

SIMULATION MODEL FOR GUIDING LEBANON'S POST-WAR RECONSTRUCTION

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Abstract

This paper describes a pilot model, NRDM-2 for National Reconstruction and Development Model Version Two, the harbinger of a package of interactive national, regional, and sectoral computer models to be used to guide reconstruction and development in Lebanon. NRDM-2 is displayed in the form of a causal diagram in Fig. 3.1. The model is comprised of 12 sectors: Manufacturing, Business, Infrastructure, Manpower, Government Services, Agriculture, Population, Utilities, Highways, Housing, Trade-Energy, and Socio-Economic Indicators. There are 435 equations expressed in the DYNAMO simulation language. The objective aspects of Lebanon's development are contained in the relationships between the variables. Knowing the values of the 435 parameters at the initial year 1980 permits their calculation at consecutive years for the next 50 years. The subjective aspects of Lebanon's development are dealt with in the way the model is used to analyze possible future development alternatives using scenario analysis. Three basic scenarios identified for investigation are: (1) Base (No-War) Scenario, (2) No Reconciliation or Reconstruction Scenario, and (3) Reconstruction and Reconciliation Scenario.

INTRODUCTION

Lebanon, the country is new; Lebanese society is ancient. Lebanon's current geographic frontiers and political institutions were defined in the Constitution of 1926 and, except for slight modifications introduced on the eve of Lebanon's independence in 1943, remain in effect. The social and cultural characteristics of Lebanese society have their origins in the Phoenician, Greco-Roman, Arab, and Ottoman civilizations. The Lebanese state, with an area of ten thousand square kilometers, and Lebanese society, with a

resident population of three million persons (and almost an equal number of expatriates), have a significance in the Middle East and, indeed worldwide, out of proportion to their size, owing to their role as a vital link between East and West.

The result of the chaos of the 1975-76 Civil War followed by six years of anarchy has left 75,000 dead and 10,000 physically wounded. The commercial, economic, and social life of Lebanese society exists in the shadow of violence and political uncertainty. Real and potential financial losses to the year 1980 by the Beirut Chamber of Commerce and Industry's tabulation is placed at 21 billion L.L. (\$1 = 4 L.L.). In terms of psychological effects on the Lebanese people, the post war years have been even more devastating than the two years of war.

PICKING UP THE PIECES

Rebuilding after any war is a long and difficult undertaking. It is even more difficult when there is political uncertainty and physical insecurity. The first obligation of the Government was to provide emergency relief--feed those who were hungry, find temporary housing for the dispossessed, and treat the many who were sick and injured. As the massive emergency efforts ended, emphasis turned from problems of relief and rehabilitation to reconstruction and development. Recognizing the long-range importance of the latter, the Government quickly established its Council for Development and Reconstruction (CDR) in late January 1977. The responsibilities given the Council were extensive, but ranking above all others was the obligation to prepare an overall, comprehensive development plan that would chart the direction, scope, and composition of Lebanon's future.

The CDR approached its post-war development planning task by commissioning a series of

Proceedings of the 1982
Winter Simulation Conference
Highland * Chao * Madrigal, Editors

82CH1844-0/82/0000-0031 \$00.75 © 1982 IEEE

"Agenda Papers" on the various sectors of the Lebanese economy, and on specific topics of vital importance to strategic planning. Suggested Agenda Paper topics included the following: housing, telecommunications, transport, roads, potable water, Beirut city center, airport, seaport, agriculture, education, health, tourism, industry, repatriation of skills and capital, role of private sector, rural-urban balance, incomes policy, fiscal reform, delivery of social services, administrative reform, culture, energy, manpower, and the transfer of science and technology. The purposes, as expressed in an advisor's memorandum, were as follows: "They will form the framework for a position paper on the Government's planning objectives to be submitted to the Council of Ministers in June, 1978; they will provide a basis for systematic and more detailed studies; and they will assess, after discussions with representative groups the degree of consensus on policy goals".

The Agenda Papers were prepared and submitted to the CDR. The CDR had reason to be grateful for the serious effort put into most of the papers without compensation for the authors. However, while each author has presented a faithful perception of a part of the system we call Lebanon, the overall picture formed is as misleading as the blindmen of Ghor's description of the elephant. Since the approach to development planning exemplified is not an illogical approach, not even an uncommon one for that matter, the metaphor is less a criticism of the CDR than it is an indictment of the development planning state of the art. What is needed is a way to synthesize many isolated, incomplete perceptions of national development into a complete picture.

In the summer of 1980 an agreement was entered into whereby the Republic of Lebanon, acting through the CDR, would grant the American University of Beirut a sum previously granted to the CDR by the U.S. Agency for International Development, to develop a pilot model, the harbinger of a proposed package of interactive national, regional, and sectoral computer models to be used for the reconstruction and rehabilitation of Lebanon. The following main guidelines set forth the overall plan of action agreed upon by the parties:

- Phase 1: The development of NRDM (National Reconstruction and Development Model), an operational computerized simulation model of Lebanon.
- Phase 2: The performance of sensitivity analysis and calibration of parameters for three basic scenarios, identified as follows: (1) the "no War" Scenario, (2) the "Reconstruction Plan" Scenario, and (3) the "No Reconstruction Plan" Scenario.
- Phase 3: The preparation of the final report completely documenting the pilot model NRDM to serve as a training manual for CDR personnel and AUB students.

NRDM-2 is a model of Lebanon. It was distilled from the Agenda Papers which, taken collectively, is also a model of Lebanon. Each of the Agenda Papers deal with goals involving certain variables and policy interventions involving other variables. To link the goal and policy variables, the authors of the Agenda Papers have implied an understanding of a complex set of intervening relationships, a system. Since the prose of the reports is the model representing the system, the Agenda Papers may be thought of as a verbal model. In contrast, the complex set of intervening relationships between variables in NRDM-2 are expressed by equations and it is referred to as a mathematical model. The verbal model of Lebanon contained in hundreds of pages of Agenda papers spanning many disciplines can not promote communication and understanding leading to consensus and it is too fuzzy, static, incomplete and imprecise to be used for decision making. NRDM-2 can be represented on a single page in the form of a "causal diagram" displaying the intervening relationships between goal and policy variables (see Fig. 3.1).

The causal diagram in Fig. 3.1 not only facilitates writing the equations that permit one to perform the arithmetic tasks that will trace Lebanon's development through time (see Appendix for the model equations and for the identification of parameters), but portrays a gestalt-like statement of the Lebanese socio-economic National development system in its own right. The significance of this graphic gestalt in the modeling paradigm is that it takes us out of a communication cul-de-sac providing a common vocabulary and structure of reasoning between individuals, professions, specialists, administrators, and cultures. Because of the sense of fragmentation and isolation conveyed by the Agenda Papers prepared for the CDR, the communicative ability of NRDM-2 is as important as its scientific rigor.

GENERATION OF SCENARIOS

In the research we generate three variants of possible future configurations of Lebanese development activity, or three "scenarios". Scenarios are attempts to describe future changes in the state or condition of a social system--in this case, Lebanon. One of the scenarios has been dubbed the "No-War" Scenario. In this scenario the Lebanese economy is assumed to preserve in the future the pattern that existed in 1975 before the Civil War. The other two scenarios take conditions as they existed in 1980 as the initial state of the system with the difference between the two being whether or not there is a formal reconstruction effort. These are referred to as the "Reconstruction Plan" Scenario and the "No Reconstruction Plan" Scenario.

The three scenarios which cover a fifty year period starting from the present are expressed graphically to facilitate comparison. Specifically, the more than 300 variables of NRDM-2 have been weighted and condensed into 31 indicators representing fourteen socio-economic domains:

human resources, wealth, distribution of wealth, government and politics, health, education, housing, land resources, agriculture and food, communications, transportation water resources, energy resources, and pollution. The 31 indicators, in turn, are weighted and combined linearly to produce an overall measure of the quality of life.

The development indicators selected for aiding in scenario analysis are summarized in Table 4.1. In Table 4.2 the values assigned to parameters in NRDM-2's equations in order to generate the three scenarios are given. For example, the values in the first column are based on the CDR five-year plan that was unveiled in 1979. This plan has been interpreted as follows. Private sector needs are reckoned at 9 billion Lebanese pounds, 0.8 billion per year for five years to manufacturing (Equation 26) and 1.0 billion per year for five years to business (Equation 59). It includes 10 billion Lebanese pounds over five years in the public sector spread among telecommunications (Equation 92), ports and airports (Equation 98), highways (Equation 104), and low-income housing (Equation 169). For the purpose of this study it was assumed that private sector needs were supplied by loans which are repaid to Government (Equations 36 and 69) which in turn invests the money in irrigation (see Equation 217).

The manner in which the 3 futures can be compared using development indicators is illustrated in Figs. 4.7, 4.11, 4.32 and 4.33.

POLICY EXPERIMENTS

Armed with the knowledge that we have in NRDM-2 the capability to observe the time paths of hundreds of socio-economic variables over the next 50 years of Lebanon's future, we are about to do what all development planners would like to be able to do: to see what the next 50 years would look like if any of several variations in the Reconstruction Plan Scenario are substituted. This will be illustrated by testing two hypothetical policies identified as a Taxation Policy and a Zoning Policy.

Taxation Policy. Traditionally Lebanon has tended to pursue a policy favorable to private interests--laissez faire. But if social justice is to accompany physical and economic reconstruction, it is doubtful that needed social programs in the future can be undertaken without a budget fueled by taxes. To show how we use NRDM-2 to experiment with various tax policies, two computer cards were changed and a simulation run was made. Specifically, the parameter FMPGX, the Fraction of Manufacturing Product to Government after Reconstruction which is Equation 108.1, was made equal to .10, and the parameter FBPGX, the Fraction of Business Product to Government after Reconstruction which is Equation 112.1, was made equal to .15. Recall from Table 4.2 that under the basic Reconstruction Plan Scenario the values used for these two parameters were FMPGX = .05 and FBPGX = .10. Referring to Table 4.2, note that the two fractions during the period of reconstruction would remain .05 and .10 respectively. Thus, the tax increase would take effect after the formal reconstruction period. One result of this computer run is presented in Figure 5.1. To

facilitate evaluation and comparison to the basic Reconstruction Plan Scenario of this modified plan, some of the same development indicators employed for comparison of the three principal scenarios in Table 4.1 are used.

Zoning Policy. Zoning decisions determine the supply of land available for various socio-economic activities. In Lebanon zoning is an unexploited policy instrument. The amount of land and its use influence such things as the present and future housing market, population mix, economic growth, employment conditions, and environmental quality. Since a country must live with its zoning decisions for decades, local decisions affecting land use should be made in the context of the total national system. Land zoning policy tests afford a basis for accomplishing this. To illustrate this capability, four parameters in the model were changed as indicated in Table 4.3. The impacts of the present policy values on selected development indicators are shown in Figure 5.2.

In addition to policy experiments, additional experiments can be performed with NRDM-2 to try to ascertain the potential effects of factors such as fuel costs and world economic development that are beyond Lebanon's control.

National Cost of Fuel, NCF. This variable in NRDM-2 is defined in Eqs. 285 and 285.1. Translating the equations from mathematics to English: the present cost of fuel in Lebanon is taken as 750 LL per TOE (Ton-Oil-Equivalents) and that it increases steadily to 2500 LL/TOE in the year 2030. How good is this assumption? How critical is it?

Fortunately it is not the task of this research or any research to forecast the values of its exogenous variables, but only to understand the effects of varying forecasts on important national development indicators. The effects of a steady state value in 50 years for the exogenous variable NCF that is twice that assumed originally in NRDM-2 is shown in Figure 5.9 for selected development indicators.

World Per Capita Income, WPCI. As in the case of NCF, above, WPCI is treated as a time-dependent exogenous variable. It is defined in Eq. 221. The significance of WPCI in the model is that it is a principal determinant of the Emigration Rate, ER (Eq. 235). The higher world per capita income with respect to the national per capita income in Lebanon, the greater the number of Lebanese that will leave each year, according to the assumptions in the model.

If we accept a recent report, "Global 2000", our projection for WPCI is NRDM-2 is too low. An experiment was designed based on almost doubling WPCI so that it reached 2300 LL/yr. in 50 years. A comparison of the outputs based on the two alternative forecasts for WPCI is summarized in Figure 5.11.

SUMMARY AND CONCLUSIONS

During the last two decades, Lebanon has witnessed rather sudden prosperity which not even the Civil War could suppress. It has also engaged in a rat-race for procuring the largest share of the bonanza with the least expenditure of effort in the shortest time possible--illegitimately if necessary. The intensity for the need for success

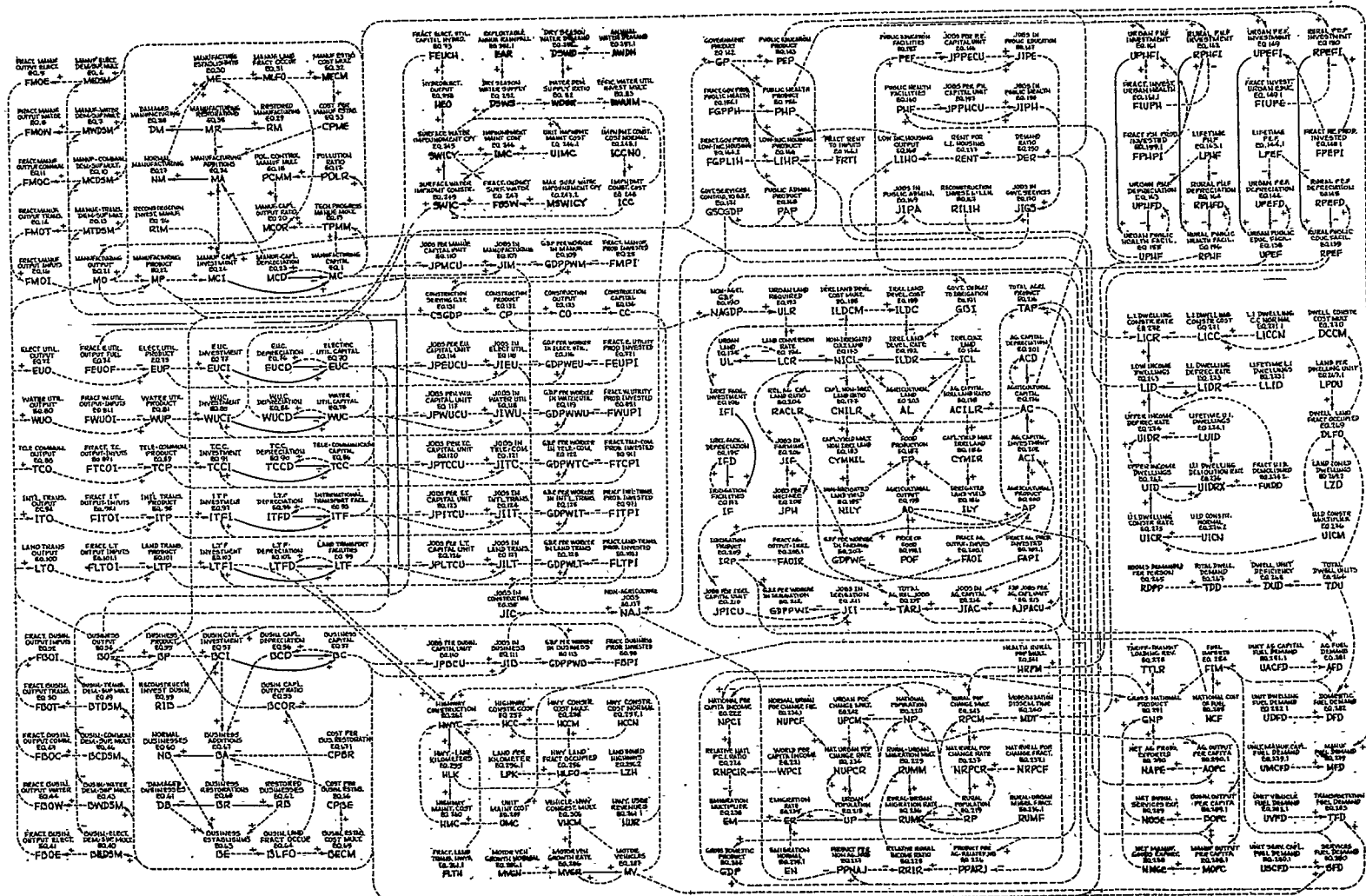
has resulted in the bending of the interpretation of such words as professionalism, scholarship, honor, and equity. Illegitimate means, before the war, gradually became justifiable, and justifiable means, during the worst period of the war in 1975-76, have become laudable by many--described as "guile" and even "genius" as long as it succeeds.

When development--the control of our density--is considered in system terms, some of the bewildering complexity of our world and its cities and its regions disappears. The broad, subjective goals of development seem to find meaning in the concept of entropy. While development in this context is maximization of negentropy, this is not an application of a law of physics, but merely a method of reasoning that helps to show us what must be done. We must redesign our institutions because requisite variety for running the world, a nations, or even a great city does not exist in any man's head, whether he is a premier, president, party secretary, governor, mayor, congressman, economist, engineer, or clergyman.

While it is possible for experts to understand portions of development systems fairly well,

but to put together more than a few of these relationships in an internally consistent manner without a formal technique is impossible. Development systems are composed of many feedback loops with delays, nonlinearities, and noise in the information channels and their behavior cannot be anticipated by studying isolated portions sequentially. The difficulty multiplies when considerations of policy formation and their impacts are needed. It is well within the state-of-the-art for us to improve our mental models for policy analysis and planning through the development and use of computer simulation models such as NRDM-2.

NRDM-2 is now on-line and is being used by the staffs of the Council for Development and Reconstruction and by faculty and students of the American University of Beirut. Some of the immediate benefits of the simulation have been in (1) forecasting of macro behavior; (2) predicting consequences of government actions and refusal to act; (3) conducting sensitivity analysis to establish research and data gathering priorities; and (4) providing aids to communication among specialists and in achieving understanding.



NATIONAL RECONSTRUCTION & DEVELOPMENT MODEL - 2

TABLE 4.1 DEVELOPMENT INDICATORS FOR COMPARISON OF PRINCIPAL SCENARIOS

<u>INDICATOR AND CATEGORY</u>	<u>VARIABLE</u>	<u>EQ. NO.</u>	<u>FIG. NO.</u>
<u>HUMAN RESOURCES</u>			
1. National Population	NP	220	4.2
2. Percentage of Population Urban	POPU	370	4.3
3. Annual Natural Population Increase	ANPI	308	4.4
4. Percentage of Population of Working Age	PPWA	309	4.5
<u>WEALTH</u>			
5. Gross National Product	GNP	291	4.6
6. National Per Capita Income	NPCI	222	4.7
7. Population Density	POPDEN	310	4.8
8. Trade Balance Percentage of GNP	TBFGNP	311	4.9
<u>DISTRIBUTION OF WEALTH</u>			
9. Percentage Unemployment	PUNEM	312	4.10
10. Relative Rural Income	RRI	225	4.11
<u>GOVERNMENT AND POLITICS</u>			
11. Budget as Percentage of GNP	BPGNP	315	4.12
12. Govt. Transfer Payments as % of GNP	TPFGNP	316	4.13
<u>HEALTH</u>			
13. Population Per Physician	PPP	295	4.14
14. Percentage Health Subsidized	PHSUB	317	4.15
<u>EDUCATION</u>			
15. Adult Literacy	ALT	302	4.16
16. Percentage Education Subsidized	PESUB	319	4.17
<u>HOUSING</u>			
17. Average No. Rooms Per Person	ANRPP	300	4.18
18. Dwelling Unit Difficiency	DUD	268	4.19
<u>LAND RESOURCES</u>			
19. Urban Population Density	UOPD	321	4.20
20. Average Farm Size	AFSIZ	322	4.21
<u>AGRICULTURE AND FOOD</u>			
21. Food Per Capita	FPCC	323	4.22
22. Percentage Ag. Land Irrigated	PALI	324	4.23
<u>COMMUNICATIONS</u>			
23. Television Sets Per Capita	TSPC	325	4.24
24. Cinema Attendance Per Capita	CAPC	326	4.25
<u>TRANSPORTATION</u>			
25. Motor Vehicles Per Capita	MVPC	297	4.26
26. Highway Density	HWYDEN	328	4.27
<u>WATER RESOURCES</u>			
27. Surface Water Impoundment Capacity Per	SWICPC	329	4.28
28. Water Demand Supply Ratio	WDSR	82	4.29
<u>ENERGY RESOURCES</u>			
29. Per Capita Energy Consumption	PCEC	296	4.30
30. Fuel Imports as Percentage of GNP	FIPGNP	330	4.31
<u>ENVIRONMENT</u>			
31. Pollution Ratio	POLR	17	4.32
32. Quality of Life	QOL	331	4.33

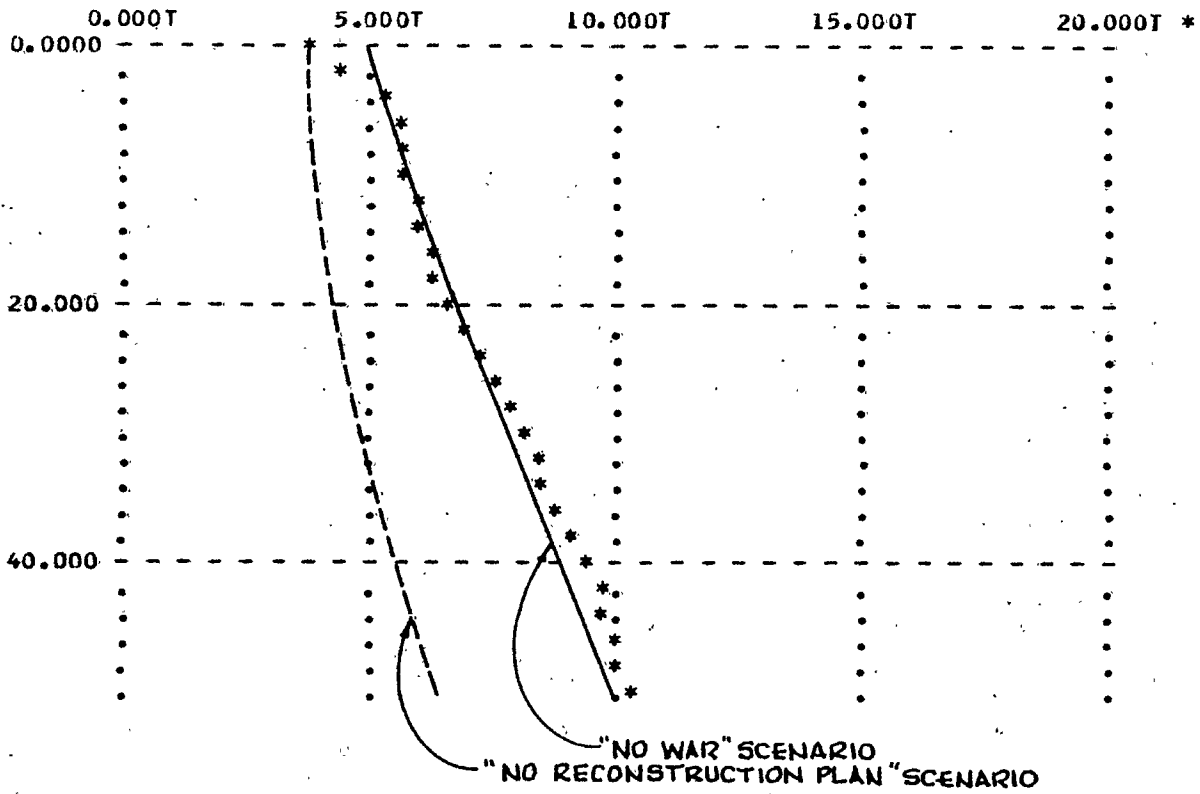
TABLE 4.2 PARAMETER SUMMARY FOR SCENARIO ANALYSIS

Eq.No.	Parameter	Parameter Values for Three Scenarios		
		Reconstruction Plan	No. Reconstruction Plan	No 1975-76 Civil War
1.2	MCN	4.8E9	4.8E9	8.0E9
25.1	FMPIX	.40	.20	.40
25.2	FMPIY	.45	.20	.40
25.3	RECPEF	5.	50.	0
26.1	RIMC	.8E9	0	0
27.2	NMN	3000	3000	6000
28.2	DMN	3000	3000	0
35.1	MRP	600	60	0
37.2	BCN	18.0E9	18.0E9	24.0E9
58.1	FBPIX	.35	.25	.35
58.2	FBPIY	.40	.25	.35
59.1	RIBC	1.0E9	0	0
60.2	NBN	20000	20000	30000
61.2	DBN	10000	10000	0
68.1	BRP	2000	200	0
70.2	EUCN	1.0E9	1.0E9	1.2E9
78.2	WJCN	1.0E9	1.0E9	1.2E9
86.2	TCCN	.5E9	.5E9	1.5E9
92.1	RITCC	.44E9	0	0
93.2	ITFN	1.0E9	1.0E9	1.5E9
98.1	RIITC	.1826E9	0	0
99.2	LTFN	3.0E9	3.0E9	4.5E9
104.1	RILTC	.485E9	0	0
108.1	FMPGX	.05	.03	.05
108.2	FMPGY	.05	.03	.05
112.1	FBPGX	.10	.05	.10
169.1	RILIHG	.10	.05	.10
224.1	RNPCIN	.894E9	0	0
255.2	HLKN	3.6	3.6	4.8
258.1	HCCMT	1.2E4	1.2E4	1.8E4
262.2	UIDN	.9/.9/1/2/10/40	.9/.9/1/2/10/40	.9/.9/.9/1/8/25
263.2	LIDN	.75E6	.75E6	1.0E6
270.1	DCMTC	.7/.8/1.2/2.5/5/10	.7/.8/1.2/2.5/5/10	.7/.8/1/2/4/7
287.2	MYN	250000	250000	300000
36.1	FMOGC	.055	.05	.05
69.1	FBOGC	.105	.10	.10

TABLE 4.3. PARAMETER CHANGES

Parameter Name	Description	Equation	Normal Value (ha)	Present Value (ha)
LZM	Land Zoned for Manufacturing	31.2	4500	6000
LZB	Land Zoned for Business	64.2	8000	10000
LZH	Land Zoned for Highways	256.2	1500	2000
LZD	Land Zoned for Dwellings	269.2	10000	12000

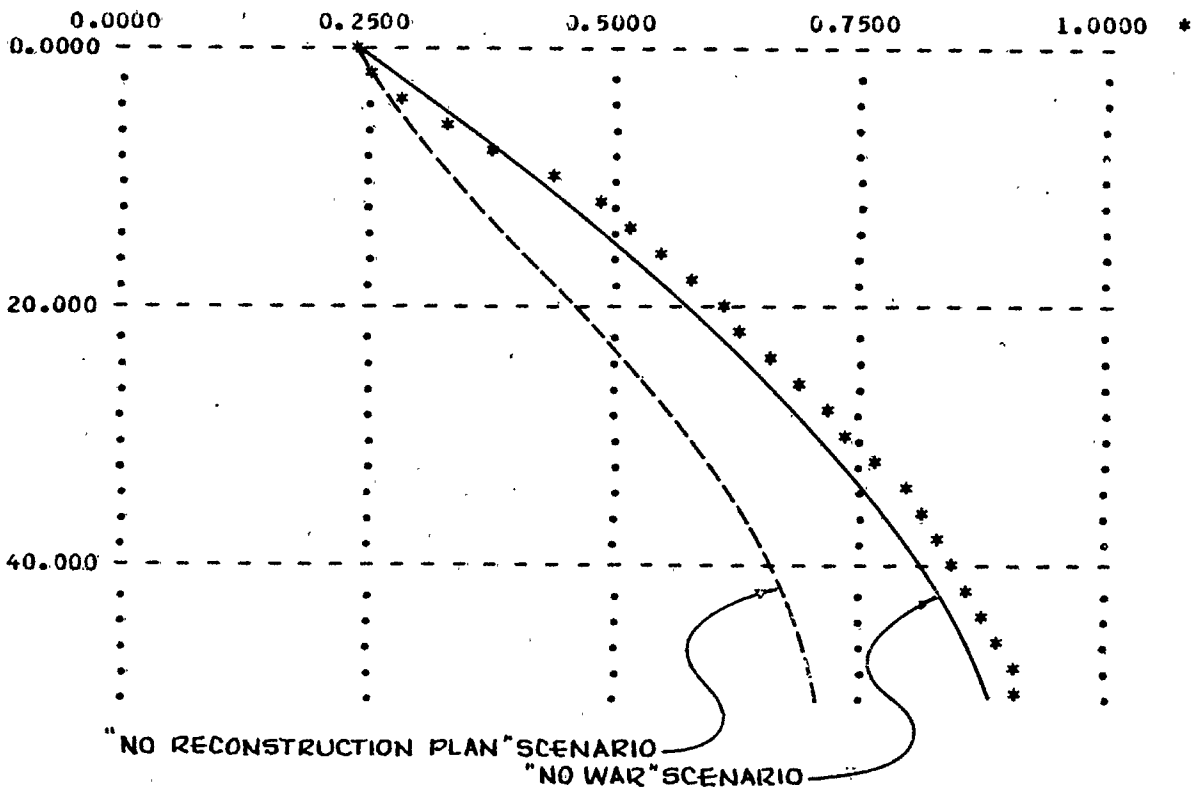
NPCI=* FOR "RECONSTRUCTION PLAN" SCENARIO



3 SCENARIOS IN TERMS OF NPCI-NATIONAL PER CAPITA INCOME

FIG. 4.7

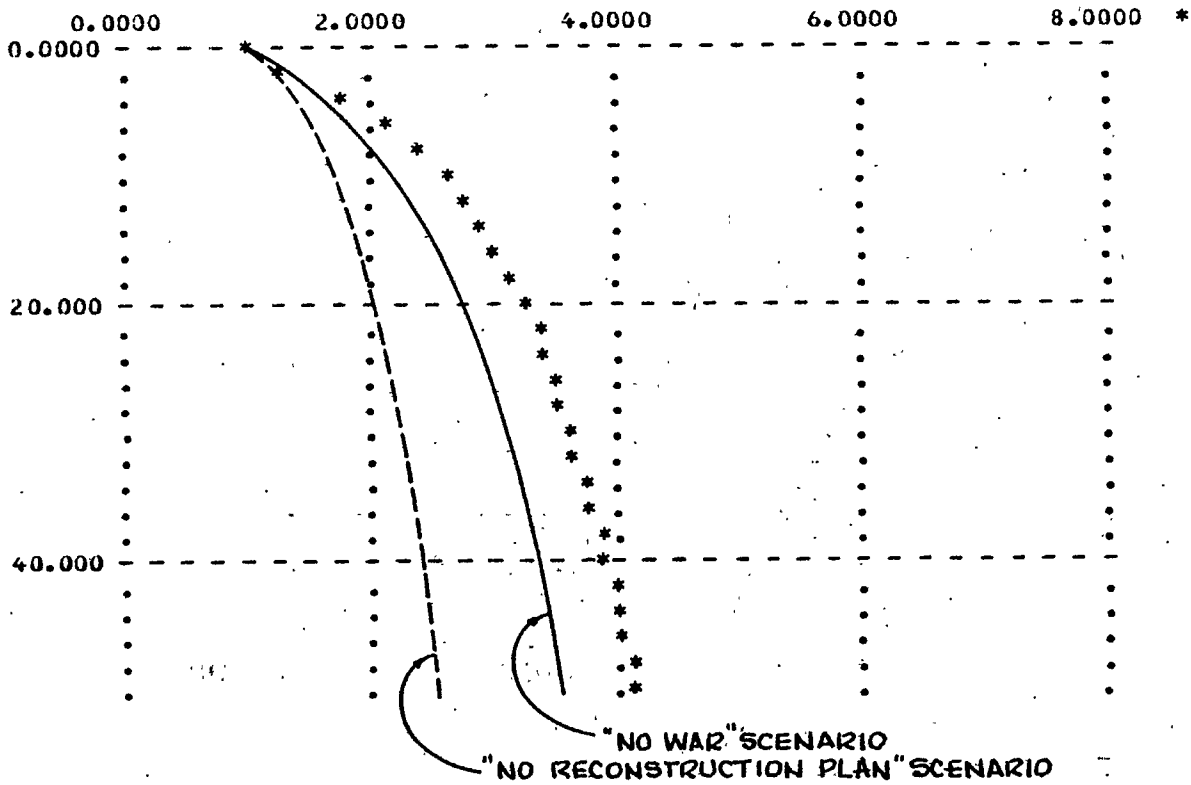
RRI=* FOR "RECONSTRUCTION PLAN" SCENARIO



3 SCENARIOS IN TERMS OF RRI-RELATIVE RURAL INCOME

FIG. 4.11 38

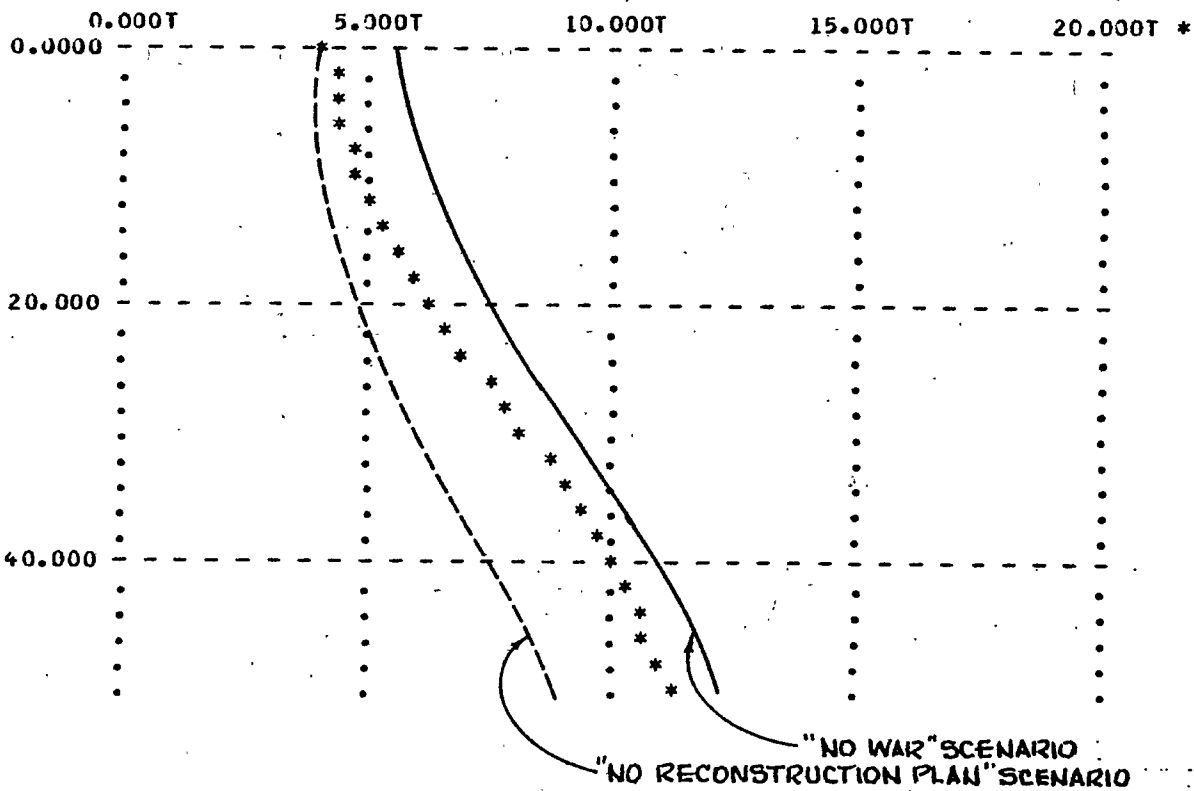
POLR=* FOR "RECONSTRUCTION PLAN" SCENARIO



3 SCENARIOS IN TERMS OF POLR-POLLUTION RATIO

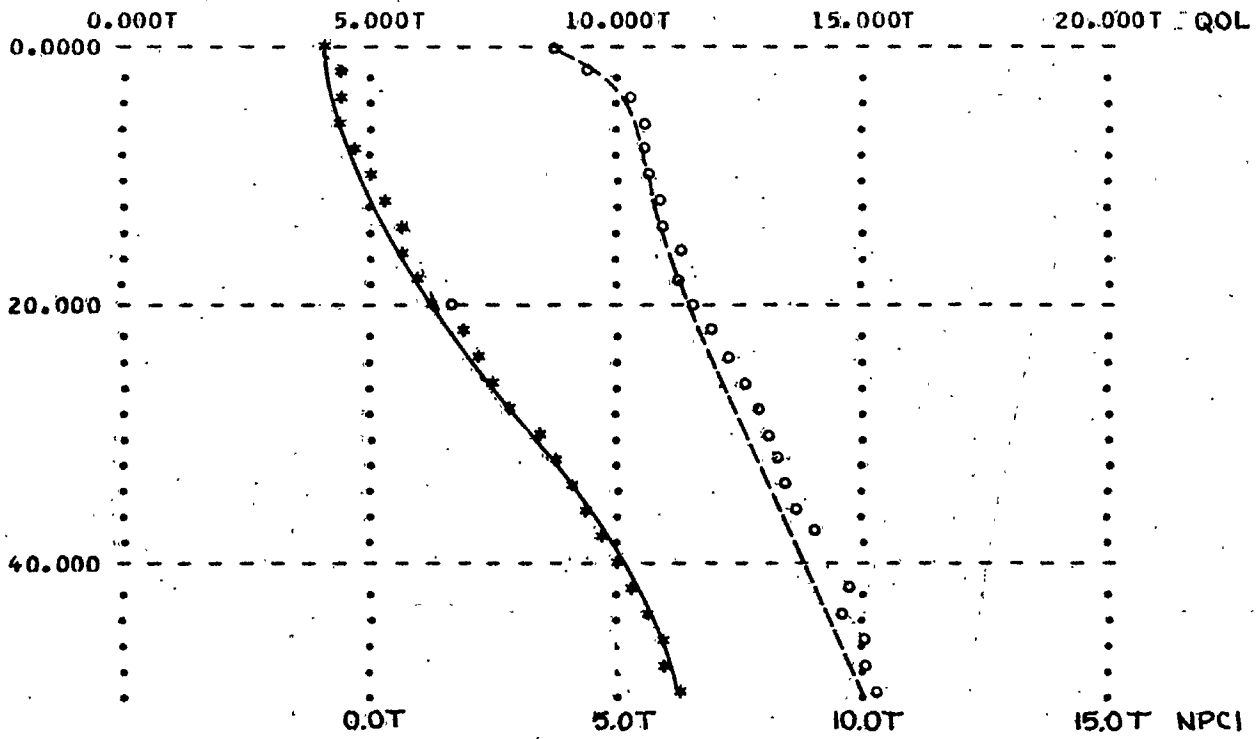
FIG. 4.32

QOL=* FOR "RECONSTRUCTION PLAN" SCENARIO



3 SCENARIOS IN TERMS OF QOL-QUALITY OF LIFE

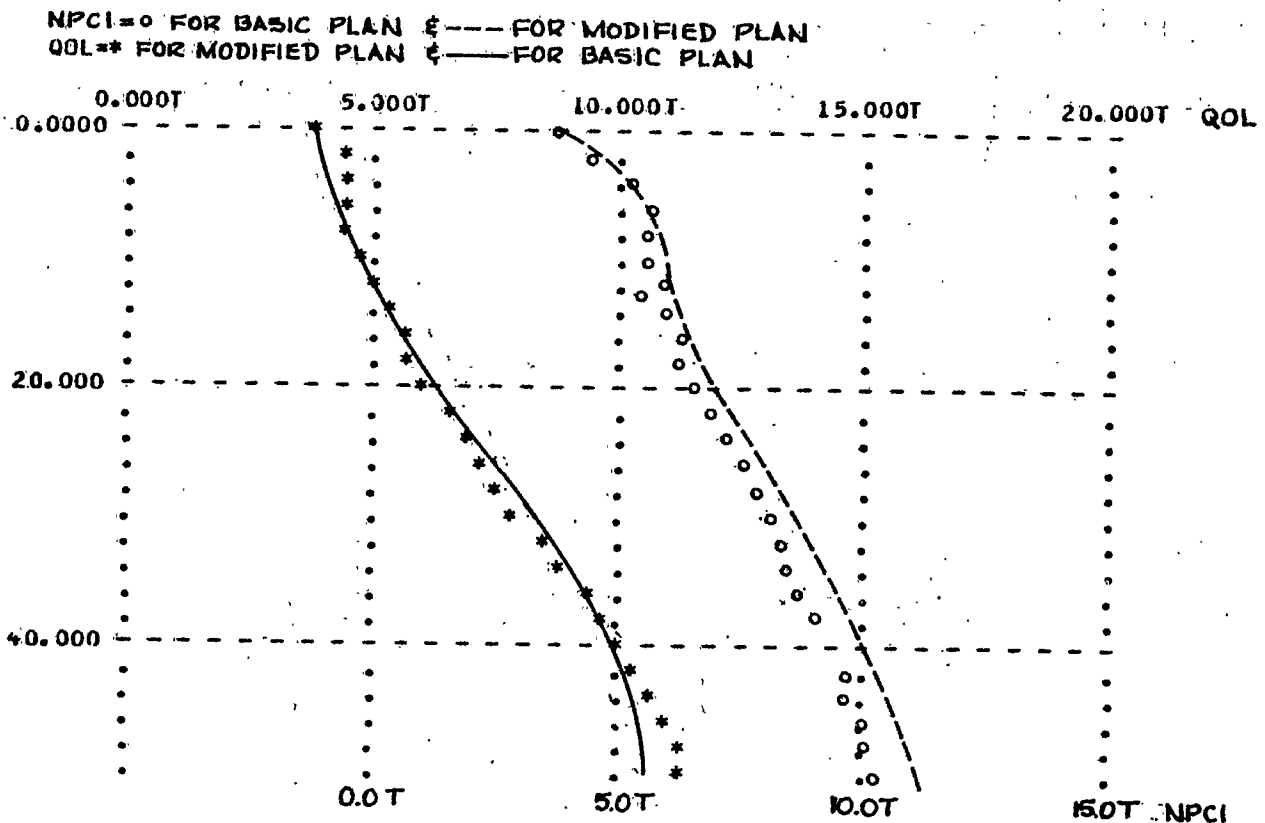
FIG. 4.33



NPCI = ○ FOR BASIC PLAN ⋈ --- FOR MODIFIED PLAN
 QOL = * FOR MODIFIED PLAN ⋈ — FOR BASIC PLAN

MODIFIED RECONSTRUCTION PLAN SCENARIO BASED ON TAXATION POLICY

FIG. 5.1

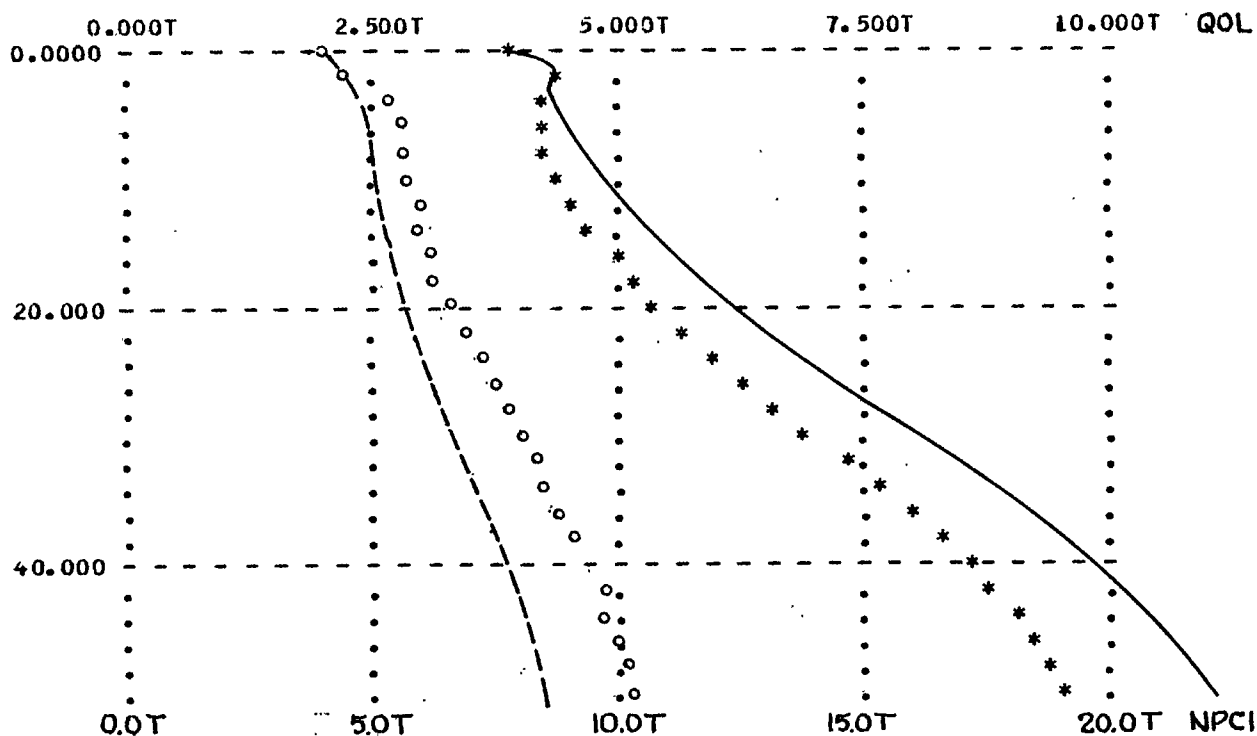


NPCI = ○ FOR BASIC PLAN ⋈ --- FOR MODIFIED PLAN
 QOL = * FOR MODIFIED PLAN ⋈ — FOR BASIC PLAN

MODIFIED RECONSTRUCTION PLAN SCENARIO BASED ON ZONING POLICY

FIG. 5.2

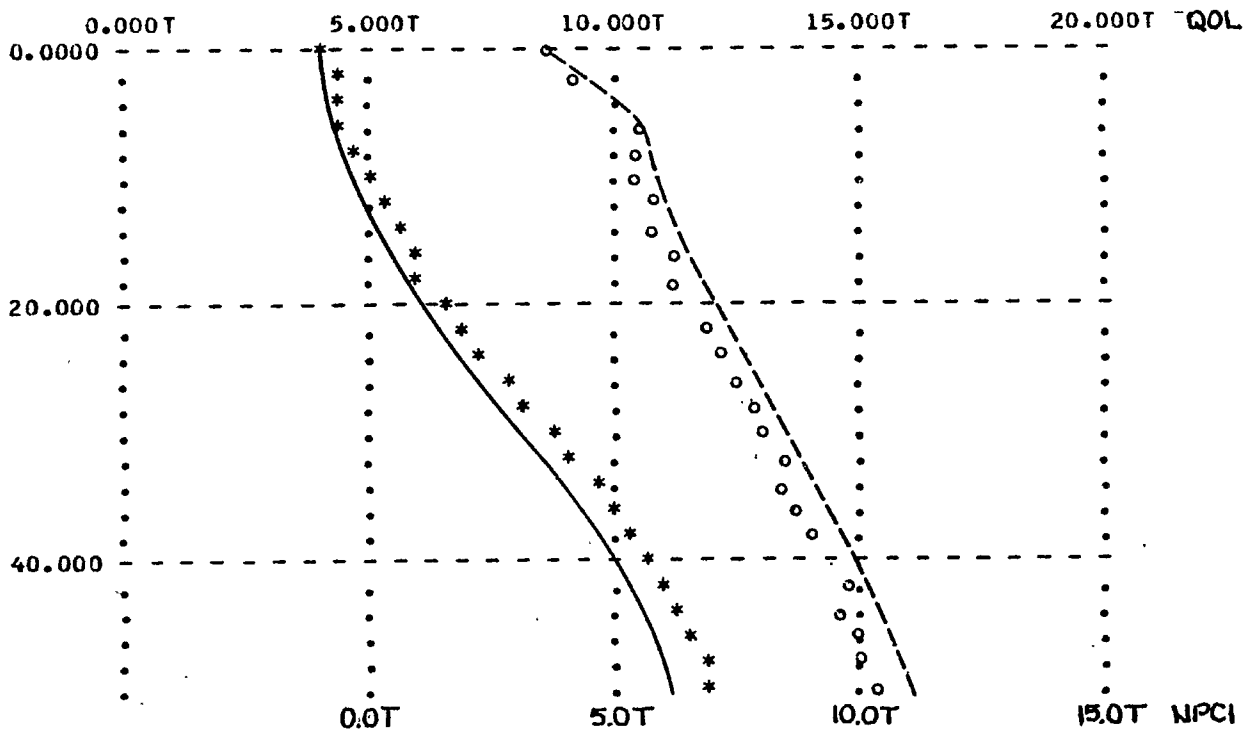
NPCI = ○ FOR BASIC ASSUMPTION & --- FOR MODIFIED ASSUMPTION
 QOL = * FOR MODIFIED ASSUMPTION & — FOR BASIC ASSUMPTION



EFFECT ON LEBANON OF NCF-NATIONAL COST OF FUEL

FIG. 5.9

NPCI = ○ FOR BASIC ASSUMPTION & --- FOR MODIFIED ASSUMPTION
 QOL = * FOR MODIFIED ASSUMPTION & — FOR BASIC ASSUMPTION



EFFECT ON LEBANON OF WPCI-WORLD PER CAPITA INCOME

FIG. 5.11