CHAPTER FIVE

AIR POLLUTION OCCURRENCE AND DISPERSION

5.1 When Air Pollution is Most Likely to Occur

It is suggested that the atmospheric conditions during which pollutants accumulate lie below the vertically averaged wind speed of 6m/sec through a 2000m mixing height (Preston-Whyte, 1980). This author refers to the persistence of these conditions over 24 hours as an episode day. During such pollution episodes, residential areas in South Durban are greatly affected.

Table 5.1: Wind speed table modified from (http://www.ukkiting.com/new_page_139.htm)

Metres/ Sec	Description	On land
0 – 0.2	Calm	Calm, smoke rises vertically
0.3 – 1.5	Light Air	Smoke drift indicates wind direction
1.6 – 3.3	Light Breeze	Wind felt on face, leaves rustle
3.4 – 5.4	Gentle Wind	Leaves and twigs in motion, light flags extended
5.5 – 7.9	Moderate Wind	Leaves and loose paper lifted up, flags flap
8.0 – 10.7	Fresh Wind	Small trees begin to sway, flags flap and ripple
10.8 – 13.8	Strong Wind	Large branches in motion, whistling in wires
13.9 – 17.1	Near Gale	Whole trees in motion, resistance walking into wind
17.2 – 20.7	Gale	Whole trees in motion, resistance walking into wind (again)
20.8 – 24.4	Strong Gale	Slight structural damage, shingle blown from roofs
24.5 – 28.4	Storm	Trees broken and uprooted, major structural damage

Mixing depth has been defined by Holzeworth, (1972) as the altitude above the surface through which vigorous vertical mixing of heat, moisture, momentum, and pollutants occur.

Preston-Whyte,(1980) has shown that from 1970-1972 at Durban, short term episodes lasting 2 days occurred throughout the year but were generally absent during the summer months due to higher wind speeds during this season, while long-term episodes of 5 days were restricted to late autumn, winter and early spring. He further showed that the winter season registers the highest number of pollution episodes. This is so because of the frequent nocturnal temperature inversion that blocks the upward escape of pollutants.

In the South Durban basin, wind speed is registered at the time of each complaint. The table below shows recorded wind speed for some selected months in 1999.

Generally, the table shows lower wind speeds at late night and in the early mornings. Depending on the concentration of pollutants emitted, at these times, the effect on communities would be greater due to the lower wind speeds.

Table 5.2: Recorded wind speed in South Durban at the time of complaint (1999)

SUMMER				WINTER			
Complaint ID	Starting Date	Starting Time	Wind Speed m/s	Complaint ID	Starting Date	Starting Time	Wind Speed m/s
416	20/02/1999	09:25	6	187	01/07/1999	11:15	1.4
415	20/02/1999	09:15	6	186	01/07/1999	06:40	3
421	20/02/1999	23:50	1	185	02/07/1999	08:18	6
424	20/02/1999	09:34	6	568	02/07/1999	11:30	
422	20/02/1999	14:50	3	184	03/07/1999	22:30	
425	21/02/1999	02:00	1	182	04/07/1999	22:21	
423	21/02/1999	05:25	1	183	04/07/1999	14:30	
428	22/02/1999	22:20	4	181	05/07/1999	14:35	6
426	22/02/1999	02:00	1	569	07/07/1999	22:30	3
427	22/02/1999	18:30		570	09/07/1999	20:40	
429	25/02/1999	08:12	8	571	09/07/1999	21:46	3
436	26/02/1999	23:11	2	572	10/07/1999	18:00	10
430	26/02/1999	01:00	1	573	10/07/1999	20:15	10
431	01/03/1999	18:30	6	575	10/07/1999	20:12	10
432	01/03/1999	18:35	6	577	10/07/1999	21:03	10
433	02/03/1999	14:00	6	579	12/07/1999	11:50	10
472	03/03/1999	08:30	4	580	12/07/1999	11:45	10
434	05/03/1999	21:40	6	137	13/07/1999	20:15	
435	07/03/1999	14:30	7	582	15/07/1999	14:12	3
437	07/03/1999	11:50	7	584	16/07/1999	02:54	3
438	09/03/1999	01:13		587	16/07/1999	14:40	7
439	11/03/1999	01:55	4	586	16/07/1999	10:25	3
440	12/03/1999	03:50	4	590	16/07/1999	17:30	
441	12/03/1999	04:10	4	588	16/07/1999	21:00	5
442	15/03/1999	14:45	5	592	17/07/1999	08:10	3
443	16/03/1999	19:50	5	593	17/07/1999	22:12	12
444	18/03/1999	05:45	1	594	17/07/1999	18:15	
445	21/03/1999	17:00	9	596	17/07/1999	13:29	
446	21/03/1999	21:10	12	597	18/07/1999	07:44	9
449	22/03/1999	19:15	1	598	19/07/1999	18:45	8
448	22/03/1999	19:05	1	600	21/07/1999	14:19	4
447	22/03/1999	09:10	4	619	23/07/1999	16:55	12
451	23/03/1999	15:25	6	630	23/07/1999	20:23	14
450	23/03/1999	07:37	5	629	23/07/1999	20:22	14
454	24/03/1999	06:56	7	628	23/07/1999	20:44	14
452	24/03/1999	05:45	8	627	23/07/1999	20:25	14
455	24/03/1999	07:40	7	625	23/07/1999	20:20	14
456	24/03/1999	07:40	7	623	23/07/1999	19:27	14
457	24/03/1999	12:40	8	622	23/07/1999	19:23	14
453	24/03/1999	06:54	7	139	23/07/1999	16:55	
464	26/03/1999	20:45	6	620	23/07/1999	19:15	14
465	26/03/1999	20:52	7	626	23/07/1999	20:24	14
463	26/03/1999	20:36	6	621	23/07/1999	19:20	14
462	26/03/1999	20:12	6	624	23/07/1999	19:42	14
461	26/03/1999	20:05	6	631	24/07/1999	20:24	14
460	26/03/1999	18:40	9	633	28/07/1999	19:41	2
459	26/03/1999	18:20	9	132	28/07/1999	19:41	
458	26/03/1999	17:35	9	632	28/07/1999	09:39	1
466	26/03/1999	20:47	6	129	30/07/1999	15:34	6
467	27/03/1999	08:58	7	130	30/07/1999	06:16	6
468	29/03/1999	00:00	2	634	30/07/1999	06:16	8
469	29/03/1999	10:05	3	635	30/07/1999	15:34	9

5.2 Air Pollution Dispersion

The prevalence or dispersal of air pollution depends on a number of factors. These include the conditions discussed in section 5.1 above as well as those below.

5.2.1 Precipitation: Air pollutants act like condensation nuclei around which water or rain droplets form. When they fall to the ground, the pollutants are washed from the atmosphere. However, due to the acid content of the rain (resulting from the presence of pollutants like sulphur dioxide and nitrogen dioxide), it has a negative effect on plants, buildings and human life. In Durban, rainfall occurs mainly in summer with 60% of the annual precipitation from November to March and only 15% from May to August.

5.2.2 Winds: Turbulent winds with high wind speeds disperse air pollutants faster than light winds. As already noted, high wind speeds occur in summer and lower wind speeds in winter. Wind direction determines where the pollutants go. For example as already noted in chapter four, land mountain winds and land breezes blow away air pollutants from the South Durban into the Indian Ocean at night. Also, areas located downwind from a smoke stack are more affected by a pollution source.

5.2.3 Passage of Frontal Systems: The passage of a frontal system in Durban from the SW (during winter) contributes to air pollution dispersion. It is associated with a strong south-westerly wind diffusing pollutants through a deeper mixing layer.

Figure 5.1: A cold front would blow away pollution

5.2.4 Surface heating: During the day, the earth surface heats and warms the air lying above it. The air then begins to rise through convection dispersing pollutants, which accumulated overnight.

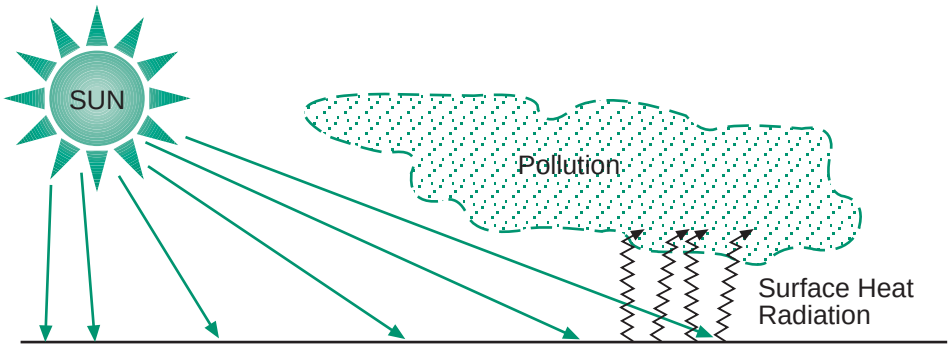

Figure 5.2: Surface heat radiation dispersing pollution from below

5.2.5 Irregular topography: At night, mountains and elevations produce differential heat and pressure balance in opposition to plains, valleys and the sea. This results in airflow from mountains down slope, through the valleys towards the sea. They disperse and blow pollutants in the South Durban basin into the sea during summer. (See details in Chapter Four)

Exercises

1. State the average vertical wind speed and mixing height during which air pollution episodes occur in South Durban.

.....

2. Define mixing depth.

.....

.....

.....

3. Why does winter register the highest polltuion episodes?

.....

.....

.....

4. Why are pollution episodes less in summer months?

.....

.....

.....

5. Name the factors that favour the dispersal of air pollution.

.....

.....

.....

6. Briefly explain how surface heating disperses air pollution.

.....

.....

.....

7. How does the passage of a cold front in Durban affect air pollution?

.....

.....

.....

8. Which wind blows pollutants at night from the South Durban basin into the sea?

.....

.....

.....

9. Which winds re-transport air pollutants onto land far from the pollution source?

.....

.....