limitations that restrict the choice of plants, require very special management - or both.

LAND LIMITED IN USE - GENERALLY NOT SUITED TO CULTIVATION

Class V — Soils in Class V have little or no erosion hazard but have other limitations, impractical to remove, that restrict their use largely to grazing, woodland, wildlife, or recreation use.

Class VI — Soils in Class VI have severe limitations that make them generally unsuited to cultivation and limit their use largely to grazing, woodland, wildlife, or recreation use.

Class VII — Soils in Class VII have very severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland, wild-life or recreation use.

Class VIII — Soils in Class VIII have limitations that make them unsuited for commercial plant production use and restrict their use to recreation, wildlife, water supply or scenic purposes.

THE SECOND LETTER OF THE CAPABILITY SYMBOL TELLS THE MAJOR CONSERVATION PROBLEM--

e for EROSION, w for WETNESS OR OVERFLOW, and s for STONINESS-SANDINESS-or DROUGHTINESS.

THE THIRD NUMBER OF THE CAPABILITY SYMBOL GIVES A GENERAL GROUP OF SOILS IN EACH HAZARD CLASS(e-w-s)

e-problem soils - occurring on slopes

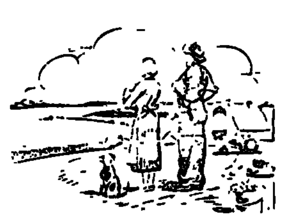
- e1-deep soils, favorable physical condition throughout.
- e2-soils with favorable upper layers but rock or other restrictive layers within 24" to 36".
- e3-soils with rocky or other restrictive layers within 10 to 20 inch depths.
- e5-soils with very tight (or hard) subsoils that are very slowly permeable.
- e6-deep soils with moderately heavy subsoils that are of slow or moderately slow permeability.

w-problem soils - normally nearly level

- w1-soils with moderately heavy subsoils and occurring on flat or depressional areas.
- w3-soils with tight subsoils with very slow permeability.
- w9-organic soils.
- w14-bottomland soils with clayey surface soils and slow and very slowly permeable sub-soils.
- w15-wet soils that are sandy.

s-problem soils - sandy or stony

- s1-well drained soils, favorable throughout but having sand or rock layers within 30".
- s4-excessively drained soils sandy throughout.
- s6-stony soils of variable depth and texture - clearance of stones not practical.



Soil descriptions explaining the soil in more detail are available from your Soil Conservationist.

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13. ABSTRACT

This report is designed to present in some detail the results of successfully applying a land value approach using a multiple linear regression technique to two study areas. The bulk of the monograph is not directed to analyzing the utility of the approach per se, although the strengths and weaknesses are reviewed. The main concern is with a rather detailed exposition of the statistical analysis of areas in the Wabash and Missouri River Basins. In this respect it is written primarily for use at the field levels of the Corps to serve as a guide to the use of the approach in terms of the types of data required, the form of the data for use in the regression model, and the interpretation of the estimated regression model.

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