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VALUES IN DECISION MAKING ON WORLD PROBLEMS

Fred Bernard Wood
Computer Social Impact Research Institute, Inc.
2346 Lansford Ave.
San Jose, CA 95125
408/269-9327

ABSTRACT

Platt's type of table of world problems is used to find a problem just below nuclear war in intensity and having a short time to go critical. The problem selected is the glaciation cycle of our planet. Since neither The Hamaker Thesis nor any competing theory has been adequately tested, we have to make desisions under uncertainty. Using the elements of Decision Theory under Uncertainty, we produce a "regret matrix" of the maximum loss of human life for different states of nature versus different actions that could be taken. This exercise aids in obtaining the data needed for a value judgement on preventing loss of human life and preventing destruction of civilization.

INTRODUCTION

This is a study to see if working from a background of general systems theory can bring some prospects of aiding in the development of world peace. The approach here is to take John Platt's (1969) table of world problems and update it to the year 1985. We used three approaches for updating. One was to use the 1982 update that appeared in the General System Bulletin (Wood, 1982). The second was to compare the table with the conclusions given by the analysis of the earth as a system (Miller and Miller, 1982). The third was to search the scientific literature for reports since 1982.

The objective was to see if there exists a major world problem of less severity than the danger of nuclear war that could be used as a focus for developing international cooperation on this second problem that would have a spill over effect toward world peace.

COMPUTER SPREAD SHEET OF WORLD PROBLEMS

Table I, Parts A, B, C, D, is a print out of a computer spread sheet containing the updated table of world problems. The columns are for a series of estimated time to crisis. Additional columns have been added to include a column for "minus five years to zero" and "50 to 1000 years."

When the glaciation cycle appeared to be the focus of secondary problems such as rising atmospheric carbon-dioxide, deforestation, and food shortage, additional references on the glacial cycle were added to the table.

TABLE I-A: MAJOR WORLD PROBLEMS.
Classification of problems and crises by estimated time and intensity.

Grade	Estimated crisis intensity: Numerical (number affected times degree of effect) & Descriptive (word description)	Estimated time to crisis: -5 to 0 years...	Estimated time to crisis: 1 to 5 years....
1.	10 Total annihilation		Nuclear or RCBW escalation
2.	9 Great destruction or change (physical, biological, or political)		NUCLEAR WINTER

ENG('85) Hamaker Drought, famine & death in Africa. We can still influence cycle with remineralization & reforestation.

ENG('82) Hamaker Critical point of glaciation process 1984.

ACID RAIN

TABLE I-B: MAJOR WORLD PROBLEMS.
Classification of problems and crises
by estimated time and intensity.

********** ========== ########## ====

Estimated time to crisis

5 to 20 years...	20 to 50 years.	50 to 1000 years	Grade
NUCLEAR OR POPW ESCALATION	*(solved or dead)		1.
63**********	79==========	98##########	====
NUCLEAP WINTER Famines Ecological balance Development failures Local wars	Economic structure and political theory Population and ecological balance Patterns of living		2.
CARBON DIOXIDE, GLACIATION, DEFORESTATION, FOOD SHORTAGE, HUNGER ADEATH ENG(84) Hamaker Temperate zone gone in 1990, few people alive in 1995.	SCI('77):Kukla et al: New cooling data. SCI('79): Wolllard Abrupt end of last interglacial (20 y).	SCI('72) Kukla et al: End of interglacial a few 100 yr.	
Rich-poor gap	Universal education Communications-Integration Management of world Integrative philosophy		

=====	#####	$$$$$$$ $$$$$$$$	%%%%%%%%%%%%%%	&&&&&&&&&&&&&&&
3.	10^{8}	Widespread almost unbearable tension		Administrative management Need for participation Group & racial conflict Poverty-rising expectations Environmental degradation
=====	#####	$$$$$$$$$$$$$$$	%%%%%%%%%%%%%%%	&&&&&&&&&&&&&&&&
4.	10^{7}	Large scale distress		Transportation Diseases Loss of old cultures WOMEN'S RIGHTS
=====	#####	$$$$$$$$ $$$$$$$	%%%%%%%%%%%%%%%	&&&&&&&&&&&&&&&&
5.	10^{6}	Tension producing responsive change		Regional organization Water supplies OCEAN FLOOR MINING UNDEP UNITED NATIONS LAW OF THE SEA
=====	#####	$$$$$$$ $$$$$$$$	%%%%%%%%%%%%%%%	&&&&&&&&&&&&&&&&
6.		Other problems--important, but adequately researched		Technical development design Intelligent monetary design
=====	#####	$$$$$$$$$$$$$$$	%%%%%%%%%%%%%%%	&&&&&&&&&&&&&&&&
7.		Exaggerated dangers and hopes		
=====	#####	$$$$$$$ $$$$$$$$	%%%%%%%%%%%%%%%	&&&&&&&&&&&&&&&&
8.		Noncrisis problems being "overstudied"		Man in space Most basic science
=====	#####	$$$$$$$ $$$$$$$$	%%%%%%%%%%%%%%%	&&&&&&&&&&&&&&&&
			-5 to 0 years	1 to 5 years

TABLE I-C

Poverty Pollution Racial wars Political rigidity Strong dictatorships	COMPUTERIZED DESTRUCTION OF WESTERN CIVILIZATION	3.
Housing Education Independence of big powers Communications gap NEED FOR GENERAL SYSTEMS LEARNING AT ALL LEVELS	CARBON DIOXIDE, CLIMATE WARMING, SEA LEVEL RISE. (NRC'83) (EPA'83)	4.
		5.
		6.
	Eugenics	7.
		8.

5 to 20 years | 20 to 50 years | 50to 1000 years

TABLE I-D

CONFLICTING PREDICTIONS ON CLIMATE

The table shows scientists like Kukla (1972, 1977) and Wollard (1979) pointing to cooling and impending glaciation and the engineer, Hamaker, saying the critical point of glaciation has already occurred. On the other hand the reports of the National Research Council (1983) and the Environmental Protection Agency (1983) indicate a concern over the planet getting warmer leading to some melting of the polar ice caps. How do we know whether glaciation or warming is more probable? The warming predictions come primarily from computer simulation of the rising atmospheric carbon dioxide. The indications of glaciation come from paleoclimatology studies of the past glacial cycles.

IS THE EARTH WARMING OR COOLING?

This symposium has invited three speakers to help us plan how to determine what is happening. A geologist has been invited to tell us what evidence is available to indicate if we are moving into a glacial period.

We have a problem in the theory of the glacial cycles. The most comprehensive thesis on how the glacial cycle works was developed by a mechanical engineer outside the earth sciences, who has been unable to get constructive feedback on his theory. In November 1982 the secretary of the U.S. Climate Board at N.A.S., Washington, D.C., advised me that his group had a copy of Hamaker's book, but did not plan to review the Hamaker Thesis. It is important to review the Hamaker Thesis, because it is consistent with the cooling of the Northern latitudes and slight warming of the lower latitudes shown in data from Hansen (1981), Idso (1983), and Watt(1985). The Hamaker Thesis involves material from about twenty-five fields of science. According to Roederer of the Geophysical Institute, Fairbanks, Alaska, our scientists, universities, government agencies, and scientific societies are ill-prepared to deal with interdisciplinary problems (Roederer, 1985).

Hamaker and Weaver have been invited to participate in this symposium. To give us a perspective on the data collection, analysis, and computer simulation capabilities of our country an analyst from the Congressional Office of Technology Assessment has been included in this symposium.

VALUES IN MAKING DECISIONS

Suppose that Congress appropriates $20,000,000 for a three year study of the Hamaker Thesis. If the evaluation arrived at in 1990 proves that Hamaker is incorrect, the twenty million dollars was insurance against a possible catastrophe. On the other hand suppose the study shows that the Hamaker Thesis is correct and that 500,000,000 people have died of starvation by 1990 due to our failure to take some remedial action in 1986. Are we going to regret that our failure to take some action led to 500,000,000 people dying? Where are our values? Are we going to risk half a billion people dying by 1990, while we wait for scientific certainty? Let us examine decision theory as used in business administration to see if decision theory can aid us.

DECISION THEORY

Decision theory isn't going to make decisions for us, but use of decision theory can organize our information on the problem so we can better understand the consequences of alternative decisions. First we shall consider some historical stages in decision theory.

Luce and Raiffa (1957, sec. 2.1) gave a classification of decision making. If a choice must be made between two actions, we say that we are in the realm of decision making under:

(a) CERTAINTY if each action is known to lead inevitably to a specific outcome.

(b) RISK if each action leads to one of a set of possible specific outcomes, each outcome occurring with a known probability.

(c) UNCERTAINTY if either action or both has as its consequence a set of possible specific outcomes, but where the probabilities of these outcomes are completely unknown or are not even meaningful.

Our specific problem of the CARBON DIOXIDE-climate-GLACIATION relationship fits "decision making under uncertainty". Luce and Raiffa (1957, chap.13) discuss individual decision making under uncertainty. The core of the problem is to construct a matrix in which the possible states of nature are the columns and the possible acts are the rows. Then one fills in the matrix with the potential outcomes for each pair of states of nature and acts.

van Gigch (1974: 69-71) discusses decisions under certainty, risk, and uncertainty. Under uncertainty, the probabilities for the states of nature are not known so the analyst must choose from a number of alternatives, such as:

(1) Equal likelihood criterion.
(2) Minimax criterion.
(3) Minimax regret.
(4) The Hurwicz criterion.

The "minimax regret" criterion appears to be appropriate to our CLIMATE problem. Looking for an example, we find Lial and Miller (1974: 318-323) consider the case of a farmer deciding whether to use smudge pots to protect his orange crop from frost is used to illustrate the different criterion, including the minimax criterion with a regret matrix.

DATA ON GLACIAL CYCLES

To apply the minimax criterion to a regret matrix, we first examine glacial cycles for the last 900,000 years in Fig. 1. We see that there is a minimum in ice volume approximately every 100,000 years and that we appear to be rising out of a minimum. To find more detail we plot the climatic history for the last 140,000 years in Fig. 2. This shows the parts per million of carbon dioxide in the atmosphere, the global ice volume in millions of cubic kilometers, and the variation of the mean mid-latitude air temperature in degrees centigrade.

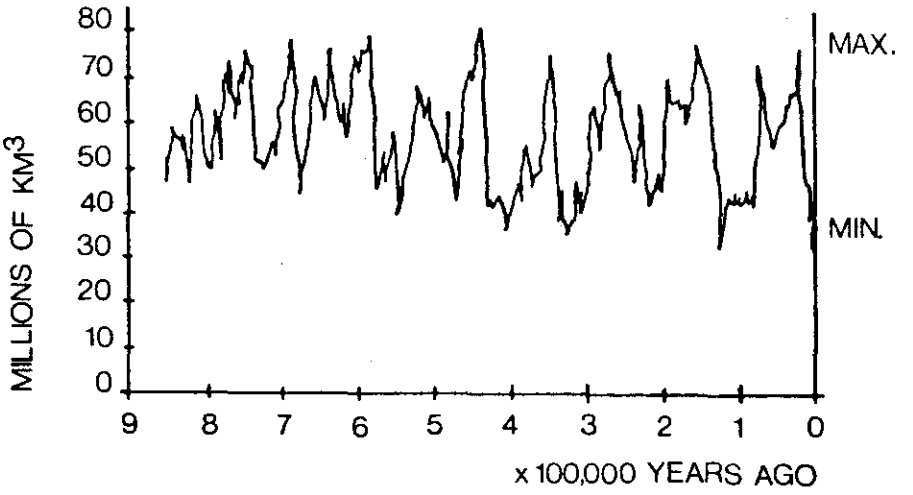


Fig. 1. Variation of Global Ice Volume

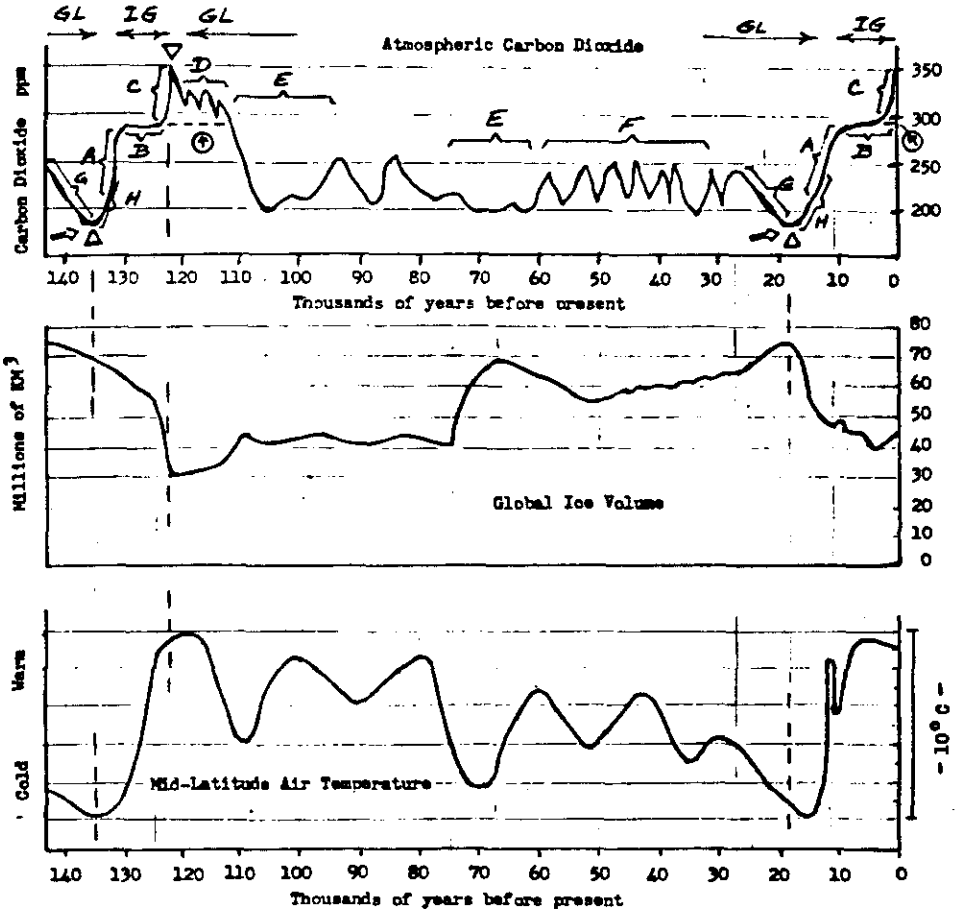
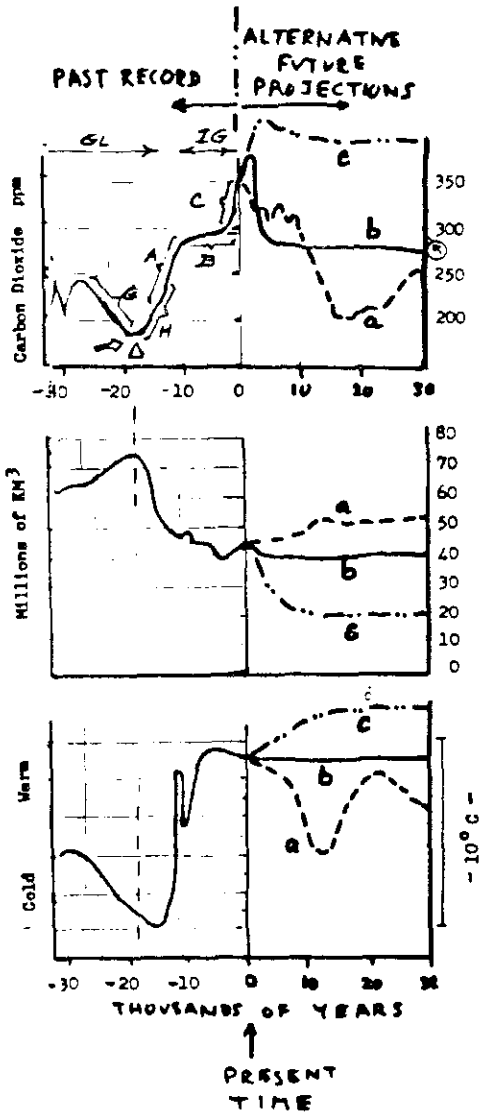


Fig. 2. Historic Variation of Carbon Dioxide, Global Ice Volume, and Temperature

STATES OF NATURE

If we had no information other than the curves, I would deduce that we were moving into a 90,000 year glacial period. Since there is so much scientific literature talking about carbon dioxide warming, there is a state of confusion over what is happening. Since we don't know with scientific certainty, we can draw three alternative future projections for carbon dioxide, ice volume, and temperature. In Fig. 3 alternative curves (a) represent a continuation of the historical glaciation cycle. Curves (b) represent a man-made change in the glacial cycle by remineralization, reforestation, and reduction of fosil fuel burning based on the Hamaker Thesis. Curves (c) represent a warming due to atmospheric carbon dioxide. These three sets of projections are our major alternative states of nature.



Atmospheric Carbon Dioxide

Global Ice Volume

Mid Latitude Air Temperature

Fig. 3. Projection of Alternative Future States of Nature

REGRET MATRIX

Since we have determined that we have a decision to make under uncertainty we next estimate the possible number of deaths due to starvation for the period 1983 to 1995 for each of the three projections of glaciation for six different actions we might consider. We have taken Hamaker's and Bryant's estimates of probable deaths due to crop failure during the start of glaciation and then discounted the result similar to the process described by Linstone (1977: 5-7) to scale down longer range predictions for future unknown factors.

TABLE II: REGRET MATRIX FOR CLIMATE CHANGE

Estimated number of people dying from starvation on planet Earth from 1983 to 1995 for different states of nature and different actions taken.

ACTIONS ↓	STATES OF NATURE a GLACIATON INCREASING NOW	b REMAINING AT PRESENT LEVELS	c WARMING PROCEEDING NOW
DO NOTHING	2,000 M	24 M	12 M
REMINERALIZATION & REFOPESTATION STARTING NOW	250 M	12 M	12 M
REMINERALIZATION & REFOPESTATION STARTING IN 5 YEARS	1,200 M	12 M	12 M
DISCONTINUE BURNING OF FOSSIL FUELS	1,000 M	8 M	8 M
REORGANIZE DISTRIBUITIO OF FOOD	1,000 M	8 M	8 M
GROW SPIRULINA ALGAE FOR FOOD	700 M	6 M	6 M

"M" means 1,000,000 in this table.

Our base estimate is for the case we do nothing about the glaciation cycle. For this case the estimated deaths from 1983 to 1995 is two billion, if the glaciation cycle is proceeding now. If the rising carbon dioxide is causing a compensating effect to hold glaciation to the present level the deaths due to starvation would be 24 million for the same period. If warming is occurring then the deaths would be 12 million for the same period.

The full matrix of estimates is shown in Table II.

MINIMAX REGRET CRITERION

We now apply the minimax regret criterion to the regret matrix. We look for the row that has lowest maximum regret for all three columns. This is row number two, "Remineralization & Reforestation Starting Now." Starting now we would expect 250 million people to die of starvation between 1983 and 1995. This is the lowest value in column "a".

We have invited Bryant and Malveaux to present a paper on a plan of action to carry out the action indicated by this use of decision theory.

CONCLUSIONS

Through viewing the earth as a system composed of both living and non-living sub-systems interconnected, we can develop a more comprehensive view of the major world problems. The bio-geophysical glaciation cycle of our planet is a very important base underlying many problems. Through a perspective of general systems theory we are able to utilize concepts from business decision theory to define the parameters needed for deciding what action to take about the glacial cycle. These processes in the absence of more scientific data on how the glaciation cycle works point to a program of remineralization of the soil, reforestation, and reduction of fossil fuel burning to minimize the loss of human life due to the glacial process.

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