Kates, R. W., 1963. "Perceptual Regions and Regional Perception in Flood Plain Management", Papers and Proceedings of the Regional Science Association, Vol. 11, pp. 217-227.

PERCEPTUAL REGIONS AND REGIONAL PERCEPTION IN FLOOD PLAIN MANAGEMENT

By Robert W. Kates

The author is an Assistant Professor in the Graduate School of Geography, Clark University, and he gratefully acknowledges the review of an early draft by J. W. Birch, Ian Burton, Raymond E. Murphy, and Gilbert F. White.

THE FLOOD PLAINS of the United States comprise a distinct sub-sector of our land resources. While sometimes offering great comparative advantages, they are not unique in their desirable qualities of low slope, fertile soil, and access to water. Their distinctiveness, therefore, lies in the special inputs of labor and capital needed to offset the hazard arising from occasional inundation. In a current geographical idiom, these inputs are part of a series of human adjustments.[1]

There are two general types of adjustments: those that involve suffering monetary or other loss when floods occur, and those that involve damage-reducing activities. The losses that occur from flood damage may or may not be expected by flood plain users. Individual loss is often reduced by the relief activities of government and community. In rare cases there may be reimbursal from insurance. In the forefront of damage-reducing activity is the construction of engineering works designed to reduce or abate flood flows: reservoirs, levees, and channel improvements. Temporary measures include flood fighting, the evacuation of men and material from the flood's path, and the re-scheduling of production or agricultural activity. The adoption of land use regulations to control the growth of damage potential has spread widely. Finally, there has been the slow diffusion of techniques designed to make structures flood-resistant.

The magnitude of the costs of adjustment to flood hazard might be conservatively estimated at an annual charge of a billion dollars. Present flood damage is variously estimated at between 250 million and a billion dollars a year.[2] Added to this would be the cost of public works designed to reduce flood damage (the federal rate of expenditure is about $300 million a year), relief costs, and expenditures by individuals.

Despite the investment in damage-reducing adjustments, the costs of adjustments are increasing, due in part to the increase in national wealth and and to the risk-taking behavior that partial flood protection appears to generate.

For this paper, the relevance of the foregoing is briefly this: Neither

---

[1] G. F. White, *Human Adjustment to Floods.* Department of Geography Research Paper No. 29. (University of Chicago, Department of Geography: Chicago, 1945.)

[2] G. F. White *et al, Changes in Urban Occupance of Flood Plains in the United States.* Department of Geography Research Paper No. 57. (University of Chicago, Department of Geography: Chicago, 1958), p. 4.

flood hazards nor human adjustments are evenly distributed, but vary with a set of natural factors of climate and land forms and a set of human activities that characterize the kind and intensity of occupance. The theme of this paper is to consider, for two cases, the regional interplay of man's perception of these sets of variables.

In the first case, we consider the relation between flood frequency and a set of attributes of flood plain users that describe their perception of hazard and willingness to adopt flood-damage-reducing actions. We seek to establish a basis for the regional definition of perceived flood hazard.

In the second case we consider certain aspects of the influence of the river basin on flood plain and water management. Here we seek to examine, in a more speculative fashion, some of the effects of the perception of a region, whose boundaries are drawn by nature, as one that provides certain unique opportunities for development.

FLOOD FREQUENCY AND THE PERCEPTION OF HAZARD

For the civil engineer and hydrologist, the frequency of floods, or how often a river overflows its banks, is amenable to statistical analysis[3]. This analysis is hampered by the paucity of observations in time and space and by their lack of independence. For the most part, our knowledge of the spatial distribution of floods comes from a non-random point sample, the streamflow records collected at some 7,000 gaging sites. The hydrometeorological conditions that cause floods may be common to a large area and persist for days. Thus observations from different gages are not independent but may be repeated observations of the same phenomenon.

At any given site or reach of stream, the number of individual observations of floods is about equal to the years of observations. Each record of flood occurrences at this point is a slice of a long time series of extreme events. In this country, a fifty-year record is relatively long, but compared to the almost infinite population of river flow it ostensibly samples, it is very short. Yet it is our best estimator of both past and future floods, and with considerable ingenuity we attempt to extract the maximum information from these records.

So despite these difficulties of inadequate sampling both in time and space, it is feasible within broad margins of error (not accurately determined, but on the order of ±25% or less, 95% of the time), not only to count the number of flood events but also to attach probabilities to flood occurrences of various sizes within a modest range.[4] These probabilities can be stated in the per

---

[3] For a useful review or introduction to this subject, see M. A. Benson, *Evolution of Methods for Evaluating the Occurrence of Floods*, U. S. Geological Survey Water Supply Paper 1580-A. (Government Printing Office: Washington, 1962.)

[4] The order of magnitude of error is for the prediction of a fifty year flood based on a thirty-nine year record and was empirically derived by Benson from a theoretical 1,000 year record. M. A. Benson, "Characteristics of Frequency Curves Based on a Theoretical 1,000 Year Record," *Flood Frequency Analysis*, U. S. Geological Survey Water Supply Paper 1543-A (Government Printing Office: Washington, 1960) p. 64.

cent chance of a flood occurring in any year. More conventionally, floods are identified by a period called the recurrence interval, which indicates the long run average period of time within which a flood of given size might be equaled or exceeded. In this way we might speak of a flood with a 2% chance of occurrence, or of a fifty year flood.

For the makers of technical estimates of flood frequency, the uncertainty that surrounds flood occurrence is a problem to be grappled with, estimated, manipulated, reduced, but, in the last analysis, to be lived with. Consider the case of the flood plain user, often a home owner, tenant, or proprietor of a small commercial venture. In his estimating procedure, he cannot bring to bear the technician's skill, knowledge, or detachment. It is only rarely that he shares with the technician the assumption of the independence of flood events or has available in understandable form the record of flood occurrences. The assessment of those floods actually experienced is often highly colored by personal involvement.

To an observer, the actions of the flood plain user often appear puzzling. If he persists in occupying an area of repeated flooding, we are likely to ascribe his actions to ignorance, foolhardiness, or some other form of irrationality. What is the relation between the perception of flood hazard by flood plain users and the best technical estimates of flood frequency?

Earlier studies of this question appeared inconclusive and succeeded in raising more questions than they answered.[5] The writer undertook an investigation into this and related questions with a series of studies beginning in the summer of 1961.[6] Detailed interviewing was carried out among 110 flood plain users in La Follette, Tenn. (pop. 7,000) and supplemented by 68 concise interviews in areas chosen to provide regional and climatic contrast. (Desert Hot Springs, California; El Cerrito-Richmond, California; Aurora, Indiana; Darlington, Wisconsin; Watkins Glen, New York.) Recently, to extend the initial results, 38 interviews were obtained in the Farmington Valley of Connecticut.

The original interviews were very detailed, and included in addition to flood-related material, data on aspects of a respondent's personality and common socio-economic indicators. In addition, independent technical estimates were made of each respondent's hazard and potential damage.

The following classifications of attributes (in some cases, scales) were derived from these data. The distribution of respondents at each of the study sites for the four classifications appears in Table 1. Three of the classifications deal with the perceptions of hazard, the fourth with perceived and adopted flood damage reduction actions.

---

[5] W. Roder, "Attitudes and Knowledge on the Topeka Flood Plain," and I. Burton, "Invasion and Escape on the Little Calumet," G. White (ed.), *Papers on Flood Problems*, Department of Geography Research Paper No. 70. (University of Chicago, Department of Geography: Chicago, 1961), pp. 62-92.

[6] A detailed statement of purpose, methology and findings of the initial studies can be found in R. W. Kates, *Hazard and Choice Perception in Flood Plain Management*. Department of Geography Research Paper No. 78. (University of Chicago, Department of Geography: Chicago, 1962.)

TABLE 1. Distribution Of Attributes By Per Cent Of Respondents At Seven Study Sites.

ATTRIBUTES	DESERT HOT SPRINGS, CALIFORNIA	WATKINS GLEN, NEW YORK	EL CERRITO-RICHMOND, CALIFORNIA	FARMINGTON VALLEY, CONNECTICUT	LA FOLLETTE, TENNESSEE	DARLINGTON, WISCONSIN	AURORA, INDIANA
Flood knowledge and experience:							
No knowledge of floods	68.8%	0.0%	9.1%	10.5%	7.3%	0.0%	0.0%
Knowledge, no experience	18.8	60.0	18.2	31.5	43.1	7.6	6.6
One on-site experience	6.2	20.0	18.2	31.5	36.6	15.3	33.3
Two or more on-site experiences	6.2	20.0	54.5	26.3	12.8	76.9	60.0
Interpretation:							
Respondent shares in common knowledge, and:							
Floods are repetitive events:							
Decreasing in time	25.0	30.0	36.3	28.9	17.3	15.3	13.3
Constant in time	6.2	10.0	18.2	18.4	28.8	69.2	86.6
Increasing in time	0.0	0.0	9.1	0.0	6.7	15.3	0.0
Insufficient data to detect time trend expectation	0.0	0.0	18.2	10.5	13.4	0.0	0.0
Personal exclusion	25.0	20.0	0.0	15.8	9.6	0.0	0.0
Floods are unique events	0.0	10.0	0.0	15.8	8.6	0.0	0.0
Denies common image of "real" floods	0.0	0.0	0.0	0.0	8.6	0.0	0.0
Respondent does not share in common knowledge	43.7	0.0	9.1	10.5	6.7	0.0	0.0
Not ascertained	0.0	30.0	9.1	0.0	0.0	0.0	0.0
Future flood expectation:							
Yes	25.0	10.0	45.4	36.8	41.2	100.0	86.6
No	50.0	80.0	45.4	52.6	36.6	0.0	6.6
Uncertain	25.0	10.0	9.1	10.5	22.0	0.0	6.6
Perception-Adoption:							
No flood damage reduction actions perceived	73.3	12.5	50.0	10.5	16.7	0.0	0.0
Common flood damage reduction actions perceived	13.3	62.5	30.0	55.3	35.3	0.0	0.0
Uncommon flood damage reduction actions perceived	6.7	12.5	10.0	10.5	16.7	15.4	0.0
Adopted flood damage reduction actions	6.7	12.5	10.0	23.6	31.4	84.6	100.0
Total Number of Respondents	16	10	14	38	110	13	15

Knowledge-experience, a scale of flood awareness.—Without attempting to distinguish the quality of a respondent's knowledge, a scale of knowledge and experience was derived from the very detailed probing of each respondent's flood history, background, and experience.

Future flood expectation, a 0–1.00 probability distribution.—Respondents were asked the following question: "Do you think that you will have or there will be another flood while you are (living) (in business) here?" Their answers were classified as yes, no, or uncertain. More detailed estimates of frequency were also obtained but with considerable reluctance on the part of the respondents. These were discarded as unreliable. This reluctance of respondents to make detailed probability estimates is not in accord with the needed assumptions of game theorists and decision-making analysts of the ability to estimate probabilities and act upon them.

Interpretation, or the evaluation of additional information.—It was found that no statistically significant association existed between a respondent knowing that at least one flood had occurred (knowledge) and expecting a flood in the future (future flood expectation). The relationship between experiencing a flood and expecting one in the future was significant but weak. Further analysis suggested that there exists a variety of ways in which flood plain users absorb new knowledge and experience, and this process was called *interpretation.* The varieties of interpretation were classified and respondents allocated to each class on the basis of composite responses but independent of their future flood expectation.

Initially, respondents appear to interpret knowledge or experience from the standpoint that floods either are or are not repetitive events. Respondents who deny that floods are repetitive events ascribe to new flood occurrences qualities of uniqueness or deny to them the qualities contained in an image of a "real" flood. Respondents who view floods as repetitive events may consider that 1) floods are constant in time; 2) increasing (often due to human interference), 3) decreasing (again due to human interference), or 4) not relevant to their personal perception of hazard by virtue of their present or future position that somehow excludes them from hazard. Thus, the belief in the replicability of floods in no way assures a personal perception of hazard. However, classes of interpretation, unlike simple experience, are strongly correlated with expectation.

The belief that floods are repetitive, and constant or increasing in time, leads to affirmative future flood expectations. Respondents who do not share in the common knowledge, or believe that floods are either decreasing in time, or that they are personally excluded from hazard, have negative expectations. The denial of the repetitiveness of floods leads respondents to uncertainty in preference to either affirmative or negative future flood expectations.

The perception-adoption scale, a measure of the ability and willingness to make hazard adjustments.—For each community, a set of technically suitable adjustments was defined. Respondents were questioned as to their awareness of these adjustments, their estimate as to their utility, and details on their adoption, if such had taken place. Using Guttman scaling techniques, perception and adoption appear on a four-fold scale: 1) no adjustments perceived; 2) widely-known adjustments perceived (common); 3) less widely-known adjustments perceived (uncommon); 4) adoption. Without imputing any causal relation, the scale suggests that those who adopt also have a broader range of choice to choose from.

The internal consistency within Table 1 appears to be high, i.e., within any study site, if flood experience is low, interpretations appear to be made which lead to negative flood expectations, and such expectations are associated with little perception and adoption of flood damage reduction actions. The converse also seems to hold true. Can we generalize this relationship?

THE CERTAINTY-UNCERTAINTY SCALE

To account for the variation in attributes between study sites we hypothesize a scale of certainty-uncertainty. Such a continuum would be related to the frequency of flood events, but only partly so. In a sense it is the perceived frequency of flood events and these perceptions may vary from the best technical estimates because of a number of factors. These include the mixed effects of personal experience, the traumatic shock of catastrophic events, the perceived effectiveness of real or imagined flood protection works, and the like. Although somewhat akin to subjective probability, we refrain from using the term, for it implies the converse, a real knowable objective probability, a condition not to be found in flood frequency estimates.

Assuming the existence of such a scale, Aurora, Indiana, and Darlington, Wisconsin, with frequent floods, would rank high on the certainty end. Associated with high certainty is widespread knowledge, reinforced by many experiences. Most flood plain users expect a future flood and have evolved elaborate sets of adjustments to reduce flood damages. With high certainty, differences of personality, personal interpretation, and the awareness of real or imagined protective works, bear little on hazard evaluations. Finally, the overall dispersion of attributes is small.

On the other end of the scale might be located Watkins Glen, New York, or Desert Hot Springs, California. With great uncertainty of flood occurrence, there is also a small dispersion of flood attributes but these are oriented around negative or uncertain future flood expectations. Adjustment to hazard is very slight.

Between the extremes of the scale is an area of lessened or intermediate certainty. If El Cerrito-Richmond or La Follette are typical of this genre, then the dispersion of attributes is large. Future flood expectations divide evenly between the negative and affirmative with a large number of respondents uncertain. Extremes of concern and ignorance are observed. Adjacent flood plain users may be found, some with elaborate flood damage reduction adjustments and others totally unconcerned. In such areas of intermediate certainty, the evidence suggests that there is considerable room for personality differences or real and imagined protective works to influence hazard perception. In the aggregate, such a community presents a face of ambivalence, although the individual flood plain users frequently possess strong opinions.

In fitting the original study sites to such a hypothesized scale, pairs of sites are found with similar proportions of respondents possessing the same attributes. This finding challenges the assumption of a continuum and raises for future study the question of the likelihood of certainty-uncertainty falling into discrete classes. Such a finding would be in keeping with White's observation that there exist particular flood frequencies that are sensitivity or turning points for human adjustment to floods.[7] Members of the observed pairs provide dramatic contrast in socio-economic environment which reinforces earlier indications of the irrelevance of common socio-economic indicators for flood hazard perception.

THE QUANTIFICATION OF THE SCALE

In searching for surrogates for the certainty-uncertainty scale we have used a set of unpublished data giving the flood frequency for 496 urban places with 1950 populations in excess of 1,000.[8] The data describe the frequency of floods in number per ten years, but in most cases the actual records were considerably longer. The floods tabulated are recorded occurrences and include most minor events. Naturally, the data do not make allowances for the deviations of perceived flood frequency from recorded flood frequency, deviations thought to be of considerable importance in formulating the hypothesis.

The 496 urban places appear to be distributed log normally with respect to frequency, a condition for which there is no ready explanation (other than those that suggest log-normal distributions arising as the product of many random factors).

To provide a first approximation of a three-fold, discrete, certainty-uncertainty classification, the smoothed, log-normal distribution shown in Figure 1 was arbitrarily divided into thirds of equal area. In this manner, urban places are divided into three classes by flood frequency as shown in the first column in Table 2.

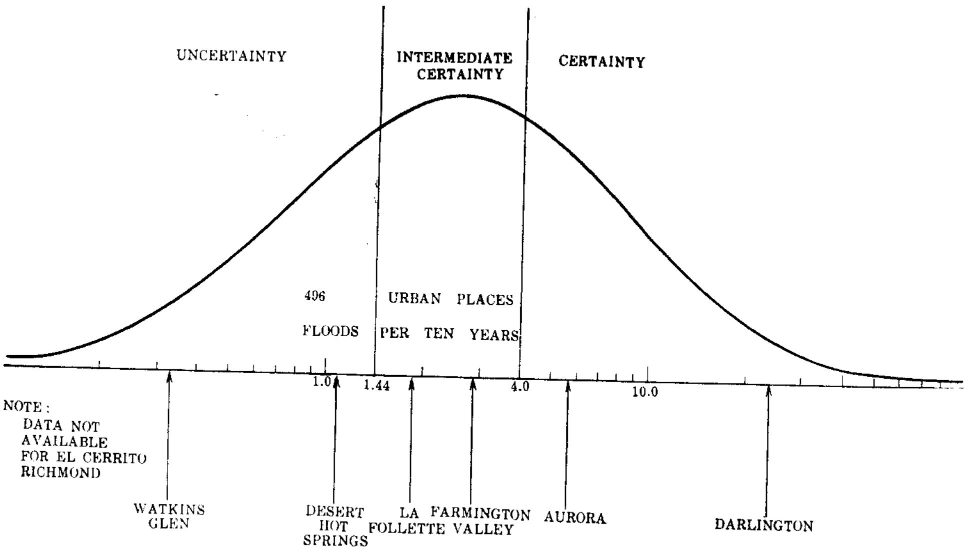

FIGURE 1.

---

[7] G. F. White, "The Choice of Use in Resource Management," *Natural Resource Journal.* Vol. I (March, 1961), p. 37.

[8] These data were collected in connection with the study of 1020 urban places reported in White *et al., Changes in Urban Occupance . . .*

TABLE 2. Flood Frequencies Of Discrete Classes Of Certainty-Uncertainty.

Class	Obtained from: Smoothed log-normal Distribution of 496 Urban Places	Description in Burton's Study of Agricultural Flood Plains
	Flood per Ten Years	
Certainty	>4.0	>5.0
Intermediate certainty	1.44—4.0	1.42—5.0
Uncertainty	<1.44	<1.42

When the six study sites, having been previously classified on the basis of their attribute distributions, are located by their flood frequency on Figure 1, they fall well within the appropriate boundaries.

In like manner the 38 observations from the Farmington Valley when treated as a single urban place, fall almost at the mid-point of intermediate certainty, a class to which it had been previously allocated by virtue of the similarity of the attribute distributions to La Follette and El Cerrito-Richmond.

Burton has independently arrived at the following conclusions regarding the behavior of farmers on flood plains:

> "While farmers undertake relatively elaborate and sophisticated estimates of flood hazard, where such hazard is high, the attention given to this problem falls off very rapidly as flood frequency diminishes. Where floods occur frequently as once a year or every two years, farmers tend to engage in careful analysis of risks which typically involves a careful choice of crops and attention to possible seasonal adjustments. As frequency diminishes to 1 in 5 or 6 years attention to the problem decreases, and beyond this point the flood hazard seems to have little or no significance for them. Expressed in a slightly different way, we may say that in this particular game with the environment, farmers are content to play up to the point of a 1 in 6 or 7 frequency, but beyond that point they lose interest in playing. Other games interest them more and hold their attention."[9]

Burton's observations appear perfectly compatible with the certainty-uncertainty scale and we have fitted his estimates of significant probabilities in Table 2 for comparative purposes. The similarity in frequency is of particular importance for Burton observes that his "study indicates that agricultural flood-plain managers are more aware of the flood hazard than urban managers...,"[10] a finding with which I would readily concur.

FLOOD FREQUENCY AND THE PERCEPTION OF HAZARD

The studies reported on herein were began with a bias towards scepticism that a simple ordered relationship exists between how often floods occur and

---

[9] I. Burton, *Types of Agricultural Occupance of Flood Plains in the United States*, Department of Geography Research Paper No. 75. (University of Chicago, Department of Geography: Chicago, 1962) pp. 148-149.

[10] I. Burton, *Types of Agricultural Occupance*..., p. 145.

what men think and do about them. This was not to deny that a relationship would exist, but that it would be highly complicated both by the varying perception of flood hazard and the differing importance to flood plain users of the utility of their presence on the flood plain. However, the results to date are highly encouraging, that in the aggregate, there is an ordered relationship, and factors that tend to obscure it are over-ruled in the limiting cases, and are self-canceling in the intermediate case.

While the results are encouraging, they are not definite. The classification represents the findings at seven sites; Burton made his observations on the basis of fifteen sites. Using a three-fold classification of recorded hazard, the probability of matching behavior with frequency is high on a chance basis alone. A considerable number of observations will be needed before one might conclude that men on flood plains perceive and respond to key changes in frequency, and to define these points of change in a more defensible manner than arbitrary curve splitting.

Equally revealing would be the identification of sites that are nonconforming to the certainty-uncertainly concept. These residuals would be extremely useful in refining and sharpening the concept.

If these findings continue to hold up with repeated observation, then we have fashioned a new and useful tool for the study of flood plain management with application to other resource study as well. We have a means to characterize the perceived areal setting within which men attempt to deal with an uncertain natural hazard, and at the same time we have an estimate of their probable behavior.

The effect of differing certainty of flood may have normative as well as descriptive value. It suggests bounds on the potential of flood users to install damage reducing adjustments on the basis of their own perception. In areas of certainty, individual adjustment is already widespread. In areas of uncertainty, floods are so rare or erratic as to preclude common hazard perception. In areas of intermediate certainty, there is considerable ambivalence that mitigates against consistent damage-reducing activity. Such an assessment supports those who feel that substantial progress in reducing future flood damages can only come about by the leadership exerted from community, state, and federal sources and not from the direct perception of flood plain hazard on the part of flood plain users themselves.

THE RIVER BASIN AND FLOOD PLAIN MANAGEMENT

In this the second case, we move from considering the empirical derivation of a region of perceived flood hazard to questioning how the perceived qualities of a naturally derived region, the river basin, influence aspects of water management policy.

The river basin is bounded by water divides that clearly mark the area drained by the master stream. As such it demarcates a natural region that provides maximum physical opportunity for water resource development and economies of scale.[11] This perception of the opportunity afforded by the river

---

[11] For a full exposition of these various opportunities, see E. A. Ackerman and G. O. G. Löf, *Technology in American Water Development*, (Johns Hopkins Press: Baltimore, 1959).

basin did not burst full bloom and White has given a succinct account of its development.[12] Directly related to this potential for development are two of the ideas that White presents as central in river basin development: multi-purpose storage, and a basin-wide program.

The ability to achieve great economies of scale through multi-purpose storage and basin-wide operation mark an exciting on-going chapter in the history of the water industry. The designation, water industry, is purposeful, for we would suggest that the selection of an appropriate water management region is analogous to industrial location. The river basin is a raw material or resource-oriented region on a grand scale.

Locational orientations appear to change through time. In generalized fashion, industries such as steel or petroleum seem to pass through a historical sequence of transition from raw material to market orientation.[13] There are signs that in some areas the water industry may be past due for a similar transition. These signs include: the possibility of power surplus in the Columbia basin; the rapidly dimishing returns of streamflow regulation received from additional increments of storage in the Colorado basin due to excessive evaporation; the exhaustion by sedimentation and early development of our scarce supply of high-grade reservoir sites; and the increase in flood damages induced by partial flood protection.

However, the mystique that surrounds water resources appears to have made regulation, for some, an end in itself, with the measure of success being an ever-increasing portion of average streamflow regulated through storage. Thus the river basin seems to carry a built-in bias towards reservoir storage at a time when there is need to shift in flood plain management from reliance on storage type protective works to other flood damage reduction measures.

White's third central idea, comprehensive regional development, arises according to Wengert from the attractiveness of the seeming physical unity of the basin. In Wengert's words:

> "... the watershed is visualized as an organic whole, having peculiar, often mystical unifying characteristics. The river basin region is, consequently, regarded as offering a logical basis for economic development, which is contrasted with the alleged inappropriateness of the traditional political boundaries."[14]

In all but the simplest level, the apparent unity is spurious. When basins are aggregated, boundaries may become as arbitrary or capricious as those of any other type of region. The major regions are a case in point designated for internal organization and data presentation by the federal agencies involved in flood plain management. The Corps of Engineers, Soil Conservation Service,

---

[12] G. F. White, "A Perspective on River Basin Development," *Law and Contemporary Problems*, Vol. 22 (Spring, 1957) pp. 157-186.

[13] See R. C. Estall and R. O. Buchanan, *Industrial Activity and Economic Geography* (Hutchinson University Library: London, 1961), pp. 179-181, 214-223 for a description of this trend in steel and oil refining.

[14] N. Wengert, "The Politics of River Basin Development," *Law and Contemporary Problems*, Vol. 22 (Spring, 1957) pp. 267-8.

Geological Survey, and Weather Bureau employ different regional river basin divisions. As members of an inter-agency committee, these organizations have helped map 78 distinct sub-basins, but these cannot be aggregated into any agency scheme.[15] The Select Senate Committee on National Water Resources attempted to harmonize water resource data using an expansion of the water regions of the Bureau of the Census but was only partly successful.

Not only does river basin unity appear spurious at the aggregation level, but in other ways as well. Indeed river basins are often characterized by extremes. These include the extremes of climate, arid and humid; of topography, upstream and downstream; of conflicting interest, rural and urban. Good water management often requires the reconciliation of these extremes, but in this sense the river basin functions not as a source of unity, but as an arena of conflict.

While the river basin will persist for much time to come as the regional form for water development, and indeed may present new, yet unrealized, economies developed through systems analyses, other forms might be expected to develop.[16] Inter-basin transfers of water and export of power will help develop alternative regional forms. Around urban areas, the prime market for water supplied goods, small drainage areas might be agglomerated regardless of where they ultimately drain. Regional scientists might contribute substantially to the development of new forms of water regions. However, this development has probably been inhibited by the attractiveness of the apparent physical unity of the river basin, and the large economies seemingly provided by its comprehensive development.

CONCLUSION

In limited fashion we have been exploring two aspects of man's perception of his environment that contribute to regional differences in flood plain management. In one example we suggest that the perceived frequency of flooding is not a continuous function, but in the cases studied appears to fall within discrete classes. These perceived classes and their related adjustments distinguish areal differences in flood plain management. In the second example, we have speculated on the impact of perceived regional opportunities incorporated in river basin development. Here we suggested that while river basins possess unique opportunities, the importance of these may change adversely through time. These are changes that to some extent are concealed by our favorable perception.

---

[15] See for example the map of river basins overlain by the major divisions of the Geological Survey; Inter-Agency Committee on Water Resources, Sub-Committee on Hydrology, *River Basin Maps Showing Hydrologic Stations*, Notes on Hydrologic Activities Bulletin No. 11. (Government Printing Office: Washington, 1961), p. 5.

[16] The application of systems analysis to river basin development is exemplified by A. Maass *et al*, *Design of Water-Resource Systems* (Harvard University Press: Cambridge, 1962).