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METEOROLOGICAL CONDITIONS THAT KEPT LONG ISLAND AND NEW JERSEY BEACHES FREE OF FLOATABLES DURING THE SUMMER OF 1989*

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ABSTRACT

During the summer of 1989, the coasts of Long Island and New Jersey were relatively free of floatable debris washing ashore on their beaches as compared to the previous two summers. The extensive rainfall recorded in this period (twice as much as the normal amount) must have contributed as an important source of floatable wastes to the New York Bight. However, the wind characteristics (speed, direction, constancy, and energy) were such that they distributed the floatables offshore and away from the coasts of Long Island and New Jersey. When compared to the climatology of the summers of 1987 and 1988, it is found that the summer of 1989 was unusual in relation to its high precipitation (567mm), its low wind constancy (19-21%), and its lower air mean temperatures (1°C lower than normal). These conditions are not those generally associated with major floatable problems. Consequently, the floatable collection program implemented in the New York/New Jersey Harbor Estuary did not get a rigorous test with regard to keeping area beaches open.

The southern coast of Long Island and the coast of New Jersey (Figure 1) are exposed to undesirable events of floatable material washing ashore when appropriate wind conditions prevail over these areas. Such conditions, consisting of persistent southerly and south-southwesterly wind for the southern coast of Long

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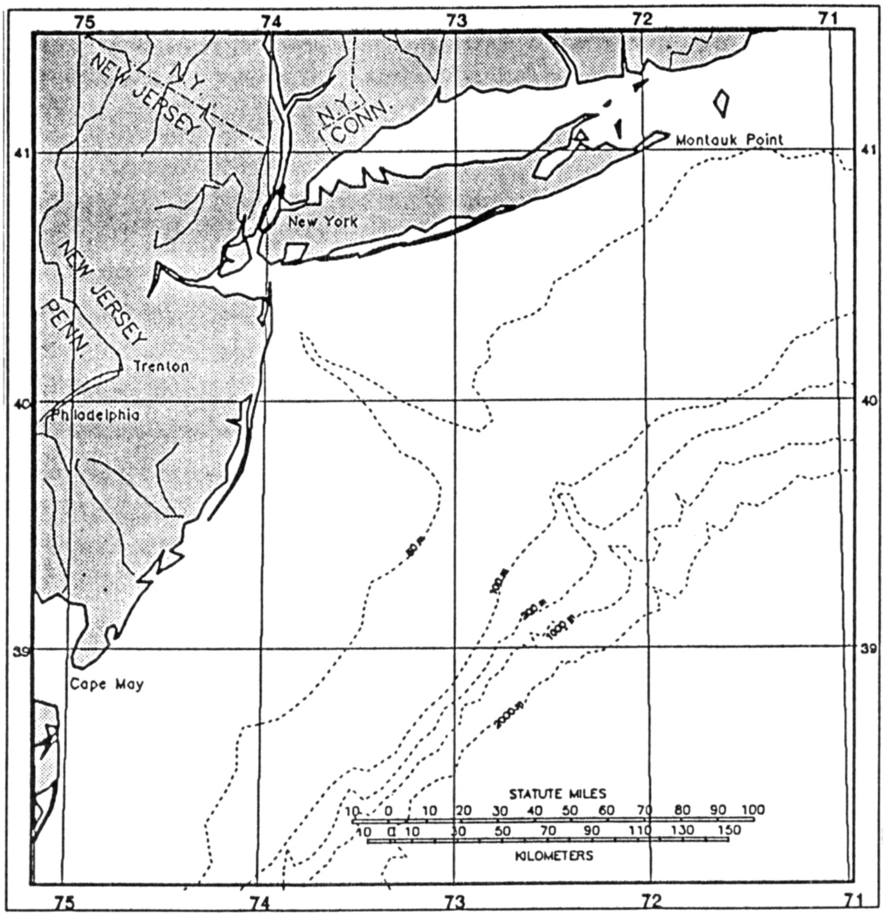

Figure 1. New York Bight area showing the coasts of Long Island and New Jersey.

Island, and easterly to southeasterly and south-southeasterly wind for the coast of New Jersey, mainly occur during the summer months. June, July, and August are also the months when the beaches are most frequented by visitors, thus bringing a great deal of support to the economy of these areas. The wash up of floatable wastes drove many visitors away from the coast of New Jersey in the summer of 1987, and from the coast of Long Island in the summer of 1988. The absence of people from the beaches translated into considerable damage to local economies [1].

For the summer of 1989, the U.S. Environmental Protection Agency, in cooperation with the Corps of Engineers, the U. S. Coast Guard, the states of New York and New Jersey, and the City of New York, implemented a short-term

Floatable Action Plan. The objective of the plan was to skim floatable debris from surface waters at its source, the New York/New Jersey Harbor Estuary, and hopefully to keep the coastal beaches free of wastes washing ashore. The Corps collected in the Harbor, approximately 535 metric tons of debris from mid-May through Labor Day. Nearly 90 percent of the debris collected was wood [2]. The beaches of Long Island and New Jersey were relatively clean of floatable wastes in 1989 in comparison to the previous two summers. During this period, there were two New Jersey beach closures as a consequence of the wash up of floatables [2]. The purpose of this article is to provide an assessment of the summer (June, July, and August) 1989 meteorological conditions, describe their relationships to the wash ups of floatable wastes on ocean beaches in the New York Bight, and compare them to the conditions in the summers of 1987 and 1988.

In the summer of 1987, the New Jersey Department of Environmental Protection indicated that the wash up of floatable material was prevalent during the periods of 27 May to 29 May, and 13 August to 16 August. These events were caused by the combined action of the spring freshet of the Hudson River (May), timely rains (August), and winds that blew from the east to southeast during at least one week before the wash ups. The normal southerly to southwesterly wind field was less persistent and less energetic than normal. Winds from the east and northeast interrupted the normal wind field and enhanced the northeasterly to southwesterly flow of surface waters in the New York Bight [1].

The summer of 1988 was quite peculiar in the sense that south-southwesterly winds persisted throughout July and carried floatable wastes to diverse locations of the southern coast of Long Island over much of that period. The first wash up reported consisted of stranding of medical wastes at Long Beach and Lido Beach on 6 July. Similar incidents were consistently reported at numerous beaches on the south shore of Long Island until 27 July [1]. This floatables event was comparable to that of June 1976 [3]. For a discussion of the sources and why certain types of debris may be increasing in the New York Bight region, see [1, 3, 4].

OBSERVATIONS

Local observations of wind speed and direction as well as rainfall data were compiled for analysis. Hourly wind data were used to construct progressive vector diagrams (PVDs), to calculate constancy and energy values for June, July, and August 1989. Constancy values C were estimated from the relationship:

$$C = \{\overline{U}/|u|\}100,$$

for the monthly mean vector wind speed $\overline{U}$ and the monthly mean scalar wind speed $|u|$. Energy values E were obtained from:

$$E = |u|^2 / |u_{norm}|^2 \times 100.$$

The term in the numerator represents the monthly mean kinetic energy of the wind, while the denominator indicates the average monthly mean kinetic energy over thirty years (1959-1988) [1].

Daily rainfall values were employed to construct precipitation graphs for each of those months. The PVDs helped to describe the wind behavior and to identify times of potential wash ups of floatable debris on the south coast of Long Island or the coast of New Jersey. The constancy indicated the persistency of the wind to blow from a given direction. The precipitation graphs served to identify periods of possible storm sewer and combined sewer overflows to the New York-New Jersey Harbor Estuary. The estimated time lag between an overflow event and an initial wash up on ocean beaches is three to five days.

Wind data from John F. Kennedy airport were used since they are the most readily available data reflecting oceanic conditions. They were provided by the National Weather Service, Eastern Region. Rainfall data for Central Park in New York City were used since they represent conditions close to the major sources of floatable wastes, namely the Harbor Estuary. These data were obtained from the daily reports in the *New York Times.*

Reports on Floatable Incidents and Anecdotal Information

During June, July, and August 1989, there were two New Jersey beach closures as a consequence of the wash up of floatables. One, accompanied by high coliform counts, was in the vicinity of Ocean City. The other closure occurred at Sandy Hook. There were no reported incidents of ocean beach closures in Long Island due to floatables. Chronological anecdotal information consisted of:

1. In early to mid-June few floatables were observed from 2-8 km off the south shore of Long Island;
2. Grease balls of varying sizes washed ashore in the vicinity of Atlantic Beach, Long Island the weekend of 24, 25 June;
3. Dead algae with trash and sewage related items mixed in were observed off Avon By Sea, New Jersey on the weekend of 24, 25 June;
4. Large quantities of debris including dunnage, pallets, and timber were observed up to 90-112 km offshore, much of it appeared as if it had been in the water for a short period of time; there was also a considerable amount of plastic debris at sea;
5. Plastic and floatable debris, oil-grease balls, as well as needle and crack vials were collected at Atlantic Beach, Long Island on 2 July;
6. A garbage slick that caused the beach closure for six hours at Ocean City, New Jersey was reported on 21 July;
7. Some needles, needle covers, and crack vials were found at Atlantic Beach, Long Island from 26 to 28 July;
8. Floatable debris caused the closure of the beach at Sandy Hook, New Jersey from 18-20 August;

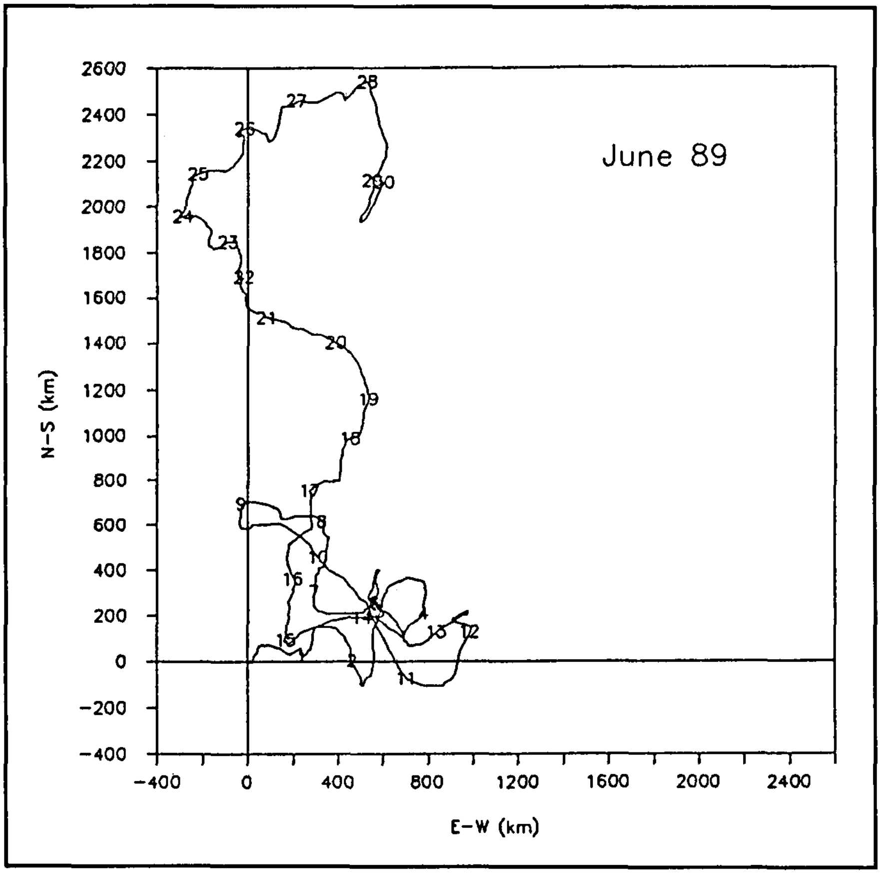

Figure 2. Progressive wind vector (km) at JFK Airport, NY for the month of June 1989.

9. Floatable debris was observed at Atlantic Beach, Long Island on 1 September, a day with very strong southerlies.

The Winds of the Summer 1989

The winds in early June (Figure 2) were extremely varied with the net drift after the first fifteen days being close to 0 while the average speed was 4.9 $m \cdot s^{-1}$. On the 16th, however, the winds began to blow out of the south and southeast until 25 June, at which time they shifted to the west-southwest and then to northerly on the 29th. West-southwesterly winds are very nearly parallel to the general trend of the Long Island coast. These winds would tend to hold floatable debris offshore. The vector mean speed was 1.6 $m \cdot s^{-1}$ out of 192°T for the period of 16-30 June.

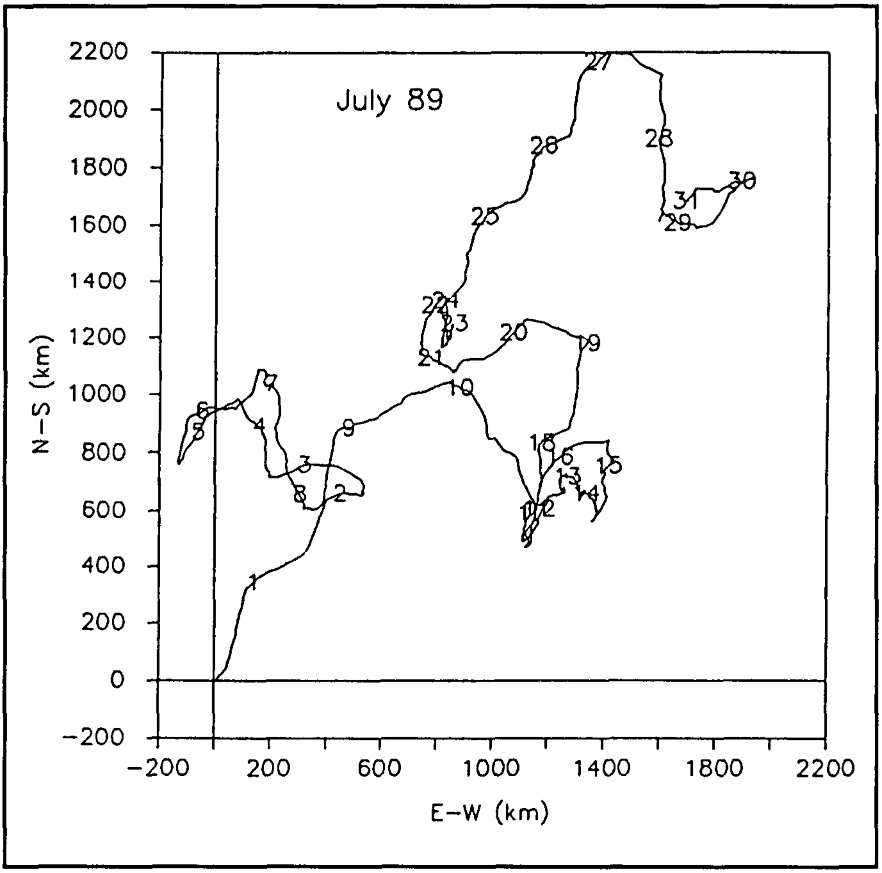

Figure 3. Progressive wind vector (km) at JFK Airport, NY for the month of July 1989.

Over the entire month, the vector mean speed was 0.8 $m \cdot s^{-1}$ from 196°T and the mean speed was 4.4 $m \cdot s^{-1}$. This compares with the 1959-1988 climatological norm for June of 1.4 $m \cdot s^{-1}$ from 208°T. Wind constancy was 19 percent, considerably less than the norm which is 34 percent. Wind energy as a percent of normal was 70. Thus, for the month as a whole, wind conditions were not favorable for a major wash up of floatable debris. Yet, for the period 15-24 June, it would not have been surprising if a significant wash up had occurred on the south shore of Long Island, if there had been a source of material. After 26 June, floatables should have been transported offshore.

In early July, the winds had a southerly component (Figure 3). The average speed for the first week of the month was 4.3 $m \cdot s^{-1}$ and the vector mean speed was 1.7 $m \cdot s^{-1}$ out of 190°T. The winds had a noticeable westerly component from the

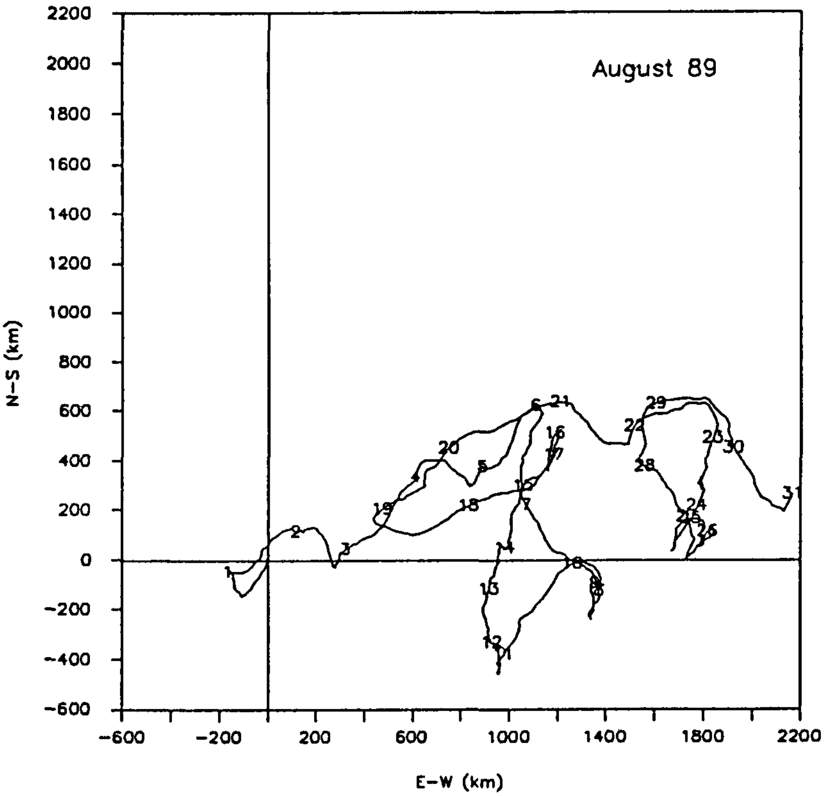

Figure 4. Progressive wind vector (km) at JFK Airport, NY for the month of August 1989.

9th to the 11th, an easterly component during the 20th and 21st, and a southwesterly component from the 22nd through the 27th.

Over the entire month, the vector mean speed was 0.9 $m \cdot s^{-1}$ from 225°T and the mean speed was 4.2 $m \cdot s^{-1}$. The 1959-1988 climatological norm for July is a vector mean speed of 1.9 $m \cdot s^{-1}$ from 210°T. The wind constancy was 21 percent, considerably less than the norm for the month of July which is 41 percent. Wind energy as a percent of normal was 78. Thus, for the month as a whole, wind conditions were not favorable for a major wash up of floatable debris on the coast of Long Island. The most likely periods for wash ups in New Jersey would have been the small windows between 3-5 July and 20-21 July.

In early August, the winds had a west-southwesterly component (Figure 4). The average speed for 1 August through 6 August was 4.4 $m \cdot s^{-1}$ and the vector mean speed was 2.4 $m \cdot s^{-1}$ out of 240°T. The winds were out of the south from the 12th to the 16th, had an easterly component during the 18th and 19th, before resuming a generally west southwesterly flow from the 20th through the 23rd. The strong easterlies led to the beach closure at Sandy Hook on 18-20 August. The rest of the month the winds were quite variable from day to day.

Over the entire month, the vector mean speed was 0.8 $m \cdot s^{-1}$ from 263°T and the mean speed was 4.3 $m \cdot s^{-1}$. The 1959-1988 climatological norm for August is a vector mean speed of 1.3 $m \cdot s^{-1}$ from 216°T. The vector mean wind direction for August 1989 was shifted to the west more than one standard deviation from the norm. The wind constancy was 19 percent, considerably less than the norm for the month of August (33%). Wind energy as a percent of normal was 90. Thus, for the month as a whole, wind conditions were west-southwesterly and were not favorable for a major wash up of floatable debris on the coast of Long Island or New Jersey. The most likely periods for wash ups in New Jersey would have been the small window between 17-19 August and for Long Island between 11-16 August and 26-29 August.

Rainfall in the Summer 1989

Rainfall for the months of June, July, and August 1989 as recorded in Central Park, are shown in Figures 5, 6, and 7, respectively. The record rains recorded in May 1989 persisted into mid-June. In the latter half of June, the rains continued but they were not as severe as earlier in the month. The total rainfall for the month was approximately 2.7 times greater than normal. In July, the heavy rains of May and June tapered off although heavy downpours were registered on the 5th and on the 16th. The last week of the month was relatively dry but the monthly accumulation was 130mm (*New York Times*), compared to the normal of 96mm. In August, heavy rains occurred between the 11th and the 17th. The last half of the month was relatively dry although the monthly accumulation was 214mm (*New York Times*) compared to the normal of 93mm.

ANALYSIS OF THE SUMMER 1989 OBSERVATIONS

The floatable load in the New York Bight throughout the month of June was most likely large. The intense rains early in May undoubtedly contributed to the problem, as did the fact that the debris collection program under the Floatable Action Plan was not initiated until mid-May. Much of this material was probably widely distributed. A considerable quantity actually washed ashore prior to the opening of the beach season on 26 May and was removed by beach cleaning operations.

By June, because of the heavy rains and flooding in May, the potentially refloatable material on shorelines and the garbage and trash typically associated with storm sewers was probably less than normal. But the rains in June caused

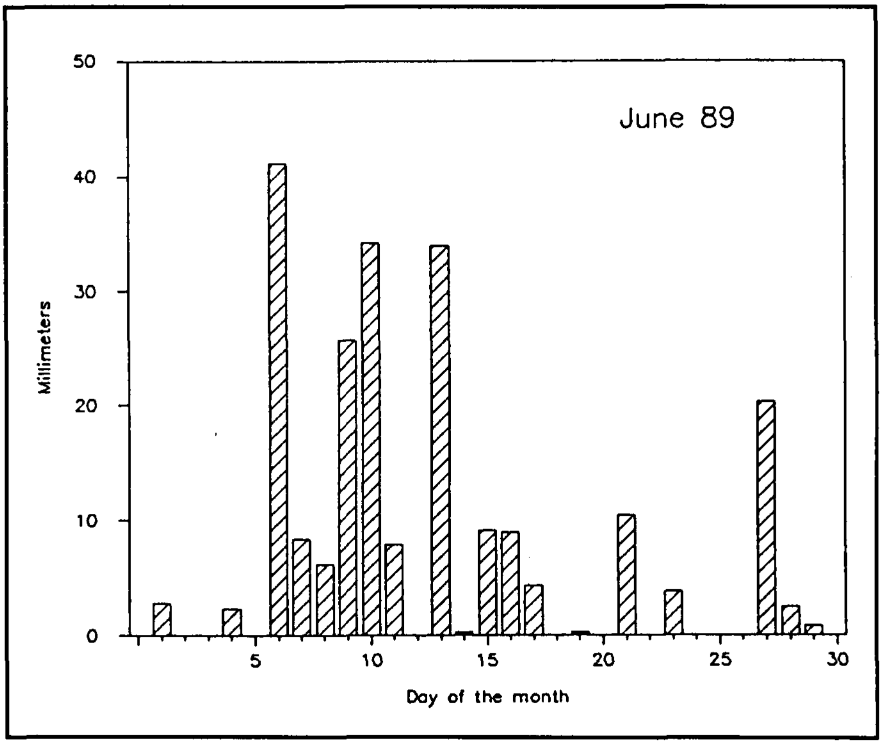

Figure 5. Rainfall (mm) at Central Park, NY for June 1989.

frequent bypassing of sewage treatment plants through the combined sewer overflows (CSOs) [1]. Estimated days that overflows occurred are shown on Figure 8. These were determined using the New York City Department of Environmental Protection Agency's approximation that overflows result when rainfall intensities exceed 10mm in 6.67 hours. This estimation indicates that out of the fifty-three days on which rain was recorded, seventeen days (one-third of the time it rained) had overflows.

During the first half of the month, floatables escaping the collection program were probably well dispersed in the ocean with some of the materials sinking, others degrading. However, it is likely that a portion of the floatables released with the mid-month rains could have begun washing ashore on Long Island beaches a few days after the commencement of southerly winds on June 16th (Figure 8).

The easterly component of the winds for the period of 20-24 June could also have been expected to cause an impact on the New Jersey coast. These conditions could explain the occurrence of some sewage related items on both the New Jersey and Long Island ocean beaches around the period 24-25 June.

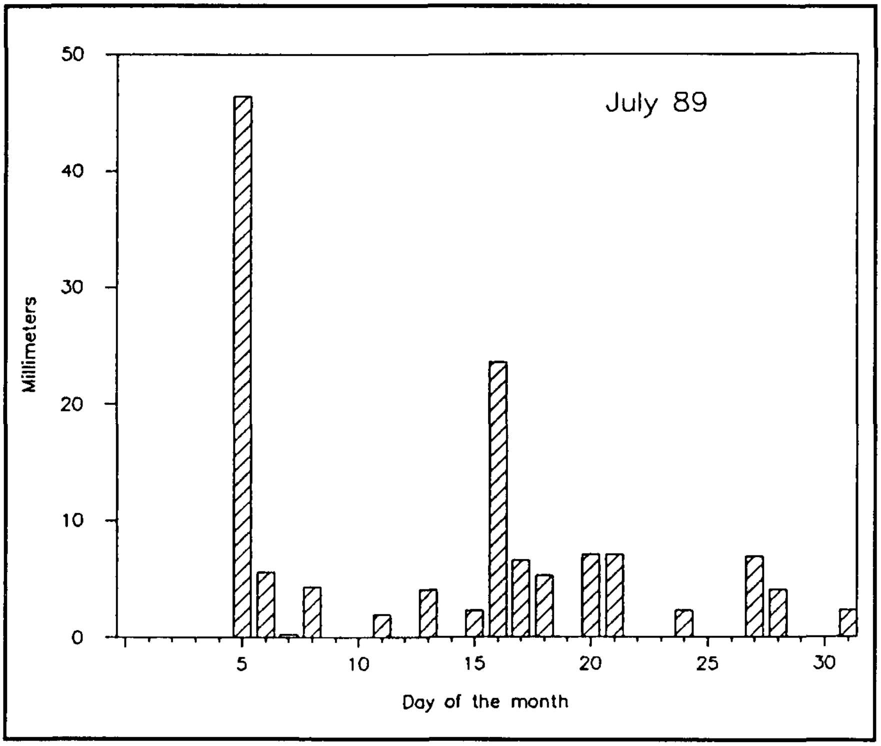

Figure 6. Rainfall (mm) at Central Park, NY for July 1989.

At the beginning of July, the floatable load in the New York Bight was probably sizeable because the heavy rains of early to mid-June caused flushing of storm sewers and considerable bypassing of sewage treatment plants. The small floatable incident at Atlantic Beach, Long Island on 2 July can probably be attributed to the normal loading of Bight waters from the Hudson-Raritan Estuary and the strong southerlies of the 1st and 2nd. Following the heavy rain of the 5th, the winds were predominantly from the west until 15 July (off the New Jersey coast and parallel to Long Island's southern coast). These conditions must have transported and dispersed, offshore, material that was bypassed through the CSOs and that escaped the floatable collection program. The wash up of 21 July near Ocean City, New Jersey, followed easterlies commencing about the 16th and which blew intensely on 20 and 21 July. The rains of mid-July may have helped to create the source of material from CSOs in the harbor and storm sewers along the New Jersey shore. It also is conceivable that the origin of some of the material was Delaware Bay. The small wash up at Atlantic Beach, Long Island in late July was clearly associated with the southwesterlies over the period of 22-27 July.

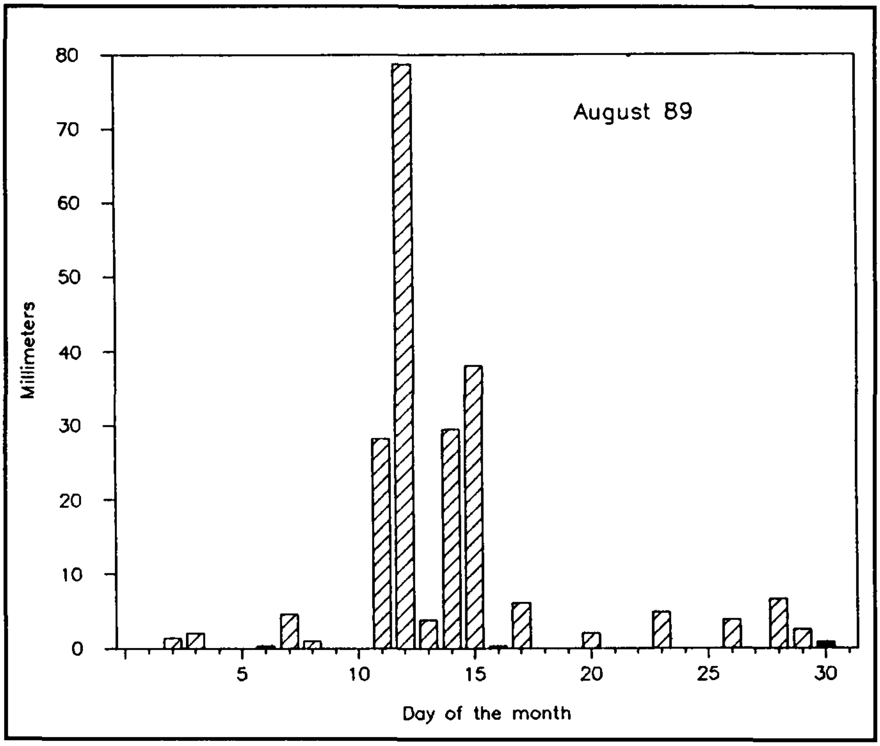

Figure 7. Rainfall (mm) at Central Park, NY for August 1989.

In mid-August, the floatable load in the New York Bight was probably sizeable because the heavy rains from the 11th through the 17th caused considerable bypassing of sewage treatment plants. These rains, followed by the strong easterlies of the 18th and 19th, led to the wash up on Sandy Hook between the 18th and 20th. The small wash up at Atlantic Beach in early September was clearly associated with the strong southerlies over the period of 27-29 August and 1 September.

Overall, for the months of June, July, and August 1989, the ocean beaches of New York and New Jersey should have been free of floatables based on what is known about their sources and transport. Casual observations and newspaper accounts generally support this.

The summer climatology as a whole was quite unusual. It was one of the wettest summers on record. At Central Park, the normal June, July, and August rainfall is 271mm. In 1989, 567mm were recorded, more than twice the normal amount. Corresponding to the wet conditions, the summer was generally cooler than

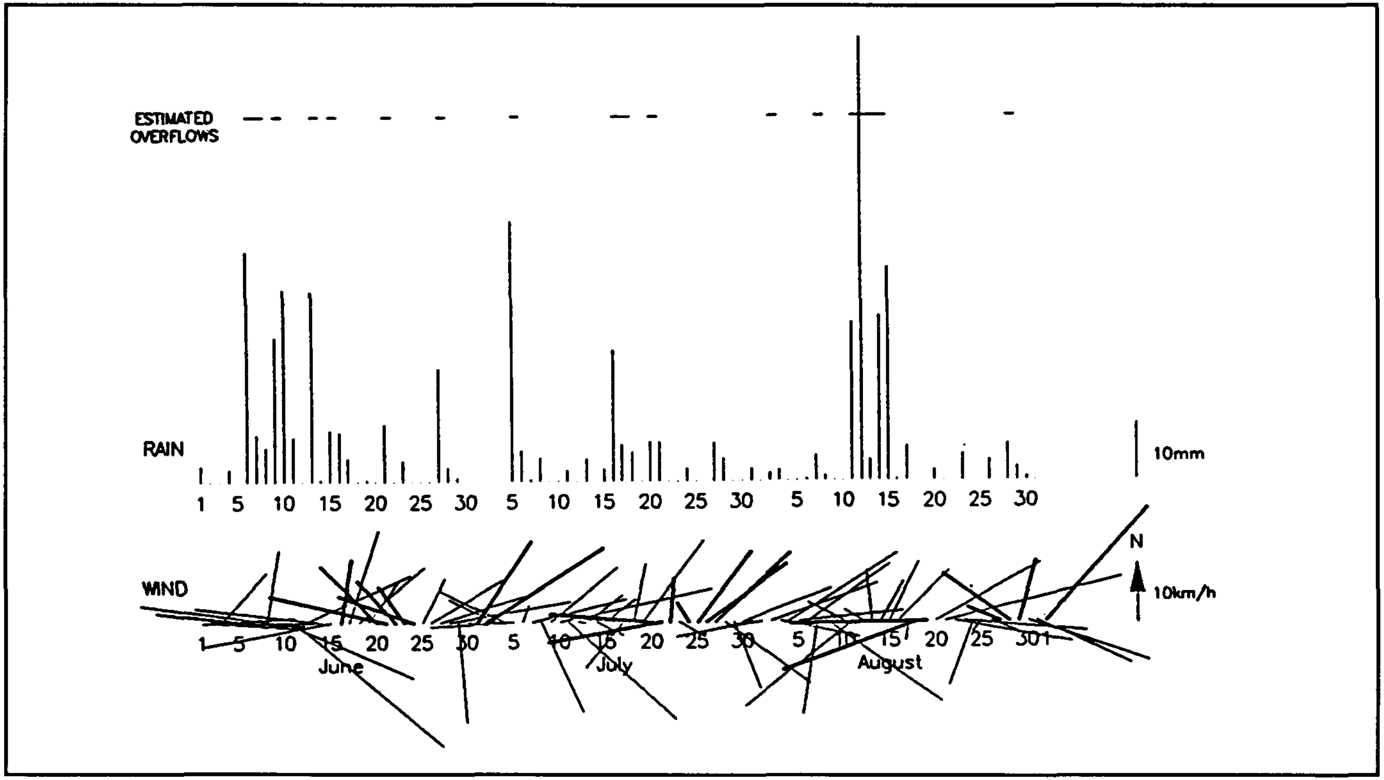

Figure 8. Summary of events for the summer of 1989. Bold lines on the wind stick diagram indicate events referenced in the text. Overflows are estimated to occur when rain accumulates at a rate of 10mm in 6.67 hours.

normal. July and August mean air temperatures were about 1°C below normal. These cooler months were accompanied by winds that were more out of the west than the typical southerly to south-southwesterly flow. Wind energies were much less than normal and the very low wind constancies reflect the generally variable nature of the winds throughout the months.

Based on our past experiences, this would not have been a summer when floatable wash ups would have been a problem. To create a floatable problem, the proper sequencing of rainfall and persistent winds from a specific sector of the compass are required. These did not occur during the summer of 1989. The short term floatable action plan undoubtedly further guaranteed that this would not be a problem year.

COMPARISON OF THE SUMMER OF 1989 TO THOSE OF 1987 AND 1988

The summer of 1989 distinguished itself from the previous two in the sense that the beaches of the coasts of southern Long Island and the coast of New Jersey remained relatively free of major floatable incidents. The resultant wind vectors for each month (Figure 9) clearly show the winds of June 1976 and July 1988 as being the most likely to drive floatables to the southern coast of Long Island (resultant speed of 2.8 and 2.4 $m{\cdot}s^{-1}$ out of 200°T and 210°T). The constancies (Figure 10) of 55 percent and 58 percent are much greater than the other values and than the norm for those months (34% and 41%). August 1988 also featured potential for producing wash ups on the southern coast of Long Island. The magnitude of its resultant wind vector was 2.1 $m{\cdot}s^{-1}$ (slightly less than July) out of the same direction (210°T) with a constancy of 44 percent. The absence of beach closures during that month was due to the little rainfall and the absence of floatable sources to the New York Bight [1].

The wash ups of August 1987 on the coast of New Jersey are explicitly reflected in the weak magnitude of the resultant vector (0.6 $m{\cdot}s^{-1}$) and its low constancy value (13%). This is an indication of variable winds counteracting the normal southerlies or southwesterlies. The wash ups were associated with easterlies. It is also very clear that the magnitudes of the resultant wind vectors for the summer of 1989 and their energy (Figure 11) were rather weak, their direction broadly variable and their constancy very small to account for the lack of any floatable incident on the coast of southern Long Island. Their characteristics (magnitude, direction, constancy, and energy) are quite different from those of the preceding summer (1988). As compared to the summer of 1987, the magnitude of their resultant wind vectors and their constancies are similar but the brief periods of easterlies were extremely timely in 1987.

These distinctive sets of meteorological conditions during the summers of 1987, 1988, and 1989 leads to a better understanding of the conditions under which a floatable event should be expected on either of the coasts of New Jersey or

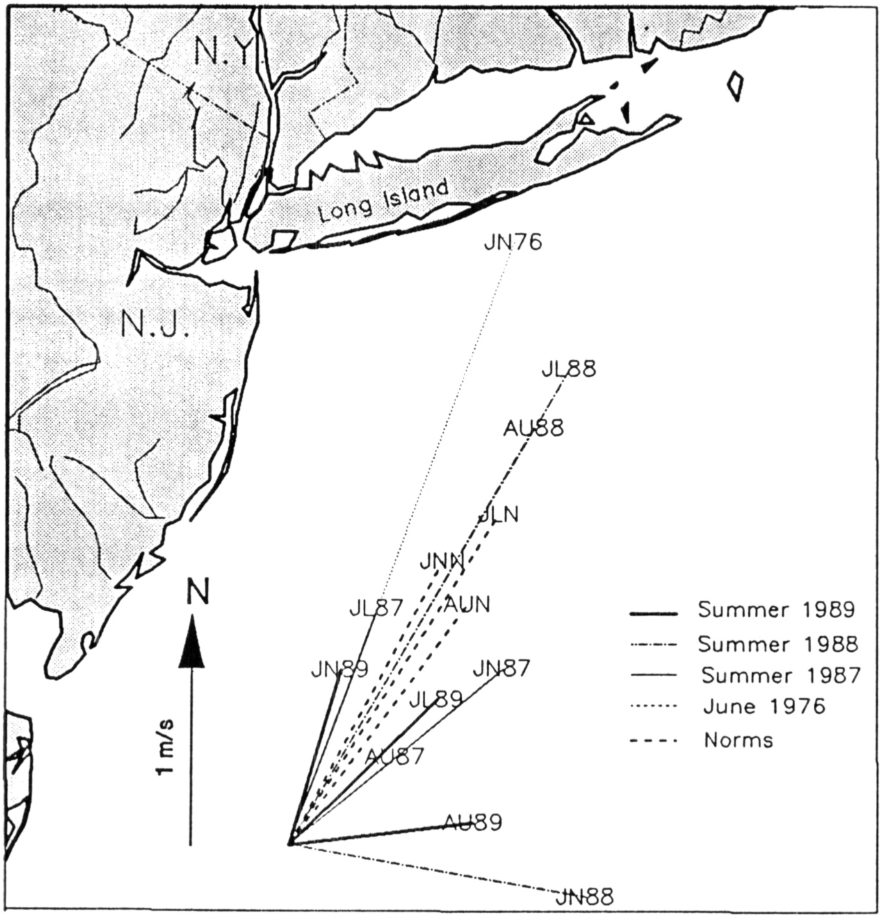

Figure 9. Resultant wind vectors for June (JN), July (JL), and August (AU) of 1987, 1988, 1989, June of 1976, and the norms for those months. JN76 and JL88 represent wind conditions most likely to drive floatables to the coast of Long Island. The resultant wind vectors in the summer of 1989 are of comparatively smaller magnitude and from an inappropriate direction to drive floatables ashore.

southern Long Island. Considered along with the major floatable event of 1976, we have an excellent history of the problem and its causes which should guide our actions for seeking solutions.

CONCLUSIONS

The climatological conditions affecting the coasts of New Jersey and Long Island during the summer of 1989 were quite uncommon. It was one of the

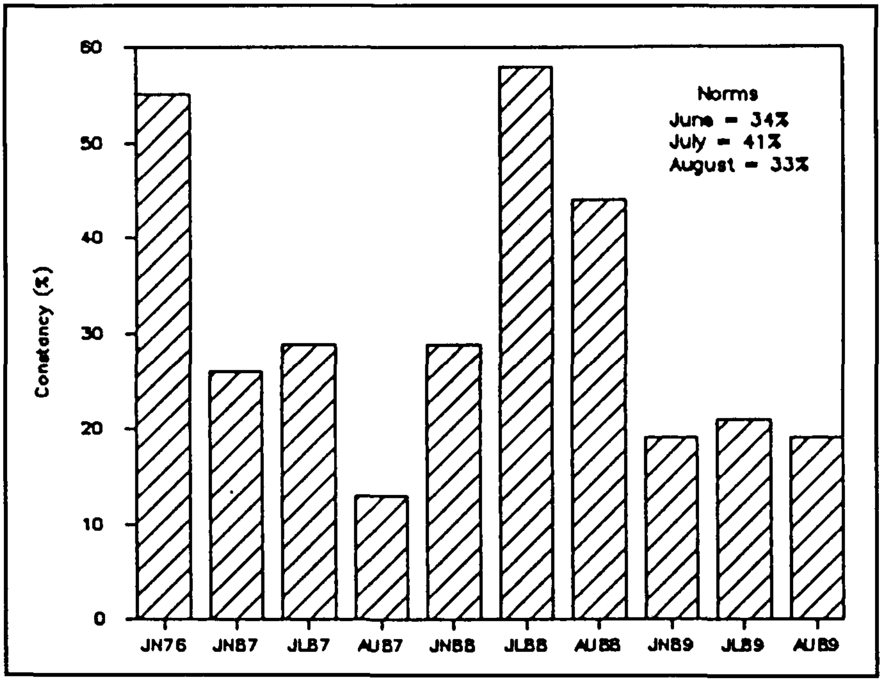

Figure 10. Wind constancy values (as in Figure 9). Note the low constancy for the summer of 1989 as compared to the norms and the summer of 1988 and June 1976.

summers of highest rainfall on record. The total accumulation for Central Park was more than twice (567mm) the normal amount (271mm) for the months of June, July, and August. That amount of rain created an overload of floatable debris to the Harbor Estuary and the New York Bight. However, only two beach closures as a consequence of floatable wastes were reported throughout the summer. The scarcity of beach closures is explained by the general offshore transport of the floatable wastes, by the high variability (low constancy) in the wind direction during the summer 1989 and by the floatable collection program.

Past experiences indicate that the summer of 1989 would not have been a period for which floatable debris washing ashore would have constituted a threat to close ocean beaches. The short-term floatable action plan further curtailed such threat. Nevertheless, this summer cannot be considered a reliable test for the suitability of the short term floatable action plan. Many summers may pass before such a summer may occur. It is important, however, to not be lulled into thinking that because no wash ups occurred that we necessarily have found a solution. Equally important, we would not think that summers similar to 1976 and 1988 on Long

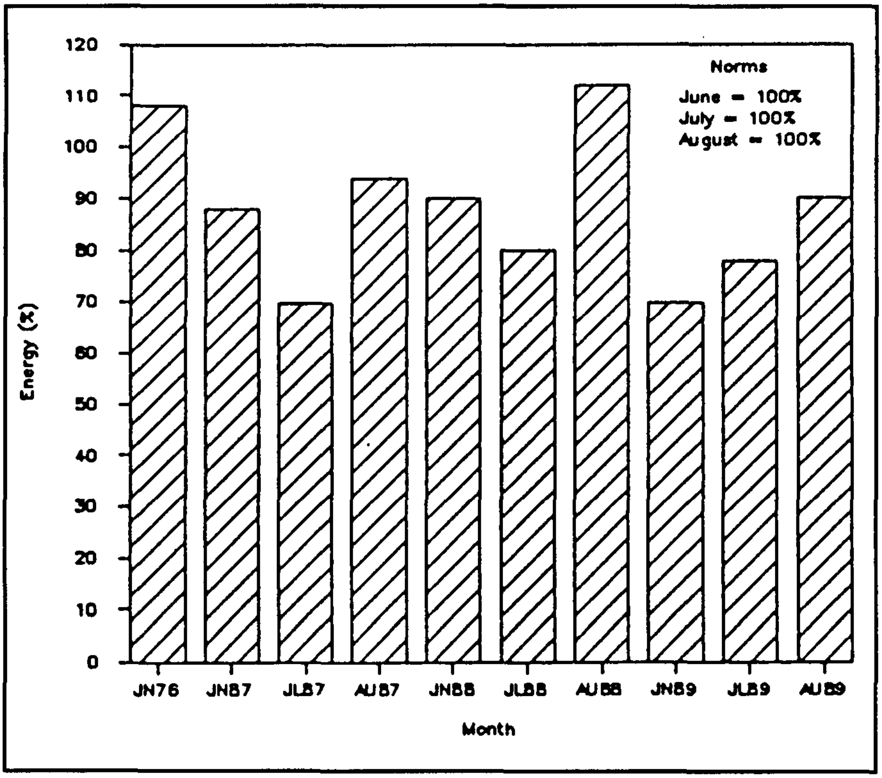

Figure 11. Relative wind energy values (as in Figures 9 and 10). The norm for all months is 100 percent. Observe the low energy values for the summer of 1989 as compared to the others.

Island or a summer similar to 1987 in New Jersey can not occur again and so divert resources, now being used to clean the Harbor, to other purposes. Unless the Harbor skimming operation can be shown to be ineffective, it is important to keep it operational until long-term solutions are found and set in place.

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