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File Ecological Effects

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NOTE ON ENCLOSURE

Enclosed is a set of notes summarizing the information presented at the recent one-day AIBS Symposium on "Some Approaches to the Effects of Nuclear Catastrophes on Ecological Systems." Although the notes were prepared by Dr. Lord, all of the staff members of the Technical Analysis Branch reviewed them for completeness and accuracy. It is our hope that the notes will be helpful. We are not sure whether AIBS plans to issue formal proceedings. Some comment is included with the summary and should be regarded as personal opinion.

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Summary of Information Presented at the

AIBS SYMPOSIUM ON "SOME APPROACHES TO THE EFFECTS OF NUCLEAR CATASTROPHES ON ECOLOGICAL SYSTEMS"

TAB
RDLord
10/10/63

Introduction

On August 28, 1963, during the meetings of the American Institute of Biological Sciences in Amherst, Massachusetts, a one-day symposium was held on "Some Approaches to the Effects of Nuclear Catastrophes on Ecological Systems." Six papers were presented (four by individuals receiving research support from the Atomic Energy Commission (AEC)), and there was informal summarization by E. P. Odum at the end of the day. George M. Woodwell, Brookhaven National Laboratory, was chairman. A summary and partial critique of the six papers follows.

Miller, Carl F.
Types of Catastrophes and Their Physical Proportions.

The purpose of this paper was principally to provide background for subsequent papers. The majority of the audience was presumed to be unfamiliar with the dimensions of possible attacks and the immediate effects and the paper indicated in a general way what the physical results of an attack of large megatonnage might be.

More specifically, the speaker proposed the following points:

1. That an external gamma infinity dose (approximated by a 2½ year dose) of 100 r or less implies a situation of no-control-required over people, including no requirement for sheltering. He labeled this criterion as conservative compared with NCRP Handbook 29.

2. As a rough, empirical estimate of the maximum external gamma dose rate to be encountered at a point from local fallout, when the estimate is to be made before this peak is measured, the rule is: $I_{max} \cong \frac{20}{t_A}$ for 5-20 MT surface shots.

3. The 50% lethality contour at Nagasaki occurred in approximate coincidence with the 5 psi contour.

4. An attack on the U. S. of as high as 20,000 MT surface burst might result in areas of 50,000 r/hr or higher standard intensity for 100% fission yield ratio. This prediction in turn implies an infinity dose of about 200,000 r or more. Maximum weapon size assumed is 20 MT.

5. The following is a list of the major fission products likely to get into biological systems: Sr-89, Sr-90, Ru-106, Cs-137, Ba-140, and I-131.

6. Re foliar contamination, a 2-week half-life would apply approximately for removal of particles from foliage, in the absence of rain.

For fractional retention, values given were 0.1 to 10% for U.S.A. from fallout; 3 to 15% for UK Operation Buffalo; experimental spraying of foliage with liquids gives higher values (U.K.).

Auerbach, S. I.
Behavior of Radionuclides in Ecosystems.

It was proposed in this paper that decay of the fission products was of such a nature that only Sr-90 and Cs-137 were of principal importance as nuclides which would be cycled in the ecosystem.

The White-Oak Lake bed site was described, including the bed's use for the production of crops, meat, and milk. Estimates of the uptake of certain nuclides were presented, based upon certain assumptions given below. These assumptions were labeled as conservative to maximize the hazard.

The assumptions of the model were:

1. 20 lbs. dry weight of forage is consumed per day per cow (Garner)
2. 400 gm/m^2 is the mass of vegetation (Auerbach, 1957)
3. 1.33 x 10^5 gm/m^2 soil contaminated to a depth of 4 inches
4. 0.16% daily Sr-90 intake per liter milk
5. a steady state is reached immediately
6. 1 liter per day milk consumption with no radioactive decay.

The results obtained from the model were:

<u>Sr-90</u>

Man gets	1.1 x 10^{-3} μc per liter or	1100 μμc/day	intake from milk
" "		275 " "	" " other dairy products
" "		53 " "	" " beef
" "		1430 " "	" " total diet

<u>Cs-137</u>

Man gets	8 x 10^3	μμc/day from milk
" "	1.03 x 10^4	μμc/day from beef
" "	1.83 x 10^4	μμc/day from total diet

<u>Ru-106</u>

Man gets 36.4 x 10^6 μμc/day from milk (= total)

The conclusion was then made that in the case of a nuclear attack the situation would be worse.

Broido, Abraham
Effects of Fire on Major Ecosystems.

The basic thesis of this paper was that non-urban fires ignited as a result of nuclear war are not likely to be different in effect than normal-peacetime fires. However, it was pointed out that certain aspects of these fires were expected to differ. First, these fires were likely to start simultaneously in many places, and second, they were not likely to be fought by man if they occurred in wildlands. The coalescence of several fires was not considered to be important because for every fire there is always in effect a finite amount of fuel to be burned; the only difference might be the duration and intensity of the fires.

Whether fires would spread is dependent on the same factors which result in peacetime "fire seasons." Whether a fire would start is dependent on the amount and condition of the available fuel. The thermal pulse from the weapons would be short and, while it might start surface flames on solid fuels, it often cannot raise the temperature sufficiently to result in continued burning. A comparison was made with a match. The match was considered the more critical test of the ignitability of a fuel.

A 20,000 MT attack delivered as high air bursts can furnish a thermal pulse sufficient to ignite 2 times the area of the United States if the proper fuel is available. There is obviously very little fuel to ignite on a desert or a snow covered area, and other ignitable areas are not all simultaneously in an optimum burnable condition.

One of the likely events of the simultaneous ignition of many fires in wildlands is spreading to burn large areas. In the past, some of the larger fires have been as follows; 4 million acres at Peshtigo, Wisconsin, 3 million acres in northern Idaho in 1910 and 2 million acres at Fort Yukon, Alaska, in 1950.

The ecological consequences of the fires were pictured to be possible replacement of plant species, promotion of better conditions for repeated fires, and a change in animal species to be found on the burned areas. Furthermore, insects and disease may increase, there may be an increase in available potassium returned to the soil and repeated fires might affect the type of biome such as occurred in the oak openings on the edge of the prairie and now occurs in the long-leaf pine regions. Really extensive burning probably would result in increased runoff with a possibility of increased erosion. Additionally, irradiated forests may result in increased fire hazard by the addition of ignitable material.

During the discussion, the point of the increased size of the affected area following a nuclear war was made, but the author declared that, in his opinion, the effect of scale could be ignored because the fire hazard remains the same per unit area and each fire is independent of the others. Another point made during the discussion, which also hinged on scale, was the possible problems encountered by putting very large areas in the same stage of succession.

Woodwell, G. M. and A. H. Sparrow
Effects of Ionizing Radiation on Major Ecosystems.

This paper was a very close parallel of Woodwell's recent paper in the Scientific American (June 1963).

Some points of dispute:

1. He said that pines and other conifers are the dominant trees of the montane and piedmont regions and that, because of the high radiosensitivity of such plants, these areas may be denuded and lead to floods and erosion.

The statement about what is dominant is true for the West (Rockies) and the piedmont deep South but not for the Appalachians from Massachusetts to Georgia nor for the piedmont from Massachusetts to Virginia. Foresters have begun to question whether trees are the best retainers of runoff water.

2. He said that so far he has not observed an insect population which is more sensitive than its hosts.

The implications of this are rather sweeping. Has anyone made pre- or post-irradiation population studies of most of the important insect herbivores found, for instance, in the Brookhaven pine forest? It seems more likely that the statement is based on noted abundances of certain insect species following exposure of the ecosystem.

3. He said that the insect populations responded to (i) quantity, (ii) quality, and (iii) concentration of food.

This is the classical density-independent approach to population regulation. Density-dependent factors such as competition, predation, and disease were neglected.

The authors presented a table of estimated radiation exposure doses that would damage ecosystems:

System	to get no effect	effect, but able to assure recovery	not sure of recovery in up to 2 years
City	≤ 200 r	> 200 r	--)
Agricultural region	≤ 200 r	> 200 r	--)
Coniferous forest	≤ 200 r	200 - 2,000 r	> 2,000 r
Deciduous forest	≤ 200 r	200 - 10,000 r	> 10,000 r
Grass-land	≤ 2,000 r	2,000 - 20,000 r	> 20,000 r
Herbaceous successional	≤ 4,000 r	4,000 to 70,000 r	> 70,000 r

Platt, R. B.
Homeostasis and Succession in Disturbed Ecosystems.

The bulk of this paper was a presentation of the differential species kill data from the Lockheed reactor site in Georgia. Homeostasis and succession were hardly discussed except in a speculative way. Platt pointed out that the recovery of the habitat began even before all of the dying original vegetation was dead. But a second dose of radiation from the reactor confused interpretation of the results.

The conclusion was a plea for experiments on effects and recovery of an ecosystem treated with artificial "fallout" pellets.

MacDonald, D. R.
Biological Interactions Within Ecosystems

This paper was probably the most well presented and received paper of the symposium. MacDonald was speaking on a subject which has already been well reported in the literature. The emphasis was placed on the results of an investigation rather than on speculation about the possible consequences of a nuclear war.

The paper reported on an investigative program related to a control project for the spruce bud worm and the balsam wooly aphid in New Brunswick and Maine. Studies were made of the effect of insecticide spraying on the pests and subsequent effects on other animal populations. The results of the spraying showed the bud worm populations to be immediately reduced but the effect on the duration of the outbreak was inconclusive because the insect populations on the unsprayed reference areas declined at the same time as the populations on the sprayed area. The effects on bird and mammal populations were also slight. An important point was that although the salmon in a particular river were killed, a few years later the salmon catch in this river was the greatest in history. The significance of this result lies in what actually amounts to a "population explosion" of salmon. In this case the abundant organism is desirable and useful to man, but this need not always be true. The balance of the aquatic ecosystem was upset by poisoning certain species (aquatic insects were drastically affected) and recovery of the ecosystem was characterized by unusual abundances of some species (e.g., the salmon). Recovery of terrestrial ecosystems following a nuclear war could be characterized by unusual abundances of some species, which may or may not be detrimental to man's interest.

<u>Conclusions</u>

As in all symposiums and all meetings, among the papers presented, there were some good ones, some fair ones and some poor ones. All the papers contributed to some extent to the increased knowledge of the audience in respect to the complexity of the problem of attempting to predict the effects of a nuclear catastrophe on ecological systems. One of the outstanding defects of the symposium was its primary concern with radiation effects. Broido spoke on fire and MacDonald spoke on spruce bud worm outbreaks, but the other speakers were picked to speak primarily on topics related to radiation and its effects. Furthermore, and possibly because of the preoccupation with radiation effects, there seemed to be a lack of interest in the long-term recovery aspects of ecosystems following a nuclear catastrophe. There seemed to be general agreement that the whole problem of long-term recovery was so vast and complex and the available information which is needed for prediction so sparse that much research will be needed to permit more definitive speculation on the ecological consequences of a nuclear war.

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