GLOBAL-SCALE OBSCURATION BY MASS FIRE SMOKE

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I. INTRODUCTION

Fire has been a major weapon in wars for centuries. In a conflict involving nuclear weapons, major fires wil form and their smoke will effect later weapon effectiveness and the post attack environment. A recent issue of AMBIO (11), the journal of the Swedish Acadamy of sciences presented "a realistic assesment of the possible human and ecological consequences of a nuclear war"(sic). It covered a large number of topics including the effects of nuclear weapons, fallout, smoke obscuration, weapon targeting, etc., - each section being written by a "specialist" in that area. This issue is being widely cited and quoted in reviews (c.f. JDA,1982 Pain, 1983) and has been edited and reproduced as a book, (Peterson and Hinrichen, 1982). It proposes that widespread forest and industrial fires would occur after a nuclear war, spreading far beyond the areas ignited by the prompt radiation. We propose to examine this premise.

II. THE FIRE-SMOKE SCENERIO

Crutzen and Birks, (1982) considers smoke from oilwell, oil storage and wildland fires. There is an almost complete absence of references to fire research literature literature, but they assumed that all ignitions will automatically spread and continue to burn for at least two months. This assumption ignores the evidence of the past. During the nineteenth century steam locomotives were prolific generators of sparks and embers in all areas of the United States, yet mass fires and conflagrations only occurred in areas where fuel conditions and weather were conducive to such fires. In what follows we attempt to arrive at a more realistic assesment of the probability of country-wide mass fires and conflagrations during a nuclear war.

III. PAST MASS FIRES

The analysis of the probality of large-scale mass fires and conflagrations is obviously one which must arrive at joint probability densities of fires occurring simultaneously over widely seperated areas. This is a problem in Baysian statistics, which states that the probability of fire occurring in another area given that it has occured in a given area is:

$$P(B_i | A) = \frac{P(B_i)\ P(A|B_i)}{\sum P(B_i)\ P(A|B_i)}$$

where $i = 1,1,\cdots\cdots$ or k

It is usually assumed that the probability densities are independent, while here, they are obviously not since they are weather and climatically related by a series of events which lead to drought and high winds. But, for the purposes of this preliminary study it was assumed that the correlations of weather and climate between the diverse areas was weak enough to ignore correlations.

The initial analysis used the United States fire spread statistics prepared by Chandler et al, (1963). We used a minimal fire spread rate of three meters per hour as the criteria for the continuation of any particular fire. The various data sets studied included California Oregon and Washington. There was no set of data pairs from any of these three states that had a joint probability greater than twenty percent, even at the afternoon time of largest spread rates.

Since this data could not be directly related to large fire events, because of the shortness of the record, a second study of the joint probabilties of observed large disaster fires were undertaken. This data was derived from various sources including Brown and Davis (1973) and Pyne, (1982). It covered 150 years of fire expe;rience in the United States. The results are presented in Table I.

intervals or areas. Conditional probabilities were computed for each area, given that a large fire had occurred in another area during the same year.

IV. ANALYSIS AND CONCLUSIONS

Two of the areas required special consideration--the Lake States and the South. Prior to the 1930's logging was extensive in the Lake States, providing a large amount of litter and slash to carry a fire. In the South however pioneer burning practices in removing the forests to provide large cleared areas (deserts in 19th Century parlance) permitted very little buildup of burnable material on the ground. In the 1930's logging practically ceased in the Lake States, while it became extensive in the South, with the attendent accumulation of slash and low growth on the ground. It seems apparent that this demonstrates an increased fire hazard if there are trash accumulations in large cities.

AREA	JOINT PROBABILITIES FOR FIRES FOR ONE YEAR, Percent
Southern California	6.5
Pacific Northwest	4.7
Northern Rockies	7.7
Lake States	0 (since 1933), 9.8 (prior to 1933)
South	81.0(since 1930), 0. (prior to 1930)

Table I. Conditional probabilities of a large disaster fire occurring in any of the given areas, given that one has occurred during that year in the first given area.

In this study, the fire areas in the United States were chosen as southern California, the Pacific Northwest, the northern Rockies, the Lake States and the South. The data was grouped on a yearly basis, no attempt being made to develop smaller

In general, these results show that the probability of simultaneous ignitions resulting country-wide large fires and conflagrations by any even, including steam locomotives, nuclear weapons, incendiaryism (or whatever) has a low probability of causing widespread mass fires. It follows that the probability of the production of large amount of obscuring smoke sufficient to cause a large climatic is limited although visibilities may be lowered. In general measurements of electromagnetic at longer wavelengths than abou 1 micrometer will relatively unaffected by smoke (Palmer, 1981a,b)

This study could be refined and expanded significantly by using both smaller areas and time intervals and more accurate definitions of the fire hazard based upon fire danger ratings. It is apparent that fire may be identified with drought periods and high winds and further study should include these factors.

V. REFERENCES

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