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OBSERVATIONS OF AN ASH LAGOON SPILL ON THE NEW RIVER, VIRGINIA

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Abstract

An estimated 7 million liters of slightly alkaline water (pH = 7.7) and ash entered New River on 23 July 1973 near Pearisburg, Virginia. The rate of dispersion, 1.4 km/hr, allowed qualitative collections of fishes and macroinvertebrates to be made immediately before and after the biological impact of the spill. Diversity and relative abundance indicated that fishes and macroinvertebrates were little affected. Physicochemical parameters from the flyash lagoon, as projected from 1971-1972 data, were within the known tolerance ranges of aquatic biota common to New River.

Introduction

An ash lagoon adjacent to the New River, Pearisburg, Virginia, collapsed on 23 July 1973 and released an estimated 7 million liters of slightly alkaline water (pH = 7.7) and ash into the system. The situation provided an opportunity to evaluate the biological impact on the New River.

Ash (flyash and bottom ash) resulted from burning 1,400 tons of coal per day at a synthetic fibers plant and was transported from furnace hoppers to the storage lagoon utilizing a once through system of New River water. Alkaline conditions occur when lime (CaO) in flyash reacts with water to form $Ca(OH)_2$ (Cairns, Crossman & Dickson, 1970). Cairns *et al.* (1970) discussed a lethal flyash spill on the Clinch River, Va., and noted that highly alkaline waters (pH = 12-12.7) in the lagoon of a fossil fuel electric facility resulted when a closed system of water recycling caused large amounts of $Ca(OH)_2$ to be formed. The transport system at the fibers plant was open, i.e., the water was not recycled and, thus, high concentrations of $Ca(OH)_2$ were avoided. Normal discharge rates from the lagoon exceeded 3.8 million liters per day; this discharge plus reserve water and ash entered New River with the rupture of the retaining wall. Input to the ruptured lagoon was immediately diverted to a standby lagoon.

The New River throughout the study area has an average summer discharge of approximately 70 m^3/sec, with an average annual discharge of 130 m^3/sec. It is characterized by a large volume of water, rapids and rugged substrate conditions (Hocutt, Hambrick & Masnik, 1973). Width averages 100 m and depth 2 m for most localities. Daily discharge may fluctuate as much as 40 m^3/sec due to hydroelectric operations of Claytor Lake Dam located 80 km upstream.

Dispersal of pollutants in streams was discussed by Godfrey & Frederick (1963), Fischer (1966), Yen (1969), and Yen & Wu (1969). Dispersion is influenced by: (1) the nature of the pollutant; (2) environmental conditions, e.g., wind; (3) physics of longitudinal dispersion; (4) manner of pollutant discharge, e.g., uniform or nonuniform ejections; and (5) decay of peak concentration (Yen & Wu, 1969). Zones of separation (eddy currents) usually occur behind stream bed irregularities. Pollutants enter the zones by eddy diffusivity and fall behind the 'core' of the pollutant. Stretch-out of the pollutant therefore occurs.

Cairns *et al.* (1971) discussed the rate of recovery of damaged streams from stressed conditions. Recovery depended on: (1) severity and duration of the stress; (2) amount of associated stresses, if any; (3) recolonization by aquatic biota; and, (4) residual effects upon non-biological units, e.g., substrate. More often, an industrial spill does not permit an analysis of the system preceding ecological effects. This situation was unique in that data gathering was possible immediately before the impact of the spill. Fishes, macroinvertebrates and water samples were collected at some stations within seconds of the first visible signs of the wash load, i.e., suspended ash traveling with a velocity of the same order as water (Einstein, 1972). The study documents the spill and discussed the environmental consequences on the aquatic biota of New River.

Materials and Methods

Water samples were collected from right and left shorelines of five stations over a 24 hour period and analyzed for hydrogen-ion concentration (pH) and total alkalinity (Amer. Publ. Health Assoc., 1971). Visual observatons of suspended ash (Table 1) were made and used to calculate the rate of dispersion. Stations were located as follows (Fig. 1): (1) reference station, A. E. Shumate bridge, U.S. 460, Pearisburg. Va., 0.8 km above the lagoon; (2) the 'Turnhole', an area 0.2 km downstream of the mouth of Stillhouse Branch (location of the spill); (3) Rt. 61 bridge, Narrows, Va., 4.0 km downstream of the spill site; (4) Lurick, Va., 11 km downstream of the lagoon; and, (5) U. S. 460 bridge, Glen Lyn, Va., 14 km downstream of the lagoon. Access to New River dictated the sampling locations.

Species diversity and relative abundance of fishes and macroinvertebrates were analyzed from collections made immediately before and after the spill. Detailed chemical

Table 1. An itinerary of the spill and dispersion.

23 July 1973		
	0845 -	Spill occured
	1130 -	First water samples taken. Suspended ash occured along the right shoreline (main channel), but not along the left of Station 3.
	1625 -	First visible signs of ash at Station 4; ash heavy at Station 3.
	2000 -	First visible signs of ash at Station 5; ash heavy at Station 4.
24 July 1973		
	0200 -	Ash heavy at Station 5. Freshet from Claytor Lake begins passage through survey area.
	0630 -	Stations 2 and 3 show vast visible recovery from spill. Stations 4 and 5 remain effected.
	1030 -	Suspended material tapered off significantly at Station 4.
	1330 -	Claytor Lake freshet receding. Visible suspended ash decreased significantly at Station 5.

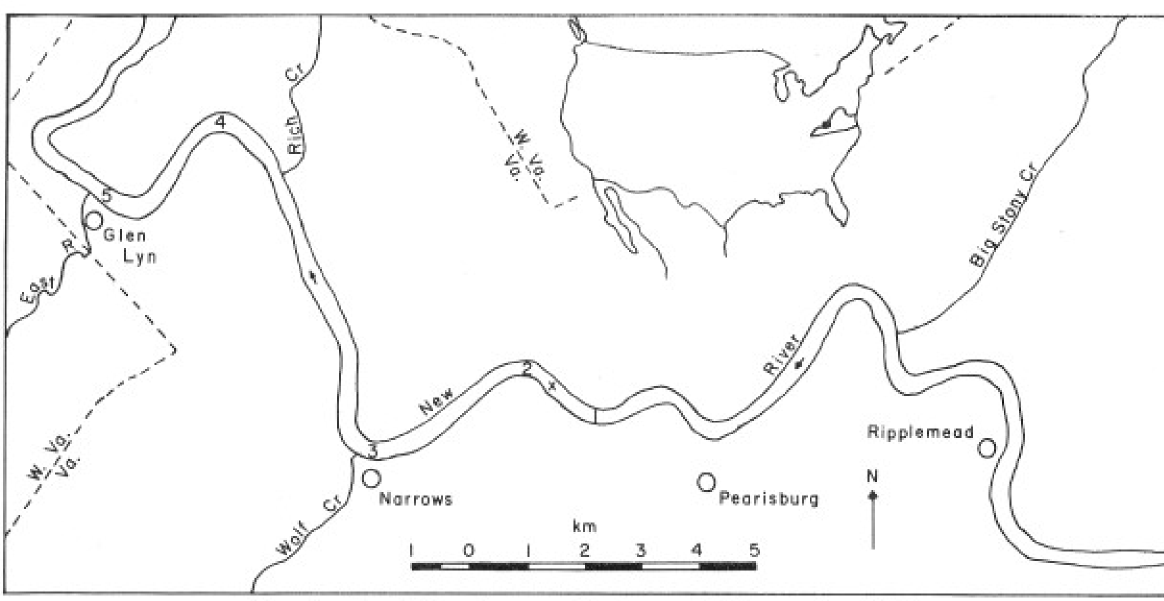

Fig. 1. Location of the study area and stations 1-5 ('x' denotes the spill site).

analyses of the ash lagoon water were not made, however data collected during 1971 and 1972 (Cairns, Dickson & Hocutt, 1973) from the lagoon effluent allowed an estimate to be made of the chemical nature of the water. New River discharge data (Table 2) were obtained from records of the U. S. Geological Gaging Station located at Glen Lyn, Va.

Results and Discussion

The rupture of the earthen retaining dam occurred at 0945 on 23 July 1973 and released an estimated 7 million liters of slightly alkaline water (pH = 7.7) into New River. An itinerary of the spill and dispersion is summarized in Table 1. pH was of little value in monitoring the spill since the parameter often shows diel oscillations above 8.0 in New River. However, spill characteristics were interpreted from total alkalinity values (Table 2, Fig. 2).

Speed of the wash load from Station 2 (the spill area) to Station 5 was calculated as 1.4 km/hr and usually preceded changes in soluble calcium carbonate as measured by total alkalinity (Table 2, Fig. 2). It is unknown what effect the fluctuation in discharge caused by the Claytor Lake hydroelectric station had on the rate of dispersion.

The senior author monitored various physicochemical parameters of the flyash discharge for seasonal trends in 1971 and 1972. Relative concentrations of the various chemical constituents that could be expected in the spilled water are summarized by Cairns, *et al.* (1973); all parameters were within known tolerance limits of fishes and macroinvertebrates common to New River.

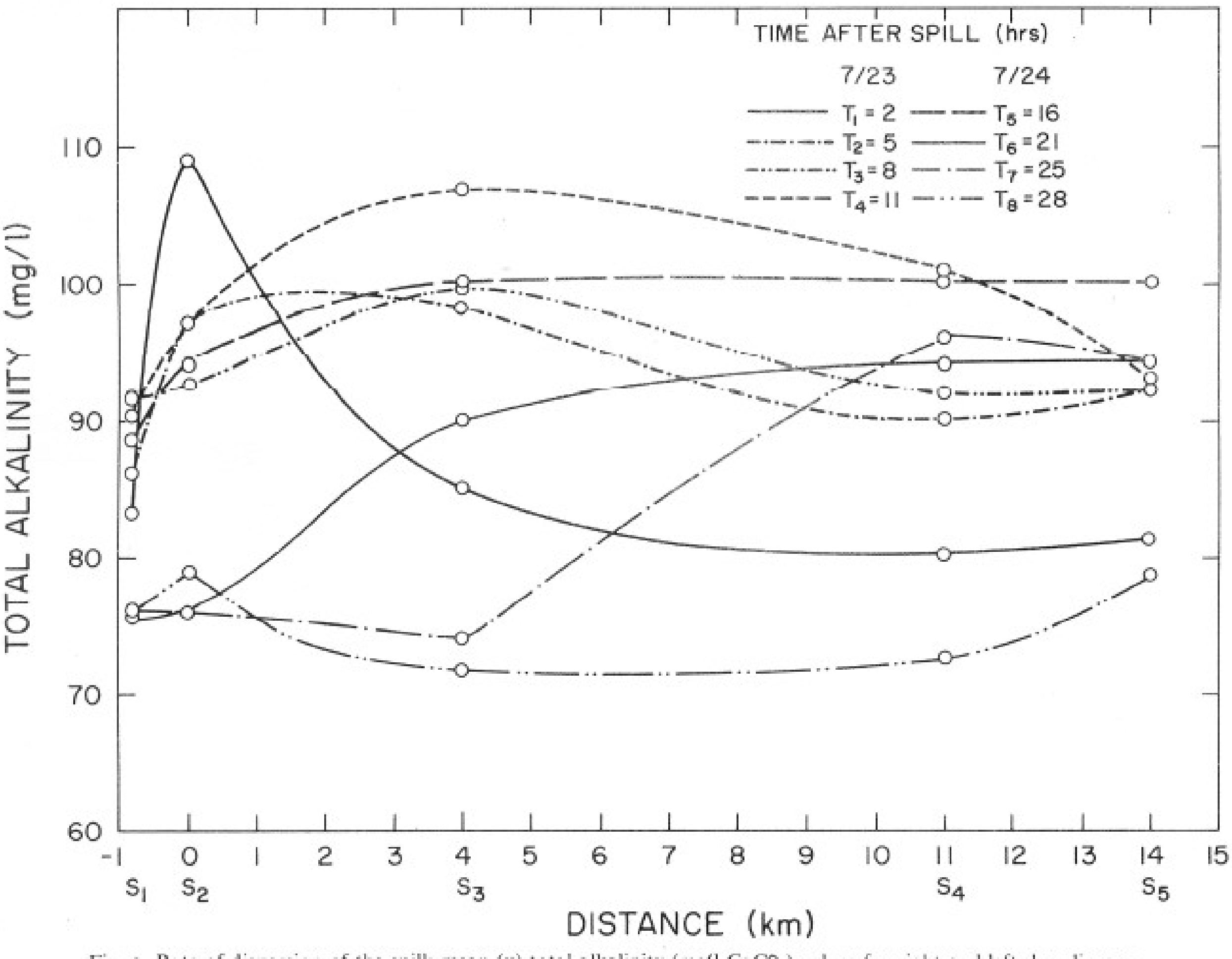

Fig. 2. Rate of dispersion of the spill: mean (x) total alkalinity (mg/l $CaCO_3$) values for right and left shorelines vs. distance (km). (S_1, S_2, .. S_5 note station localities; T_1, T_2, .. T_8 equal time in hours after the spill).

Table 2. Analysis of pH and total alkalinity (mg/l) on New River following an ash lagoon spill on 23 July 1973. (R and L denote right and left shorelines, respectively, for each station).

		Control				Turnhole				Narrows				Lurick				Glen Lyn				Glen Lyn
		R		L		R		L		R		L		R		L		R		L		Discharge
	Time	pH	Alk.	pH	Alk.	pH	Alk.	pH	Alk.	pH	Alk.	pH	Alk.	pH	Alk.	pH	Alk.	pH	Alk.	pH	Alk.	(m3/sec)
23 July	1130-1230	7.8	82	7.8	84	7.4	106	7.7	112	7.4	88	7.2	82	7.8	80	7.9	80	7.6	80	7.6	82	56.0
	1400-1500	8.0	86	8.0	86	7.9	92	8.2	112	7.9	100	7.9	96	8.2	88	8.3	92	8.3	92	8.2	92	55.2
	1700-1800	8.3	92	8.2	91	8.6	89	8.4	96	7.9	100	7.9	99	7.8	92	8.3	92	8.3	88	8.3	96	51.8
	2000-2100	8.2	90	8.2	90	8.2	94	8.1	100	8.1	106	7.7	108	8.3	100	8.2	102	8.4	90	8.3	96	49.2
24 July	0100-0200	8.1	88	8.1	89	8.0	96	8.2	92	8.0	108	8.1	92	7.9	100	8.0	100	7.9	100	7.9	100	47.5
	0630-0730	7.8	76	7.7	75	7.4	80	7.6	72	7.8	92	7.8	88	7.6	88	7.6	100	7.7	88	7.8	100	99.1
	1030-1130	7.7	76	7.5	76	7.5	76	-	-	7.5	72	7.4	76	7.3	96	7.0	96	7.0	92	7.4	96	121.7
	1300-1400	7.7	75	7.5	77	7.5	78	7.3	80	7.6	72	7.7	71	7.6	72	7.5	73	7.6	80	7.7	77	118.9

The suspended ash could be expected to have greater influence on aquatic biota than the hydrochemical aspects. The ecological effects of suspended solids include (Cairns, 1968): (1) mechanical or abrasive action; (2) blanketing effect of sedimentation; (3) reduction of light penetration; (4) provision of a suitable substrate for bacterial growth; (5) absorption and/or adsorption of various chemicals; and, (6) reduction of temperature fluctuations.

A total of 29 species of fish was collected at stations 4 and 5 immediately preceding the slug of spilled water on 23 July 1973. Subsequent collections from 24 July through September 1973 yielded the same species with similar relative abundance and indicated that fishes were tolerant of the spill and little affected. No dead fish were observed in the survey area. Cairns (1968) reported that 28 species of fishes existed in a reach of the Kansas River in 1958 when turbidities exceeded 72,000 mg/l, with no evidence of gill clogging or other damage.

A wet lab is maintained by the Department of Biology, VPI&SU, at Glen Lyn, Va. (Station 5), for temperature preference studies of fishes. Control fish under ambient conditions receive a constant supply of water from New River by submersable pumps. As the spill passed the pumping station, control aquaria were filled with settled ash to a 2.5 cm depth. No mortality was observed in the control fishes, thus supporting conclusions reached by field data (above).

Qualitative macroinvertebrate collections 1-3 weeks after the spill indicated that diversity as measured by the Sequential Comparison Index (Cairns *et al.*, 1968; Cairns & Dickson, 1971) was little affected. It was not possible to conjecture in terms of biomass or to quantify the data. It was therefore difficult to completely assess the effects on various benthic fauna, however the effects did appear minor even immediately below the site of the spill. Some settled ash remained in various zones of separation for approximately two weeks, but was flushed from rheotrophic habitats almost immediately.

Summarizing, pH and total alkalinity were normal within 36 hours of the spill at all sampling stations. Concentrations of various water chemistry parameters, as projected from 1971-1972 data, were within known tolerance limits of aquatic biota and it is expected that any effects were negligible. Residual effects of the settled ash appeared to be minor. Calculated dispersion rates should be valuable in models of the New River (and other streams with similar hydrological conditions) where the prediction of concentrated waste dispersion is important.

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