SELECTION OF FEDERAL FLOOD CONTROL PROJECTS: AN AHP APPLICATION

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(Abstract)

This paper describes an application of AHP in water resource planning, an area where no applications have been reported yet. It also describes the use of AHP as a tool to analyze pluralistic problems involving decisions where the points of view of different constituencies are represented. Backgrounds and experiences of different decision makers affect their voting styles, and AHP provides a means to understand these differences. Suggestions for use of AHP in certain decision settings are offered.

1. Introduction

The procedures used by the U. S. Army Corps of Engineers in the study of and selection of flood control projects are contained in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P & G). Briefly, the P & G mandates the use of benefit cost analysis for decision making purposes and also identifies four major accounts for grouping benefits. These are: the national economic development (NED) account, the environmental quality (EQ) account, the regional economic development (RED) account, and the other social effects (OSE) account.

The NED account is by far the most important benefits account in the actual selection of a flood control project alternative. Moreover, the selection process is generally based on the use of benefit cost analysis and NED benefits are the only type of benefits currently allowed to enter the benefit cost calculations. Recognition is given to the other benefit accounts, but it is unclear how they are weighed in making a final project selection.

The project selection process is clearly a difficult one and, although a benefit cost analysis of the NED account plays an important role, it is not itself adequate. Forman and Forman (1987), for example, argue that a method such as benefit cost analysis does not constitute a decision making process for choosing the most preferred means of achieving an objective, but only represents an input to this process. Moreover, it is difficult to know how to weigh the non-NED types of information on an *a priori* basis under the existing P & G guidelines used by the Corps in project selection.

This paper uses the Analytic Hierarchy Process (AHP) as a method to formally incorporate additional information into the project selection decision making process. AHP (Saaty, 1980) is a technique which allows a problem to be structured in the form of a hierarchy of related decision elements. The model used in this study begins with the overall objective to select the best flood control plan or project alternative. It then descends to criteria in making this selection, down further to other decision attributes which are subdivisions of the criteria, and finally to the alternative project plans from which the selection is to be made. Pairwise comparisons are then made using AHP.

AHP has been used in a variety of problem solving contexts. Golden and Wasil (1989) provide an excellent bibliography of these applications. Some of these applications include energy planning (Hamalainen and Seppalainen, 1986; Mitchell and Soye, 1983), risk analysis, accounting and finance problems (Vargas and Saaty, 1981), and conflict analysis (Gholamnezhad, 1981; Saaty, 1983a). This paper describes an application of AHP in water resources planning, an area where no applications have been reported yet. It also describes the use of AHP as a tool to analyze pluralistic problems involving decisions where the points of view of different constituencies are represented. Clearly, backgrounds and experiences of different decision makers affect their voting styles. AHP is a means to understand these differences. Finally, the paper offers some suggestions for use of AHP in certain decision settings based on our experiences.

A general statement of the problem addressed in this paper is given in section two, including an overview of historical flooding problems, the nature of related flood damages, and the set of proposed project alternatives. The development of the AHP model is outlined in section three, while data collection is presented in section four. These discussions include the method/software and mode for recording responses. Section five presents the results, analysis, and implications for federal project managers as well as practitioners of AHP.

2. Problem Description

The problem addressed in this paper is to evaluate the feasibility of providing flood protection along the Grand (Neosho) River and Tar Creek at Miami, Oklahoma, which is located in the Northeast corner of Oklahoma, near the Oklahoma-Missouri state line. The U.S. Army Corps of Engineers (USCE) was initially contacted in September 1987 by the city of Miami requesting a public meeting to discuss city flooding problems. A study was formally initiated by the Corps in March 1988. In addition, a flood committee was formed by the city of Miami to represent the interests of the city in coordinating and developing the study conducted by the Corps.

The study areas are shown in Figure 1. The Grand River is a major tributary of the Arkansas River and drains an area of about 12,495 square miles in Kansas, Oklahoma, and Missouri. The drainage area above Miami is approximately 6,071 square miles. The portion of the river relevant for this study extends from the Tar Creek confluence on the east to the Miami city limits on the west. The topography along the river in the general vicinity of Miami is described as gently rolling hills. The Grand River channel is about 300 feet wide in the vicinity of the study area and is occasionally obstructed by snags, debris, and gravel bars. The river's banks are generally stable, vary in height from 15 to 30 feet, and are covered with brush and trees above the low water line.
Tar Creek is described as a left bank tributary of the Grand River, flowing through the eastern part of Miami with a drainage area of about 50 square miles. The high flood damage portion of Tar Creek included in this study extends from the Grand River confluence north through the city to the area just north of 22nd Avenue as shown on Figure 1. Tar Creek flows in a relatively straight line over the last 7.5 miles of its course within a floodplain varying in width from about 1,800 feet to about 3,800 feet.

Historically, Tar Creek is the primary source of flooding within the city, but storms over the Grand River Basin and high stages of the Grand River have

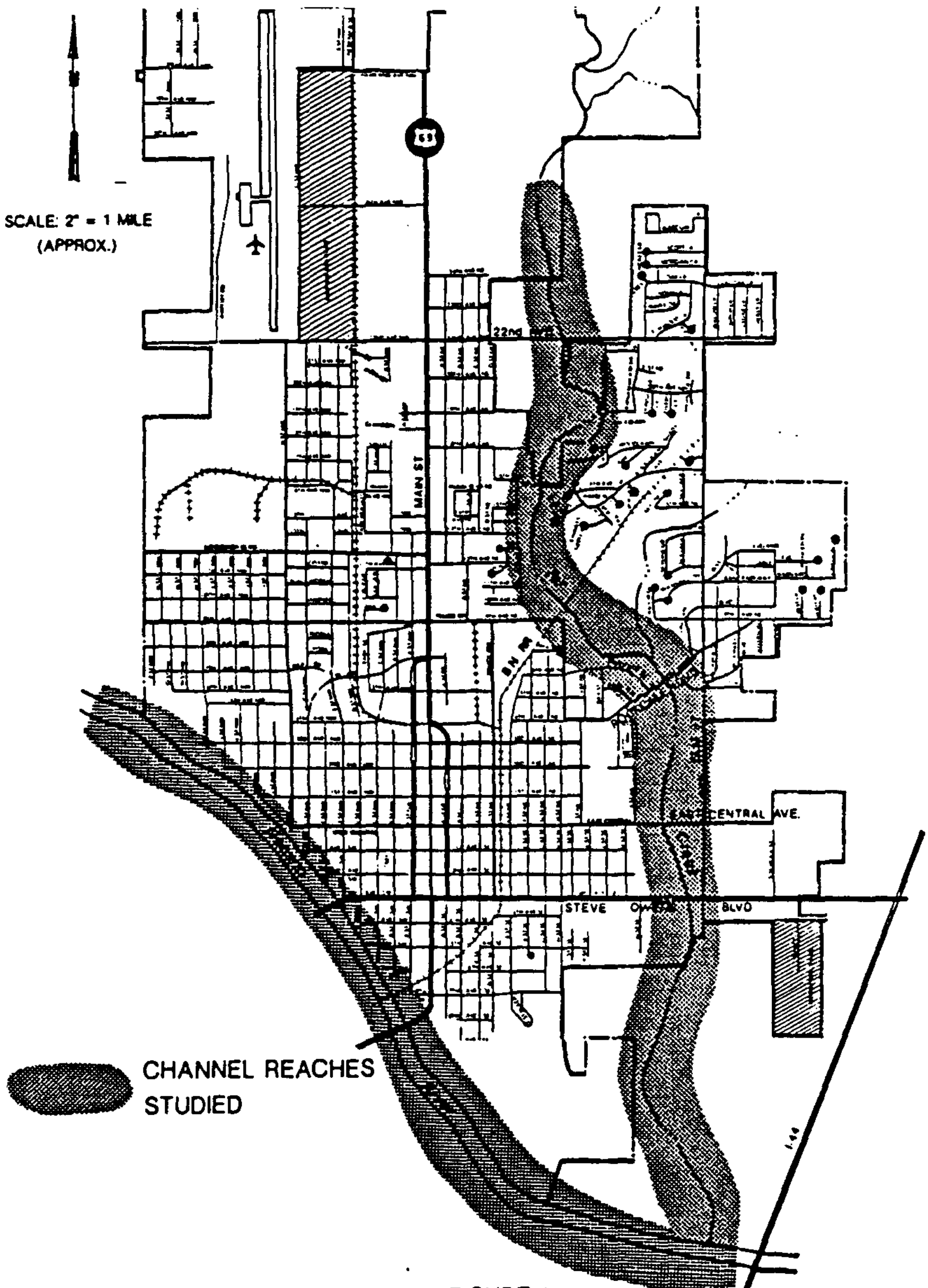


FIGURE 1
STUDY AREA

caused frequent flooding along the Grand River as well as Tar Creek. Continuously heavy rainfall has been the cause of the majority of large floods, but flooding on Tar Creek may be caused by intense local storms located over the Tar Creek Basin.

Most of the residential properties and a larger part of Miami's business district lie above flooding elevations, but a large number of residential, commercial, and industrial areas on the Grand River and Tar Creek and tributaries have been inundated by floods.

Historical records indicate that flooding on Tar Creek has often been elevated downstream from the Burlington Northern Railroad bridge (see Figure l) because of backwater effects caused by the Grand River. As noted previously, Tar Creek is a relatively small stream, but it can also cause flooding independent of the Grand River. These floods result from isolated storms on the Tar Creek watershed and are characterized by rapid rates of rise of short duration.

A broad range of flood reduction measures were reviewed as possible solutions to the flooding problem. Initial reviews of these led to some alternatives being eliminated from further consideration, including one which was suggested by Miami residents. This measure was based on the construction of a large flood control reservoir on the Grand River upstream of Miami, but this faced a number of major obstacles including poor dam site conditions. Moreover, a cursory examination of potential benefits from such an alternative indicated that the benefits would likely be quite low relative to the high estimated costs. Other measures eliminated after initial review included Grand River channelization, dredging, and small dams in the Grand River upstream of Miami. It was concluded that these measures would be ineffective in reducing flood damages.

The flood control alternatives evaluated in this paper are shown in Table 1. These reflect the fact that the majority of the flooding problems occur along Tar

Creek.

3. Development of the AHP Model

The procedures used by the USCE to study and select flood control projects places major emphasis on the use of benefit cost analysis. These procedures also require that the benefits associated with each flood control project alternative be classified into one of the four accounts listed at the beginning of the paper, but the NED account is by far the most important of these in the actual selection of flood control projects. NED benefits are defined as increases in national wealth irrespective of their point of origin in the United States. NED benefits are compared with NED costs. These costs are the opportunity costs of resources used to implement a project and the uncompensated economic loss from detrimental project effects. If the NED benefits are greater than the NED costs for a plan, that plan is considered economically feasible. The project with the highest net NED benefits, which is otherwise technically feasible, environmentally sound, and publicly acceptable, is called the NED plan. This plan is formulated in detail throughout the planning process and is given the highest priority in selecting a recommended plan.

The National Environmental Policy Act of 1969 (NEPA) requires that the environmental quality impact of federal projects be assessed and summarized in the EQ account. The nature of this assessment includes the magnitude, location, duration, reversibility, and frequency of the environmental quality impacts as well as long-term productivity of an area's value as a resource. This assessment is designed to avoid detrimental impacts in the formulation of project alternatives, to take advantage of opportunities to enhance and protect resources, as well as to assist in determining a project plan that will offset environmentally detrimental project effects.

Table 1

Project Alternatives

Levee Along Grand River, West Bank of Tar Creek, and East Bank of Tar Creek -- 50 Year Flood Event

Cost	$1,425,000
Benefit	$2,939,000
Net Benefit	$1,514,000
Benefit/Cost Ratio	2.1

Levee Along Grand River, West Bank of Tar Creek, and East Bank of Tar Creek -- 100 Year Flood Event

Cost	$1,904,000
Benefit	$3,510,000
Net Benefit	$1,606,000
Benefit/Cost Ratio	1.8

Floodplain Acquisition and Evacuation Plan -- 25 Year Flood Event

Cost	$1,661,400
Benefit	$500,000
Net Benefit	---
Benefit/Cost Ratio	0.30

Do Nothing Alternative

Average Annual Damages	$10,800,000

RED benefits are the economic gains derived from a project in a particular geographic area. These benefits are measured by the net increases in income and employment and include redistributions of wealth from other regions of the country. RED benefits cannot be used in calculating the benefits of the NED plan, but may prove useful to local officials in assessing the value and financial feasibility of a project.

All other impacts which may have a bearing on the decision making process but are not included in the other accounts are included in the OSE account. Most of these can be quantified, but it is difficult to assign monetary values to them. This account includes changes in risks to life and health, community vitality, fiscal health, and displacement, as well as the geographic/demographic distribution of income and employment impacts.

Based on this description of federal flood control project selection procedures, the authors developed an AHP model. The AHP model hierarchy, shown in Figure 2, consists of four levels. The first level represents the overall goal to select the best flood control project alternative. The second level of the hierarchy shows the criteria used to evaluate the best project alternative. The NED account, RED account, and EQ account criteria represent three of the benefit accounts outlined in the P & G document. The subcriteria for the NED account embody the benefit/cost study results and are reflected in the subcriteria of project benefits and project costs. The subcriteria for the RED account include impact on community income, community employment, and the local tax base. The subcriteria for the EQ account include endangered species habitat and water quality impacts.

The remaining criteria are risk to life and health and political acceptability. The former criterion reflects the ability of a project to provide protection to life and health (as well as property) from a flood event which is likely to occur with a

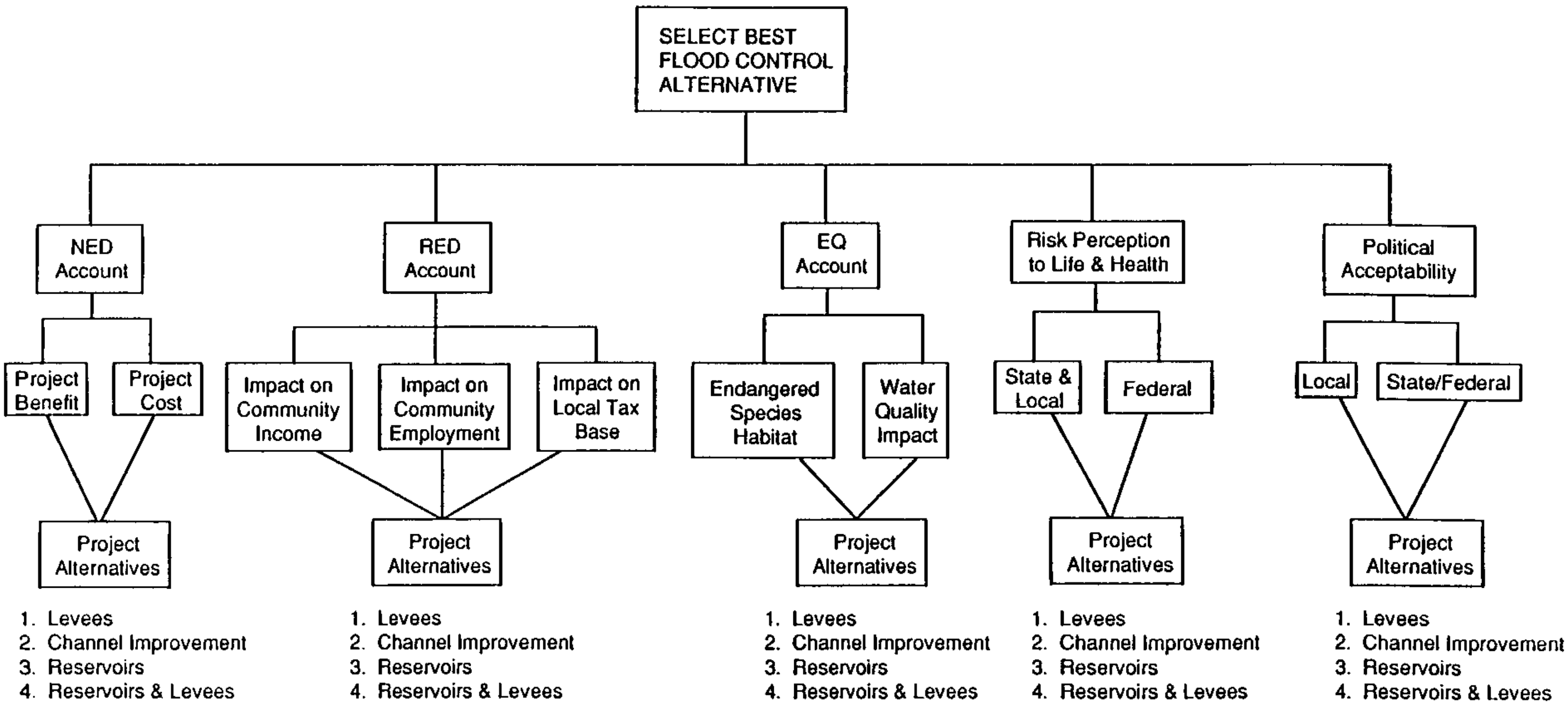


Figure 2. Initial AHP Model

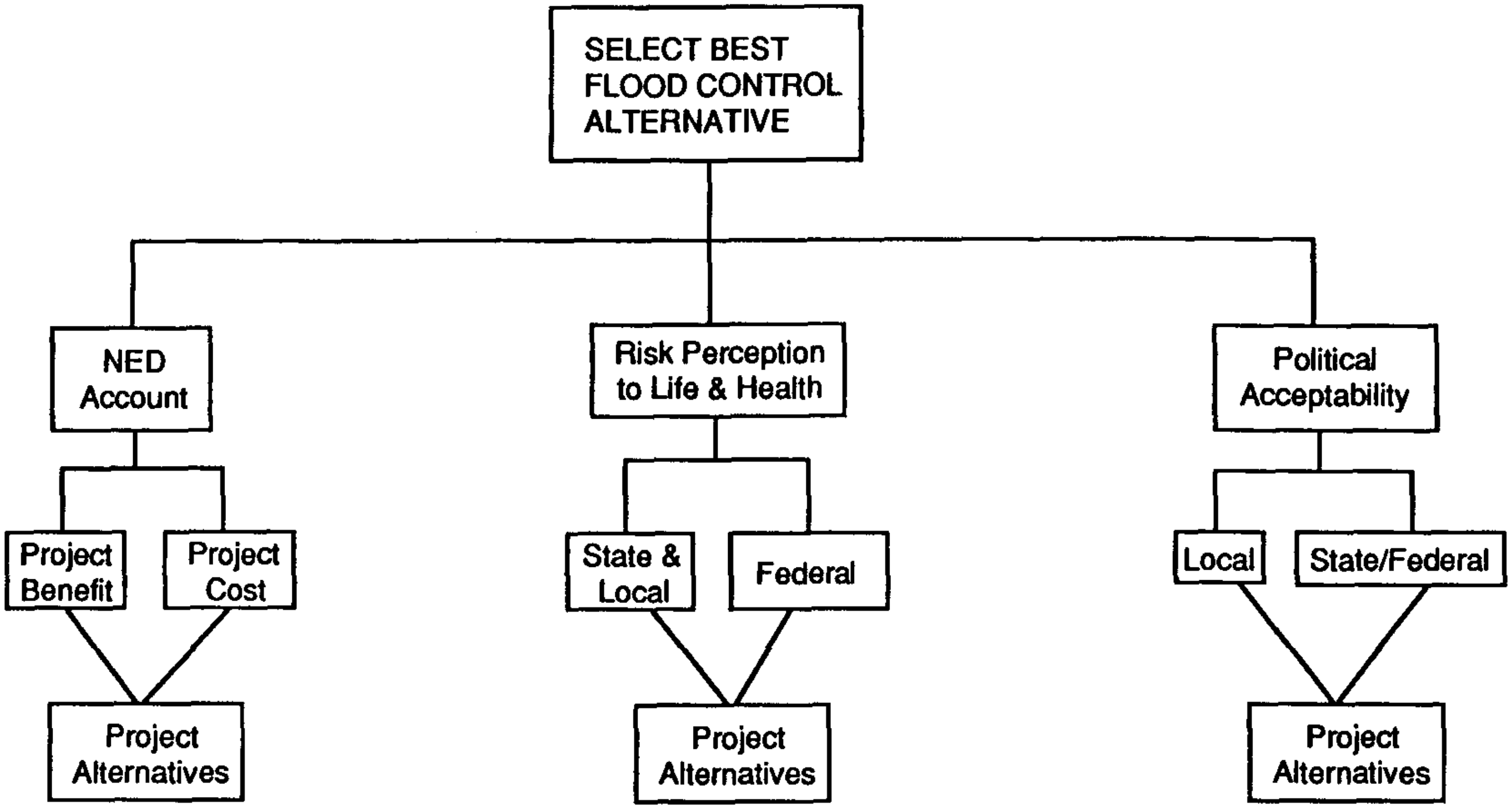
certain probability. The subcriteria in this case show that the perceived levels of acceptable protection or risk may vary among officials at the state/local level and the federal level of decision making. The political acceptability criterion includes considerations related to flood control projects such as community vitality, fiscal health, and displacement effects, as well as the geographic/demographic distribution of income and employment impacts of the different projects. The subcriteria here reflect the fact that different perceptions could occur at the local or community level as well as at the state/federal level.

The AHP model illustrated in Figure 2 was presented to a group of engineers, economists, and social scientists at the USCE. Their view of the particular alternatives considered in this study revealed that the elements of the EQ account would have little impact on the selection of an alternative. Moreover, the differential impacts of the different projects on the RED account elements were found to be insignificant as well. Thus, these two criteria were eliminated and a modified version of the AHP model shown in Figure 3 was used.

4. Data Collection

The final model was built using Criterium (Sygenex, 1989). This is a fairly easy to use package implementing AHP (Harker, 1990). The program allows the user to enter data graphically, verbally, or numerically. It permits either pairwise ranking or a direct ranking of alternatives.

Our model was presented to a group of professionals at the USCE. All of these people were familiar with the flood control problem described in an earlier section. To capture the differences in decision emphasis, we invited people from diverse backgrounds to provide their inputs to the decision problem. The group included two internal economists, two engineers, one social scientist, one environmental scientist, and an outside economist who had worked with USCE



1. Levee Along Grand River, West Bank of Tar Creek, and East Bank of Tar Creek - 50 year Flood Event
2. Levee Along Grand River, West Bank of Tar Creek, and East Bank of Tar Creek - 100 Year Flood Event
3. Floodplain Aquisition and Evacuation Plan - 25 Year Flood Event
4. Do Nothing - Maintain Status Quo

1. Levee Along Grand River, West Bank of Tar Creek, and East Bank of Tar Creek - 50 year Flood Event
2. Levee Along Grand River, West Bank of Tar Creek, and East Bank of Tar Creek - 100 Year Flood Event
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Figure 3. Final AHP Model

before, but was not an employee. One of the two engineers is a project manager and the other is a section head with supervisory responsibility. The project manager is usually responsible for performing cost-benefit analyses and making recommendations for final project selection in similar cases. The other professionals provided inputs from their respective disciplines into the decision process. The outside economist was included to incorporate a non-USCE perspective into the decision model.

Each of these decision makers (DM) was given a brief explanation of AHP and the particular model. The model was presented on an MS-DOS compatible laptop computer with no color graphics. The introduction was provided by the authors. A DM would begin with pairwise ratings of criteria and then move to subcriteria and alternatives. All DMs were only allowed to use pairwise ranking using the graphics mode. To do this, they would use the arrow keys to mark their level of preference or importance between two categories. Once they had completed pairwise comparisons at any one block, they could see the direct rankings of the alternatives in a bar chart form. If they wished, they could return to the pairwise ranking chart and adjust their rankings. While the software screen listed inconsistencies in their ratings, we did not discuss them with the DMs. We refrained from highlighting or adjusting the inconsistencies to measure any differences that may have arisen due to differences in their backgrounds.

Every effort was made to ensure that other factors such as time of the day, room setting, and computer environment would not have an effect on the DM's ratings.

5. Results and Analysis

The final project alternative rankings for all of the respondents are shown in Table 2. Table 2 shows that six out of the seven respondents selected the 100-year levee as their most preferred alternative. Moreover, five of these respondents selected the 50-year levee as their second most preferred option. In contrast, the environmental scientist selected the floodplain acquisition plan as the second most preferred alternative. One of the internal economists selected the 50-year levee as the most preferred option. This respondent picked the 100-year flood levee as the second most preferred alternative.

The degree or intensity of preferences for alternatives implied from the scores in Table 2 shows some degree of variation. For example, one of the internal economists, the social scientist, and the external economist preferred the 100-year levee over the 50-year levee by a margin of about 2 to 1. The remaining members of the group favoring the 100-year levee did not weigh this alternative as heavily. The environmental scientists had the most evenly distributed scores across the set of alternatives of the seven respondents.

The overall alternative ratings summarized in Table 2 suggest that varied backgrounds and experiences of the different decision makers affect their voting decisions. These differences can be highlighted and brought into sharper focus by briefly examining individual decision maker responses at the criteria and subcriteria levels. Consider first the responses for the different criteria. Table 3 shows that the NED account was rated as the most important criterion by the two internal economists, the environmental scientist, and the section head, while the outside economist ranked it second and the social scientist ranked it third. Risk perception to life and health was ranked as the most important criterion by the social scientist, the project manager, and the outside economist. Political acceptability was viewed as the second most important criterion by the social scientist and the section head.

Differences in decision maker perspectives are also evident at the subcriteria level of the hierarchy. For example, the environmental scientist

TABLE 2: OVERALL ALTERNATIVE RATINGS

Decision Participant	ALTERNATIVES			
	50 Yr Levees A1	100 Yr Levees A2	Floodplain Acquisition A3	Do Nothi-ng A4
Economist-I	40.9	38.81	15.97	4.32
Engr-Proj.Mgr.	33.12	46.69	12.05	8.13
Env.Sci.	24.31	35.73	27.19	12.77
Economist-II	24.97	63.34	6.78	4.91
Engr-Section Head	38.61	40.1	18.71	2.58
Soc. Sc.	26.55	57.81	9.75	5.89
Econ-out	30.32	54.1	11.86	3.71
Mean	31.25	48.08	14.62	6.04

Table 3: Ratings of Criteria & Subcriteria

Decision Participant	Criteria Rating			Subcriteria Rating					
	NED Account	Risk Perception	Political Acceptibility	NED		Risk Perception		Political Acceptibility	
				Project Benefit	Project Cost	State And Local	Federal	Local	State/ Federal
	C1	C2	C3	S11	S12	S21	S22	S31	S32
Economist-I	67	20.9	12.1	50	50	80	20	85.71	14.29
Engr-Proj. Mgr	32.18	49.56	18.26	81.25	18.75	14.29	85.71	87.5	12.5
Env.Sci.	62.23	24.7	13.07	33.33	66.67	75	25	20	80
Economist-II	74.66	19.33	6.01	63.75	36.25	88.89	11.11	75	25
Engr-Section Head	77.2	10.26	12.54	50	50	12.5	87.5	85.71	14.29
Soc. Sc.	10.93	58.18	30.9	65.79	34.21	66.07	33.93	50	50
Econ-out	39.77	50	10.23	60.94	39.06	27.47	72.53	34.38	65.63
Mean	52.00	33.28	14.73	57.87	42.13	52.03	47.97	62.61	37.39

ranked project cost as more important than project benefits under the NED account. All others ranked project benefits at least as important or more important than project costs. The outside economist and the environmental scientist ranked the state/federal political acceptability of an alternative project as more critical, while all of the other respondents ranked the local political acceptability as more critical. These results probably reflect the fact that the outside economist and environmental scientist are more removed from the particulars of the actual studies of the project alternatives than the other respondents in this study.

The greatest degree of diversity for any of the criteria by the group of respondents as a whole appeared to be for the risk perception criterion. The project manager and section head (both of whom are engineers), as well as the outside economist, considered the federal risk perception perspective as far more important than was true for the other respondents. In contrast, the other respondents gave strong support to the state/local perception of risk.

The evaluation of project alternatives at the subcriteria level also revealed some interesting insights. From a project benefit standpoint, the majority agreed that the 100-year levee would be best overall, but the environmental scientist ranked the 100-year level second to the floodplain acquisition plan. This outcome may reflect this individual's belief that the former option could completely eliminate the problem in the sense of totally removing people and property from the affected areas.

The second subcriteria under the NED account was project cost. The data in Table 4 reveal that the lowest cost alternative (the 50-year levee) was selected by an internal economist, the section head, and the outside economist. The environmental scientist and the second internal economist picked the 100-year level as their most preferred option under project cost, while the social scientist picked the do-nothing

Table 4: Ratings of Alternatives

Criteria	Subcriteria	Alternative	Decision Participant							Mean
			Economist-I	Engr-Prog.Mgr	Env.Sci.	Economist-II	Engr-Sec.H.	Soc. Sc.	Econ-out	
NED	Profit Benefit	A1	27.7	35.22	14.12	22.68	22.5	20.34	26.56	24.16
		A2	59.43	47.94	27.56	68.85	67.5	63.97	58.69	56.28
		A3	9.88	13.81	48.27	3.19	7.5	12.72	10.51	15.13
		A4	3	3.02	10.06	5.28	2.5	2.97	4.24	4.44
	Project Cost	A1	58.99	18.26	27.85	31.87	67.5	8.64	60.87	39.14
		A2	13.29	11.3	39.24	55.07	7.5	2.98	10.15	19.93
		A3	22.13	7.83	19.3	8.18	22.5	19.25	24.83	17.72
		A4	5.59	62.61	13.61	4.87	2.5	69.13	4.15	23.21
Risk Perception	State and Local	A1	31.01	24.08	27.36	19.43	7.5	19.02	25.75	22.02
		A2	53.38	60.18	42.63	62.02	22.5	67.63	57.58	52.27
		A3	11.35	12.2	16.96	13.75	67.5	10.14	11.52	20.49
		A4	4.26	3.53	13.05	4.8	2.5	3.22	5.15	5.22
	Federal	A1	21.05	37.18	27.85	22.26	22.5	21.9	23.63	25.20
		A2	68	44.87	39.24	68.66	67.5	66.51	66.1	60.13
		A3	7.92	11.54	19.3	6	7.5	7.95	7.72	9.70
		A4	3.03	6.41	13.61	3.07	2.5	3.64	2.54	4.97
Political Acceptibility	Local	A1	51.41	30.29	39.24	31.1	11	66.66	24.1	36.26
		A2	15.68	54.27	19.3	55.53	39.37	21.74	56.03	37.42
		A3	27.59	12.31	27.85	10.18	46.61	8.38	14.59	21.07
		A4	5.31	3.12	13.61	3.19	3.03	3.22	5.28	5.25
	State/Federal	A1	26.99	20.57	19.3	21.96	32.14	18.34	22	23.04
		A2	60.8	64.91	27.85	68.76	32.14	68.74	66.27	55.64
		A3	9.14	10.38	39.24	6.12	32.14	8.8	8.34	16.31
		A4	3.07	4.15	13.61	3.16	3.57	4.12	3.39	5.01

A1- 50 Yr Levees

A2-100 Yr Levees

A3- Floodplain Acquisition

A4- Do Nothing

alternative as being most preferred. All other respondents picked the do-nothing option as the least preferred, while the social scientist picked the 100-year levee as the least preferred alternative under project costs. Finally, the project manager ranked the floodplain acquisition alternative as the least preferred.

All but one of the respondents ranked the 100-year levee alternative as most preferred under the state/local perspective of risk perception. In contrast, the section head had a relatively strong preference for the floodplain alternative. There seemed to be a high degree of consensus among the respondents that the 100-year levee alternative was the most preferred given the federal perspective of risk perception. Moreover, all but one respondent ranked the project alternatives in the same order for both subcriteria. Further observations of these rankings reveal that there was some degree of variation in the intensity of feeling about these alternatives for the different subcriteria.

The subcriteria for the political acceptability of project alternatives demonstrated variation in responses as well. There was particularly large variation in responses for the local perspective of political acceptability. The project manager, an internal economist, and the outside economist ranked the l00-year levee project as the most preferred alternative. The environmental scientist, the social scientist, and the second internal economist ranked the 50-year levee as the most preferred project, while the section head ranked the floodplain acquisition plan as the most preferred. The latter sets of rankings tend to favor smaller scale projects (which are usually lower cost options) and may be motivated by a belief that these alternatives are more feasible politically. This view seems particularly appealing since the local communities must cost share in the alternative selected for implementation. In addition, smaller scale projects also provide an option for a smaller degree of protection. The federal perspective of political acceptability seems to yield a consensus favoring the l00-year levee alternative by the respondents.

These results suggest that the background of the respondent does have an impact on his/her decision. While a questionnaire may identify some of these differences, AHP has provided a more complete method to segregate and analyze differences between different groups. As such, AHP may have potential as a sound technique for constituent plurality analysis in problems where different constituent groups are involved in decision making.

The inconsistencies in criteria and alternative selections by the respondents in this study are given in Table 5. Choices are classified as inconsistent if the inconsistency ratio exceeds 0.1 (Saaty, 1983). It is interesting to note that all of the inconsistencies arise with the two internal economists and social scientist. The second internal economist recorded an inconsistency at the first level of the hierarchy in ranking the three criteria. All of the other noted inconsistencies occur at the subcriteria level in ranking the project alternatives.

The presence of inconsistencies implies that preference or rank reversals have occurred as decision makers reveal their preferences in decision making situations. Olson et al. (1986) recall two aspects of consistency: transitivity and strength. Transitive consistency means that if X is preferred to Y and Y is preferred to Z, then X should be preferred to Z. Strength consistency means that if X is preferred three times as much as Y and Y is preferred two times as much as Z, then X must be six times as much as Z. The inconsistencies shown in Table 5 appear to be related to violations of the strength consistency characteristic.

The issue of rank reversal appears to be one of the major sources of criticism of the AHP (Dyer, 1990). Moreover, the realism of rank reversal also seems to be a question in this debate. But Slovic and Lichtenstein (1982) show that there is a substantial body of research which demonstrates the robustness of preference or rank reversals. "Moreover, reversals can be seen not as an isolated

Table 5: Inconsistency in Criteria and Alternative Selection

Decision Participants	Goal	Criteria			Subcriteria					
		NED Account	Risk Perception	Political Acceptibility	Project Benefit	Project Cost	State And Local	Federal	Local	State/ Federal
	G	C1	C2	C3	S11	S12	S21	S22	S31	S32
Economist-I	0	0	0	0	0.24	0.13	0.13	0.3	0.01	0.27
Engr-Proj. Mgr.	0	0	0	0	0	0	0	0	0	0
Env.Sci.	0	0	0	0	0	0	0	0	0	0
Economist-II	0.17	0	0	0	0.27	0.07	0.07	0	0.18	0
Engr-Section Head	0	0	0	0	0	0	0	0	0	0
Soc. Sc.	0	0	0	0	0	0.38	0.26	0.21	0.32	0
Econ-out	0.03	0	0	0	0	0	0	0	0	0

phenomenon, but as one of a broad class of findings that demonstrate violations of preference models due to the strong dependence of choice and preference upon information processing considerations," (Slovic and Lichtenstein, 1982, p. 597). In any case, it is interesting that the inconsistencies arose in the use of the model by the social scientist and the internal economists. While no statistical significance may be given to this observation due to a small number of participants in this study, we believe that this has implications for practitioners of AHP. At one extreme, a strong conclusion may be that the AHP modelers should be prepared to expect and deal with inconsistencies when the model is used with behavioral/social scientists. Another conclusion may be that the explanations of criteria, subcriteria, and alternatives should be spelled out in greater detail when the model users are from this group.

6. Summary and Conclusions

This paper has presented a new application of AHP in the water resources planning area. Our analysis also indicates that AHP may be an appropriate technique for analyzing differences among groups. This has the potential to make AHP a viable technique for understanding voting behavior and emphasis of constituent groups in any plural, political decision setting. Further, the inconsistency analysis suggests that practitioners of AHP may have to prepare model descriptions differently depending upon the backgrounds of the users.

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