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Estimation of Air Environment Carrying Capacity of Dolvi, Maharashtra

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Abstract: Assimilative capacity of air environment in Dolvi, Maharashtra was evaluated. AERMOD was applied to pin down the spatial distribution of PM10 and PM2.5 concentrations. The baseline air quality was delineated, and it was found that PM10 and PM2.5 concentrations were beyond National Ambient Air Quality Standards (NAAQS) in every season. The major contribution to these particulates were from fugitive emissions i.e. mainly resuspended dust from vehicles and highway construction. As the plant had planned for expansion, spatial distribution of PM10 and PM2.5 was estimated at 5 MTPA and 10 MTPA. It was found that existing air environment in Dolvi region was very poor, however, the results of dispersion model showed that modifications in technology at 5 MTPA reduces PM 10 and PM2.5 concentration in ambient environment and at design estimations of 10 MTPA the concentrations are within standards. It was also found that paving of external and internal roads the PM 10 concentrations will reduce by 70% compared to existing scenario but due to movement of vehicles on external road PM 10 will continue to be high at some locations in the region. The estimation of VC in region showed that it does not have enough assimilative capacity in month of February and April and in month of October region has less pollution potential as higher VC values 15300 m^2/s were present. This study also revealed that VC values are an important parameter for understanding the natural capacity of region for its existing air quality.

Keywords: Ventilation Coefficient (VC), Mixing Height, AERMOD, Assimilative Capacity, Pollution Potential, PM10

1. Introduction

With the overall growth across country, it is important that sustainable development is the core concept of development and hence it is required that all the stakeholders should include sustainability constraints or limits of the environment, carrying capacity to sustain and provide the acceptable quality of life [7]. Carrying capacity concept is a crucial function with variables of planning and management of the region and if the limit to anthropogenic activity identified through inventorying different activities with real data, the resulting outcome thus can lead to sustainable development [7].

The Carrying Capacity of air environment indicates an approximate estimation of pollutant loads that can be taken and assimilated. For air environment “Carrying Capacity” and “Assimilative Capacity” for the atmosphere are used interchangeably. Assimilative Capacity is the maximum quantum of pollution load an atmosphere of a region can assimilate and remains within the laid standards [9]. Assimilative Capacity for atmosphere is the estimation of its strength to bear the pollution load from varied emission sources. This capacity is a function of atmospheric stability and the topographic features for the region. The atmospheric stability is affected by solar insulation, mean wind speed and temperature profile [1]. The assessment of assimilative capacity of region for air environment helps in devising region-based plans for mitigation of poor air quality [8]. The assimilative capacities assessment was done for different regions in India like Delhi [9, 10], Manali [11] Visakhapatnam [2], Gangtok [12], Kochi [13]. The assimilative capacity of the atmosphere in any region is directly linked to the ventilation coefficient and inversely related to pollution potential [2].

$$Ventilation\ Coefficient\ (VC) = Mixing\ height\ (MH) \times Wind\ Speed \quad (1)$$

The pollution potential for atmosphere is indicative of its capacity to dilute the pollutants and the resultant quality of air. Thus, an indirect relation exists between pollution potential and Carrying Capacity of region [3]. The estimation of VC values helps in identifying the frequent pollution episodes like smog etc. and thus helps policy makers, stakeholders also to decide the location and type of such sources which have high emissions and are a potential cause of poor air quality in the region [5, 6].

Assessment of assimilative capacities using dispersion model is the other method to assess the assimilative potential of the region. AERMOD one the approved US-EPA model helps in identifying the spatial and temporal variations of pollutants in the region. AERMOD uses steady-state dispersion equation to produce concentration of pollutants from different emission sources [14, 15]. Therefore, emission inventory for all types of sources to be fed to AERMOD along with other requirements of the software.

In this study, assimilative capacity assessment using ventilation coefficient and dispersion model has been done for Dolvi region as JSW Steel Limited (JSWSL) at Dolvi, Raigarh, Maharashtra has proposed to increase its capacity from existing 5 MTPA to 10 MTPA with future plan upto 15 MTPA in phases. The various processes starting from construction of expansion plant to plant in operation and various processes during operation is anticipated to effect surrounding environment. Hence, the carrying capacity assessment of Dolvi region was done for its air environment [16].

2. Study Area

Dolvi is a large village located in Pen Taluka of Raigarh district, Maharashtra. The study area proposed in current study for air environment is a 10 km x 10 km grid with 1 km spacing with Steel plant at center as shown in Figure 1. The extent of location is between 18°36′00″ N to 18°48′00″ N latitude and 72°57′00″ E to 73°09′00″ E longitude.

The study area is in the valley surrounded by the hills having the steepest slope of 57.4°. There are two major highways passing through the study area. One is Mumbai-Goa highway (NH-66) and the other is Pen-Alibaug Road. Also, there are railway lines passing through the area. The nearest railway station is Pen.

The study area is plain with slight undulating terrain, and it was found that most of the area is gently sloping from east to west and is present in the valley surrounded by small hills of greater than 35% slope gradient. The region has sufficient and orderly seasonal rainfall, harsh weather in summers and high humidity all-round the year. The normal annual rainfall over the district ranges from 2200 mm to > 3000 mm in the plains and > 5000 mm in the hilly areas. In vicinity of the study area, the available IMD (India Meteorological Department) is at Alibaug which is approximately 20 km from the plant. As per data from IMD and from Lakes Environmental the coolest part of the year is from November to February. With the onset of monsoon in month of June, the temperature dips down and area becomes slightly cooler and remains same throughout the monsoon. The average annual rainfall reported at Alibaug by IMD is 2177 mm as per data analysis from 1951 to 1980. Summer and winters have relative humidity levels varying from 64% to 90%. Relative Humidity is higher during south-west monsoon and retreating monsoon and is between 81% to 90%.

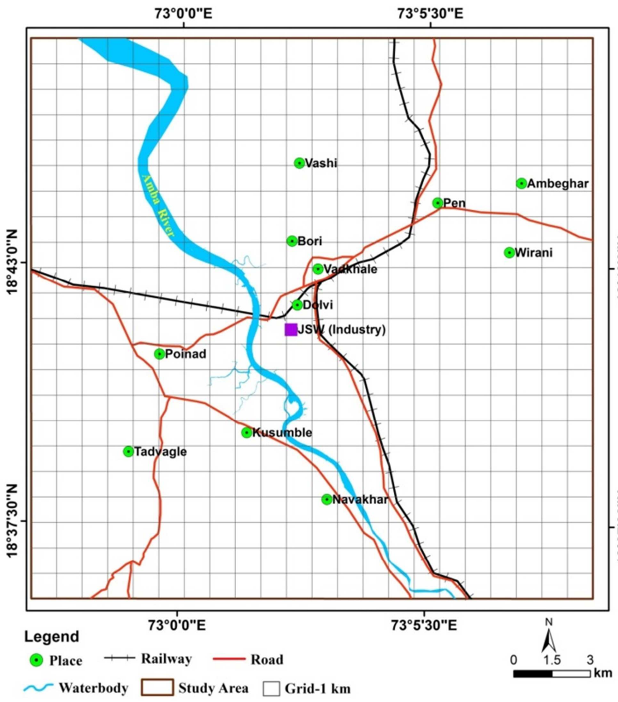


Figure 1. *Study area for Air Environment.*

3. Methodology and Data Used

In this study, for air environment assimilative capacity through ventilation coefficient and pollution potential of the region was investigated as the region was undergoing development in terms of road infrastructure and plant increasing its production. The assimilative capacity is calculated based on information on mixing height and ventilation coefficient for the region. The pollution potential was estimated using dispersion models.

The assimilative capacity for Dolvi's atmosphere was estimated using two methods. First method uses ventilation coefficient, which is a direct estimation for assimilative capacity of the atmosphere. Second method was to estimate the pollution dispersion potential, and this was done using dispersion models for concentration of pollutants, and is inversely proportional to the assimilative capacity. Dispersion models used multiple emission sources to predict the spatial and temporal distribution of two pollutants namely particulates (PM10 and PM2.5). The models were cross-checked and were validated using the monitored data. The detailed methodology is shown in Figure 2.

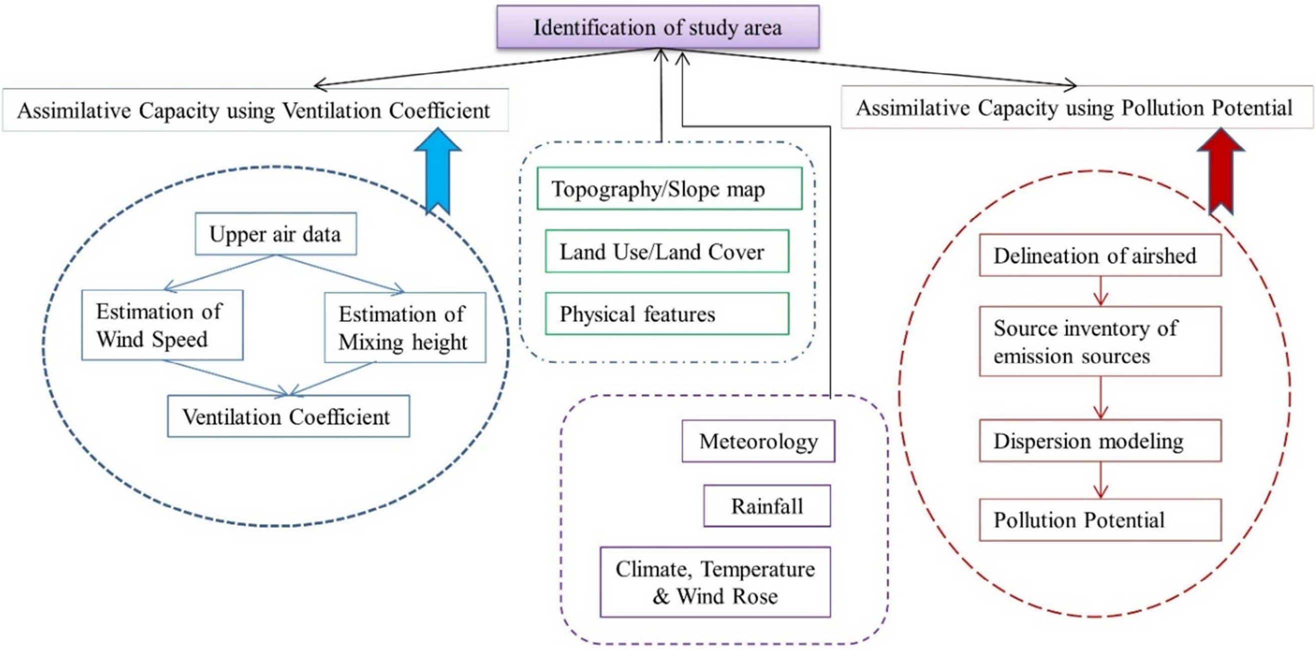


Figure 2. *Methodology for estimating Assimilative Capacity of Air Environment.*

3.1. Estimation of Assimilative Capacity Through Ventilation Coefficient

In this study, the upper air data recorded by IMD in 2006 and 2013 to 2018 was used to derive the vertical temperature profile. The RS/RW data obtained from IMD was run in MATLAB and extracted for different months data for year 2006 and 2013 at two different UTC one at 00 UTC i.e. 05:30 am IST (Indian Standard Time) and 12 UTC i.e. 05:30 pm IST (Indian Standard Time). The limitation with the data was that it has missing values across months and days and times.

Once the vertical temperature profile extracted, Holzworth method (1964 and 1967) was used to calculate mixing height of the different days for different months. Once mixing height was obtained for morning and afternoon, the average of wind speeds through mixing layers was obtained by simple arithmetic averages of the recorded wind speeds of radiosonde ascents of 1200 GMT and 0000 GMT respectively. The mean wind speed for everyday was multiplied with mixing height to estimate morning and afternoon ventilation coefficient. The flowchart showing estimation of Assimilative Capacity through Ventilation Coefficient is shown in Figure 3.

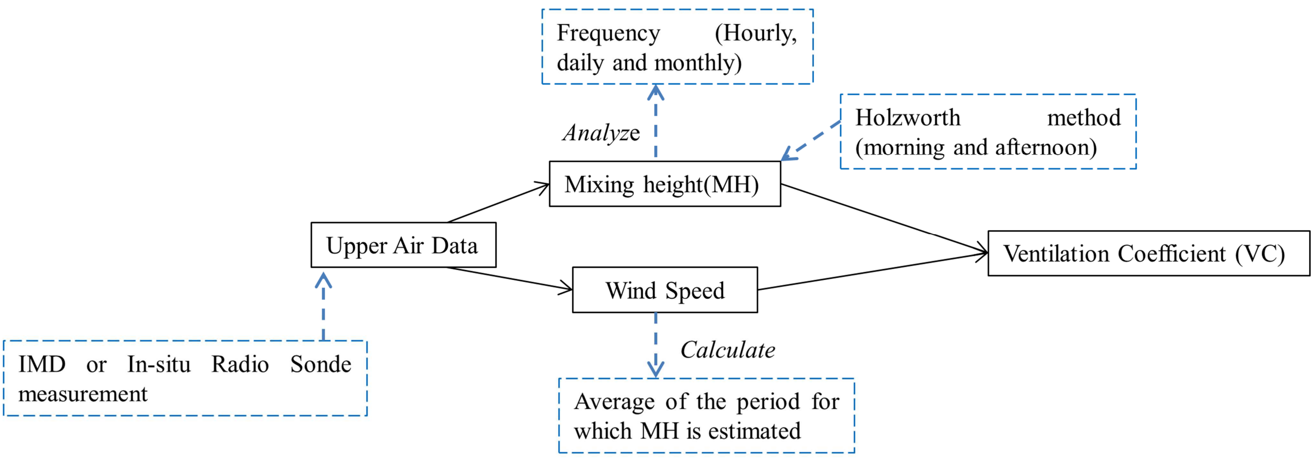


Figure 3. *Estimation of Ventilation Coefficient.*

3.2. Assessment of Pollution Potential Using Air Quality Model

Modeling behavior of pollutants in atmosphere using coupled mathematical equations with the help of some standard models helps in understanding the existing air environment. The models can integrate all complex chemical and natural processes to have an idea about quality of air, movement of pollutants and their final fate in the environment. When a pollution source releases a chemical in the atmosphere at some concentration, the chemical does not remain at that concentration which was released. Modeling air pollution is to predict or simulate the ambient concentration of criteria pollutants found within the atmosphere through physical or numerical models. Modeling tends provide an acceptable results which are quick and cheap.

The methodology to estimate Pollution Potential using Air Quality Model is shown in Figure 4.

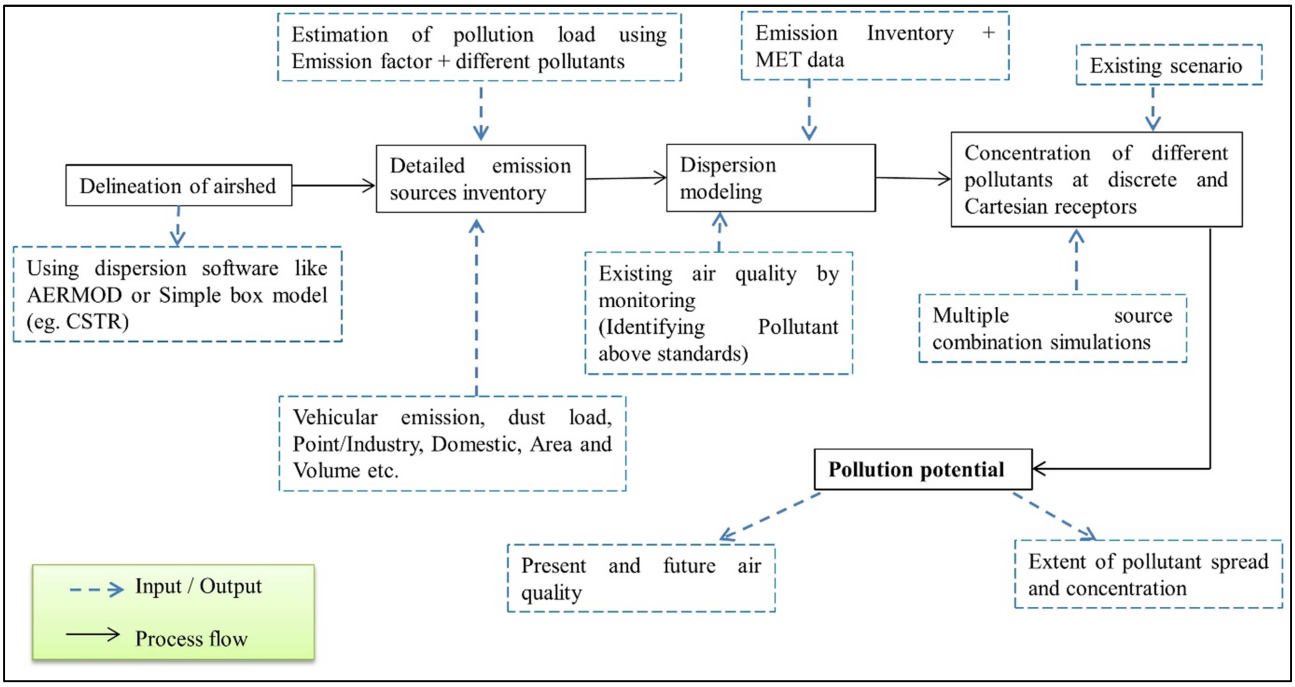


Figure 4. Methodology for estimation of Pollution Potential using Air Quality Model.

3.3. Data Used

3.3.1. Upper Air Data

For assimilative capacity of atmosphere in Dolvi, hourly upper air data taken from India Meteorological Department (IMD) for year 2013 to 2018 has been used. Ventilation coefficient (VC) has been calculated for different days of months based on morning and afternoon mixing height. Assimilative Capacity of air environment is expressed in terms of VC and is product of mixing height and average wind speed at different levels.

3.3.2. MET Data

For modeling the air quality of Dolvi region, AERMET-Ready & AERMOD-Ready Met Data generated by WRF and MMIF for year 2018 was procured from Lakes Environmental with location specified as 18.69106 N latitude and 73.03944 E longitude and base elevation as 74.75m and WRF Grid Cell of 12 km x 12 km. The data was used to understand predominant wind directions in the study area. The winds are blowing predominantly from NE to SW on an average round the year. The annual average wind speed is 3.54 m/s with calm winds frequency of 0.98%. The wind rose diagram on yearly basis is shown in figure 5.

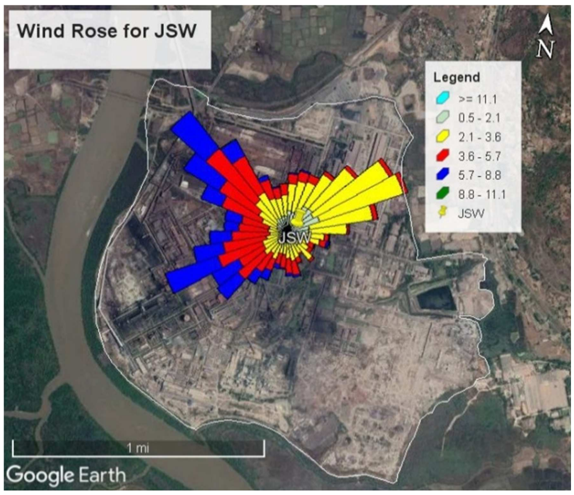


Figure 5. Prevailing Wind Direction in study area.

3.3.3. Emission Inventory

An emission inventory is a summary of the pollutant emissions under existing condition in surrounding of the proposed project activity. The sources of emission in the region were point source, line source, area and volume source.

3.3.4. Line Source

The line sources in the region are mostly the vehicles plying on highways, external roads and internal roads inside the JSWSL plant. The fugitive dust emission occurs whenever vehicles travel over paved or unpaved roads. The inventory for vehicles has been classified under Light Weight Vehicle (LV) and Heavy Weight Vehicle (HV) on internal roads inside the plant and major roads in the study area. The categorization done under paved and unpaved roads to account for different emission factors for PM10 and PM 2.5. The emission factors have been taken from AP-42 Fifth Edition Compilation of Air Pollutant Emissions Factors, Volume 1: Stationary Point and Area Sources for Metallurgical Industry for Iron and Steel Production. The paved roads in the study are of concrete type. Keeping the present activity track, the total PM10 load is 673 kg/hr and PM2.5 as 98.5 kg/hr because of external roads. The total PM 10 load is 141.8 kg/hr and PM2.5 is 20.8 kg/hr due to internal roads when there are stretches of paved and unpaved conditions.

3.3.5. Point Source

All the stack sources has been estimated using the stack details inside the steel plant and total PM 10 load was calculated based on analysis of dust collected and particulate matter came out as 402 kg/hr with approximately 50 stacks existing in different units at 5 MTPA.

3.3.6. Volume Source

A Volume source of pollution is a three-dimensional source of pollutant emissions. In Steel plant, the major emissions from volume sources are Materials handling activity at Jetty, Material handling activity at Raw Material Handling System (RMHS) and Various conveyor Junction House. The emissions at 10 MTPA capacity for PM10 were 22.69 kg/hr and for PM 2.5 were 7.13 kg/hr.

3.3.7. Air Quality Monitoring

The baseline air quality in Dolvi region was estimated by monitoring PM10 and PM2.5 in three seasons i.e. winter, summer and post-monsoon and the locations identified for monitoring are shown in Figure 6. The monitoring was done for continuous 24 hrs and 7 consecutive days. During monitoring it was found that PM10 was highest at Pen for all the three seasons and lowest was at Shahbaj during post-monsoon. It was observed that other locations where construction of highway was undergoing in vicinity, higher PM10 was reported compared to site where there was no construction activity.

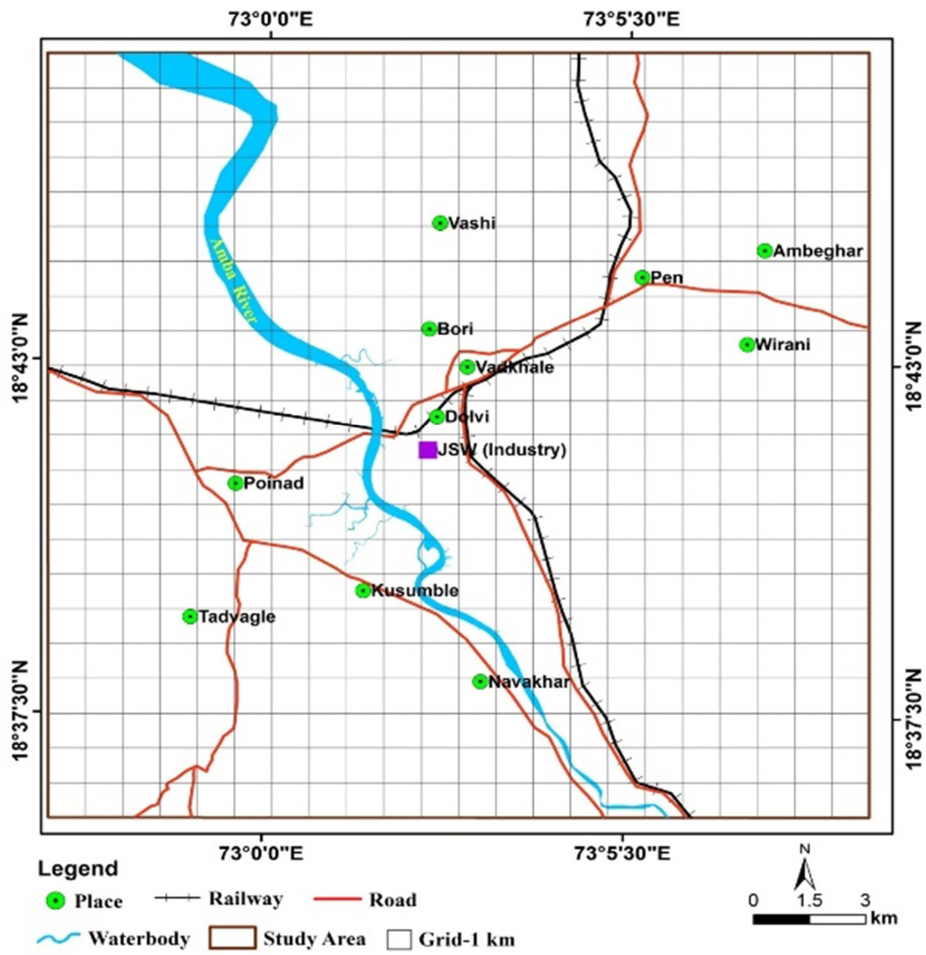


Figure 6. *Air Monitoring locations in Dolvi region.*

4. Results and Discussion

Assimilative capacity assessment for Dolvi region using both the methods i.e. VC and AERMOD dispersion model has been discussed further.

4.1. Assimilative Capacity Using Ventilation Coefficient

To understand the assimilative potential of a region, temperature profile with wind speed for months of February, April and October was analyzed to understand the effects during monitoring phase. The months for upper air atmosphere profile were selected such that the sampling period was also captured. The analysis of temperature and wind profiles across different month morning and afternoon has been shown in Table 1 and Table 2 respectively.

Table 1. *Comparison of VC morning values.*

Month		February	April	October
	Average	6	5.66	3.57
Wind Speed (m/s)	Max	7	7.65	4.7
	Min	5	4.4	2.3
	Average	200	513	1200
Mixing height (m)	Max	210	1638	2200
	Min	Ground level Inversion	200	200
	Average	1244	2789	3954
Ventilation Coefficient (m^2/s)	Max	1423	7644	8184
	Min	1064	1197	941

Table 2. *Comparison of VC afternoon values.*

Month		February	April	October
	Average	5.0	5.8	4.3
Wind Speed (m/s)	Max	8.0	8.7	10.5
	Min	3.0	3.32	2.1
	Average	607	561	1237.4
Mixing height (m)	Max	1800	1638	3000
	Min	150	100	500
	Average	3108	3404	5184
Ventilation Coefficient (m^2/s)	Max	8242	10400	15300
	Min	747	666	2103

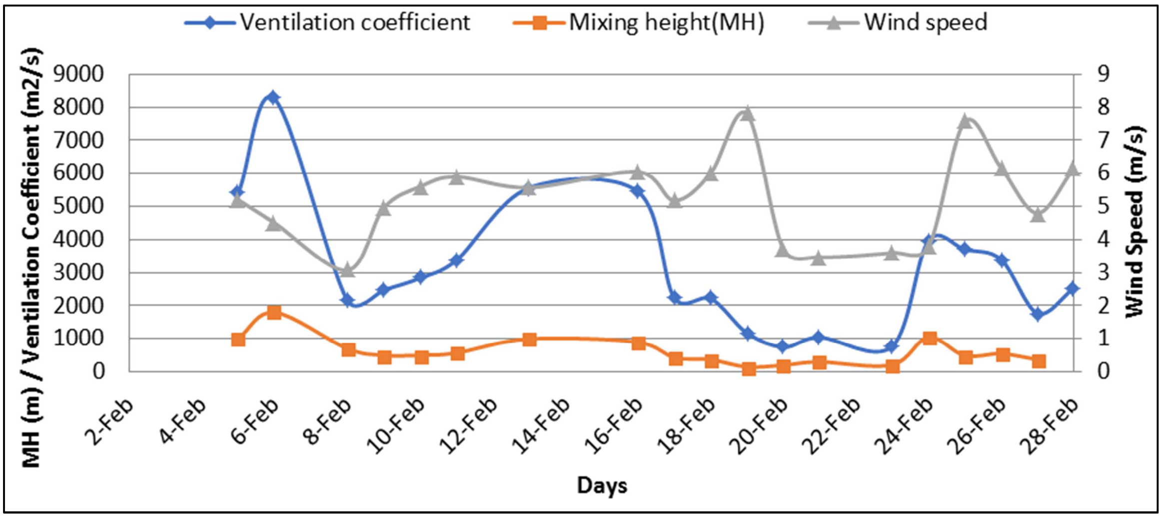


Figure 7. *Variation of Ventilation Coefficient, wind speed and MH for afternoon in Dolvi in February.*

From Table 1 it can be observed that for month of february, ground level inversions were obtained for few days in morning and therefore minimum mixing height was not available for the month. As per US National Meteorological Centre and Atmospheric Environment Services, Canada criteria for pollution potential; in month of february the region has instances when assimilative capacity was less in mid-february while it was higher in first week of february which means the region has assimilative capacity only for few days in february in afternoon and hence the pollutants for rest of the days will not be dispersed much. For morning, ground level inversions were obtained in february and thus pollutants may be found near the ground. On the other side the maximum value of VC was 8242 m^2/s which is quite above 6000 m^2/s for afternoon (Figure 7). The mixing height values in morning are less than 500m and therefore the pollution potential of the region is more in morning compared to afternoon. From table 2, it can be seen that average wind speed in the region is above 4 m/s and with even lower values of MH the VC is more because of multiplicative effect of WS and MH.

From figure 8, it can be said that in month of April, region has some days where VC is quite high in afternoon which means higher assimilative capacity during those days. The region has higher average wind speed values for April thereby dispersion of pollutants would be high in those days as well.

In figure 9, data for very few days data was available for estimation of assimilative capacity. From the data which is available it has been observed that afternoon VC values are quite high in October and average mixing height is more than 1000 m. Thus highlighting, that over 1 km space from ground is available for pollutants to disperse.

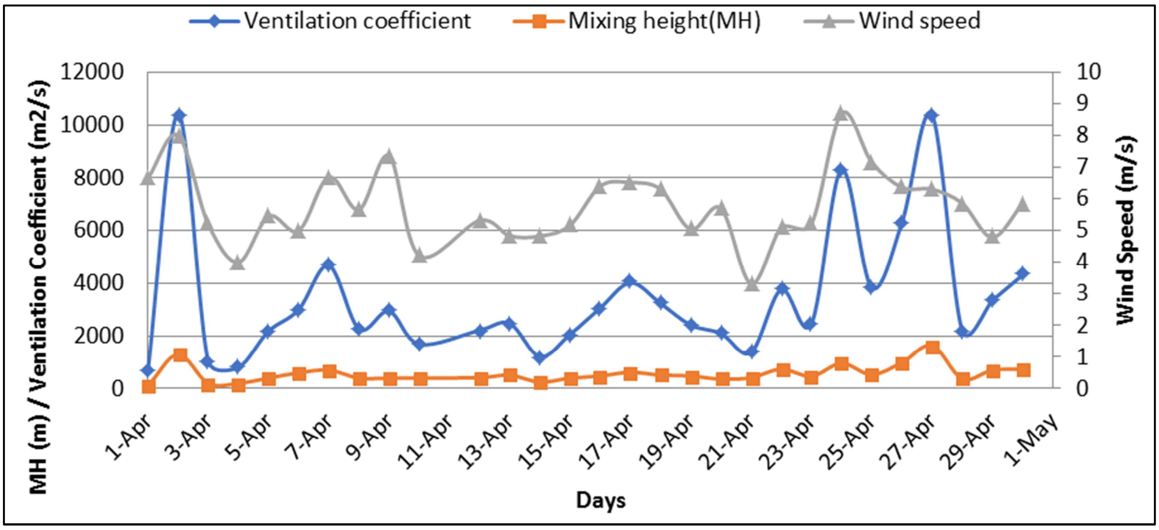


Figure 8. *Variation of Ventilation Coefficient, wind speed and MH for afternoon in Dolvi in April.*

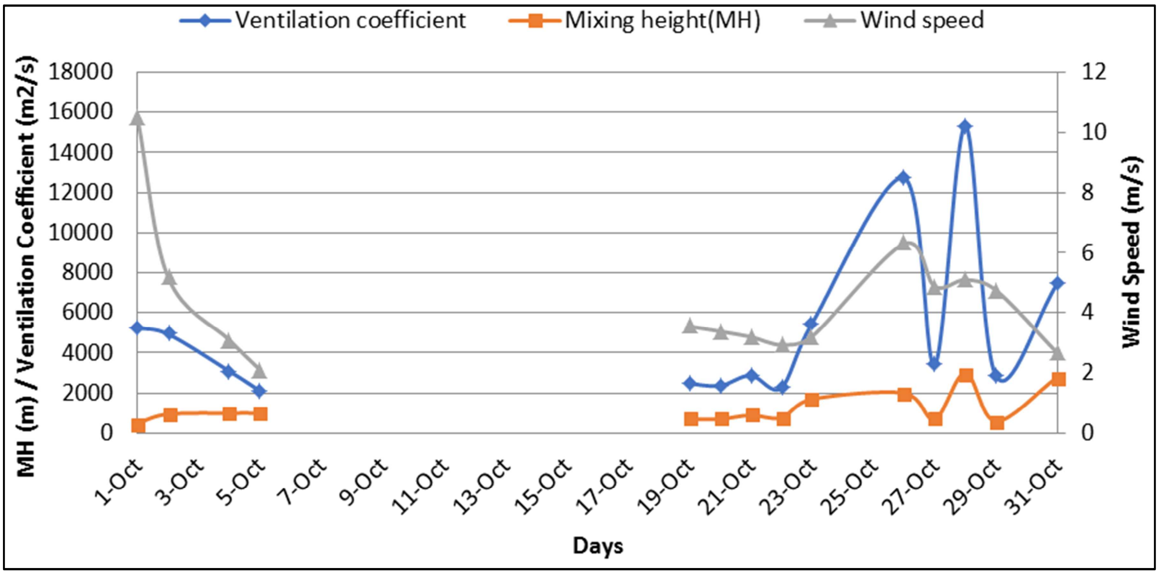


Figure 9. *Variation of Ventilation Coefficient, wind speed and MH for afternoon in Dolvi in October.*

The comparison of VC values (Figure 10) across different months reveals that assimilative capacity is poor in month of February and April and better in month of October. As per the criteria adopted in the present study, the region does not have enough assimilative capacity in month of February and April while for some days in October it has less pollution potential. The assimilative capacity as per the criteria is poor in winter (February) and Summer (April) while it is better in post-monsoon period (October) as high VC values were obtained in this month. The previous studies [17] also show that higher VC values corresponds to better air quality in region. But based on this criterion only, proper conclusions cannot be drawn because it does not give information about the source of pollutants. Also, the data used has only morning and afternoon upper air atmosphere information, hourly variation was not available and also data given by IMD has several missing days thus opening the probability of extreme or lower events missed. Based on this data alone, the safe emission hours cannot be specified to the industries existing in the region.

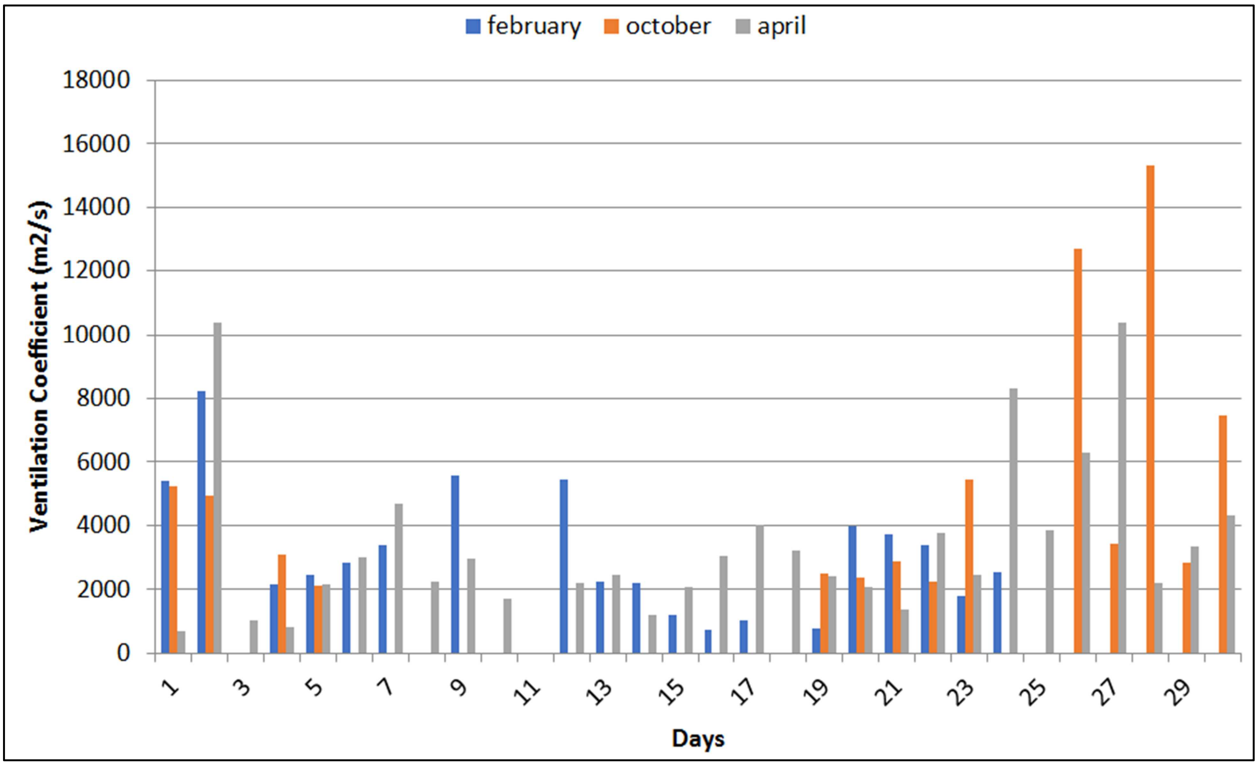


Figure 10. *Comparison of VC values across different months.*

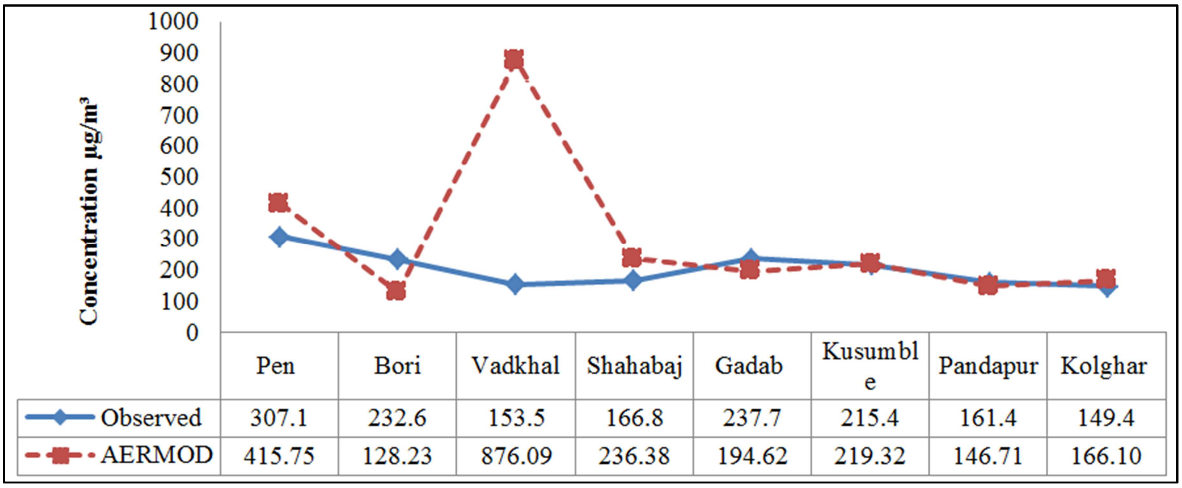
It was found that because of high VC values equal to 15300 m^2/s in October the pollution potential was less. The months of February and April had high pollution potential because of low mixing height as 607 m and 561 m respectively and hence the pollutants were not able to disperse in the atmosphere. Therefore, it is inferred that region has low assimilative capacity in months of February and April while for some days in October it has high assimilative capacity because of higher VC values [4]. The afternoon values of VC across months analysed were higher compared to morning values and hence more pollution can be seen in morning as compared to afternoon.

4.2. Assimilative Capacity Using AERMOD Dispersion Model

The spatial and temporal variation was modelled using AERMOD software for different pollutants for different months. The months were decided based on the monitoring period so that the results can be validated more closely. The dispersion modelling based on emission loads from various emission sources computes the spatial and temporal variation for different pollutants. It considers the meteorology, topography; land use and land cover etc. to compute the spatial variation in pollutant concentration and at the receptors. The discrete receptors are taken as the villages/locations at which the monitoring has been done. As it has already been figured out that the pollutants above permissible standards are PM10 and PM2.5 in the study region. These have been modelled spatially and temporally. Total area of (18 x 18) km^2 was modelled with uniform Cartesian receptor at every 2 km along with discrete receptors.

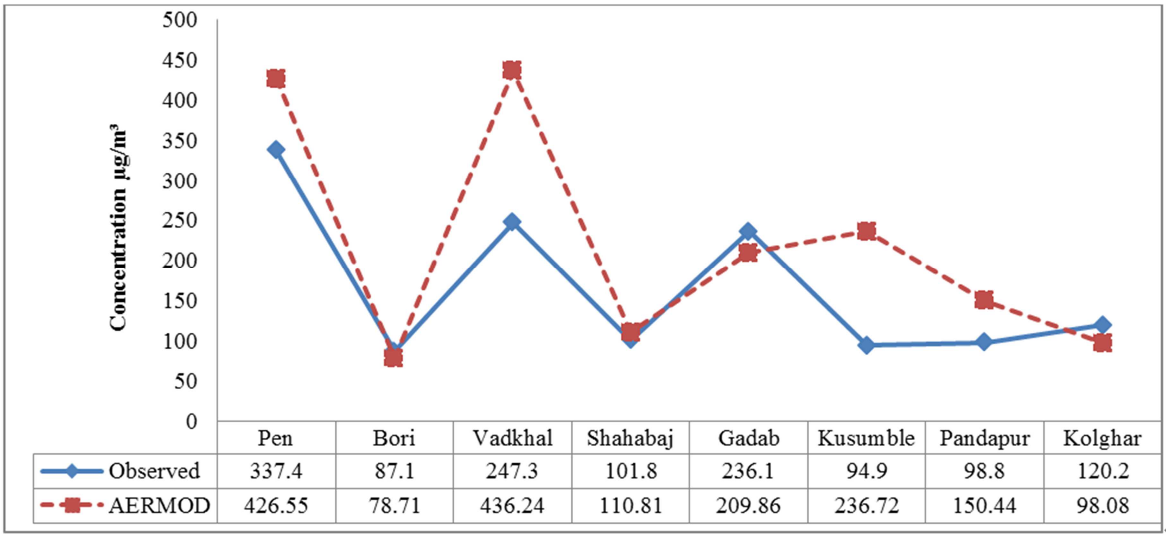
4.2.1. Existing Air Quality

The existing capacity of steel plant is 5 MTPA and the future expansion is planned for 10 MTPA. Therefore, it is important to assess spatial distribution of pollutants for existing operating capacity of plant for different sources separately and validate the results. The main constituent contributing to poor air quality is presence of PM 10 and PM 2.5. The present air quality in the region is a function of point sources i.e. stacks of steel company, area and volume sources accounted under different units of the steel plant and re-suspension of dust from roads (internal and external). To account for contribution from different sources of pollution AERMOD model was run for emissions at 5MTPA which includes all stacks, area and volume sources and the re-suspension of dust was simulated separately. This was done to understand the concentration at receptors due to various sources. The results from dispersion modeling validated with monitoring results for different seasons i.e. winter, summer and post-monsoon. The results for PM10 were validated with concentrations at discrete receptors in all seasons. The comparison of PM10 concentrations with observed and modeled values for different season at discrete receptors is shown in Figure 11 to Figure 13.



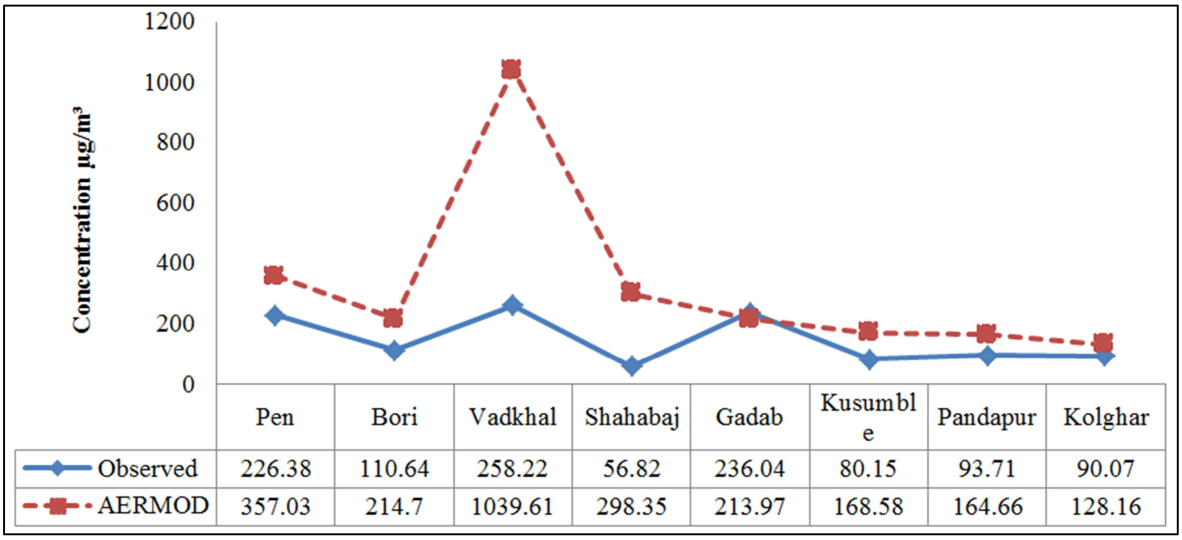
	Pen	Bori	Vadkhal	Shahabaj	Gadab	Kusumble	Pandapur	Kolghar
Observed	307.1	232.6	153.5	166.8	237.7	215.4	161.4	149.4
AERMOD	415.75	128.23	876.09	236.38	194.62	219.32	146.71	166.10

Figure 11. *Comparison of concentrations from AERMOD and observed values for Winter Season.*



	Pen	Bori	Vadkhal	Shahabaj	Gadab	Kusumble	Pandapur	Kolghar
Observed	337.4	87.1	247.3	101.8	236.1	94.9	98.8	120.2
AERMOD	426.55	78.71	436.24	110.81	209.86	236.72	150.44	98.08

Figure 12. *Comparison of concentrations from AERMOD and observed values for Summer Season.*



	Pen	Bori	Vadkhal	Shahabaj	Gadab	Kusumble	Pandapur	Kolghar
Observed	226.38	110.64	258.22	56.82	236.04	80.15	93.71	90.07
AERMOD	357.03	214.7	1039.61	298.35	213.97	168.58	164.66	128.16

Figure 13. *Comparison of concentrations from AERMOD and observed values for Post-Monsoon Season.*

From figure 11 to figure 13 it is inferred that for all the three seasons (winter, summer and post-monsoon) values computed through AERMOD software are closer to the observed values at all the locations except at Vadhkal. This high concentration at Vadhkal obtained from model values may be attributed to the inaccurate emission inventory for vehicular resuspended dust for external roads. This is because the contribution to PM10 concentration from resuspended vehicular movement on external roads was 99.9% in winter season, 89.75% in summer season and 99.87% in post-monsoon season.

4.2.2. Future Air Quality

Steel plant in future is increasing its production capacity from 5 MTPA to 10 MTPA. In this course of process it is important to understand the future air quality or the pollution potential which region will experience due to increase in production and changes in various other emission sources. The future scenario includes increase in number of stacks at 10 MTPA, modification in existing units of 5 MTPA, paving of internal roads by the company. In such scenario the pollution potential of the region needs to be evaluated as the existing air quality in the region is very poor to moderately polluted and in some places for some season is satisfactory as well. The development proposed in the area should not be a source of pollution rather the efficient technologies to be used to reduce emission levels.

Steel plant in order to reduce emissions from different industrial sources has included modifications in units existing at 5MTPA like SMS, BF which are point sources of emission, area sources like Coke Oven and SMS, volume sources like JHs and Conveyor discharges. Materials received from our Jetty located at Dharamatar Creek, which is transported to plant through closed conveyor system. For reduction in fugitive dust emissions due to handling of iron ore & coal, dust extraction and dust suppression systems was installed at suitable locations. Installing a muff in the charging car to guide emissions to the main collection duct in Coke Oven plant. Dust suppression systems at transfer points, open hoppers etc. has been installed. Shed at RMHS yard has been covered and yard sprinklers have also been installed. The speed of all vehicles has been restricted to 20 Km per hour to reduce spillage and dust emissions. Movement of two wheelers and walking inside the plant has been strictly banned. All these arrangements by the plant have been done as a step to reduce fugitive dust inside the plant.

The anticipated change in air quality due to the several modifications has been simulated using software and various scenarios have been generated for steel plant status. These scenarios include improvements carried out for 5 MTPA and technologies adopted for 10 MTPA. Steel plant has informed that the design emission limits for all air pollution control systems of 10 MTPA have been reduced to 10 mg/Nm^3, against the norm of 50 mg/Nm^3. The other changes are paving of internal and external roads in future, reduction in number of HV vehicles on external roads when construction of highway is complete.

4.3. Future Development Scenario and Anticipated Impacts

The company is going to increase its production from 5 MTPA to 10 MTPA and hence the number of stacks will increase from existing approx. 50 at 5 MTPA to approx. 100 stacks at 10 MTPA. There are small industries like Johnson & Johnson Industries Ltd and Nitco Tiles Ltd. in the vicinity of 10 km radius. The emissions from these industries were not modelled due to unavailability of data and hence percentage contribution of particulate matter from these is not known.

The present status of air quality is poor in Dolvi region as analysed at various receptors with high PM 10 concentration. Increase in production capacity of existing industries will increase the pollution load in environment if proper emission control systems are not installed. The results obtained are shown in Table 3.

Table 3. *PM 10 under different scenarios.*

	Combination of scenarios	**PM 10 (μg/m^3)**		
	Major locations	**Near steel plant**	**Pen**	**Gadab**
Existing Scenario	At existing 5 MTPA steel plant after improvements	8.11	0.80	5.00
	Due to internal roads	495.15	No effect	200.00
	Due to external roads	300	500	250
Anticipated Future Scenario	At 10 MTPA as per design standards of 10 mg/Nm^3	3.00	0.10	0.80
	When all internal roads are paved	20.50	No effect	8.00
	When all external roads are paved	304.00	100.00	70.00

From Table 3 it is clear that PM 10 concentration at 5 MTPA after improvements i.e. emissions from stacks is within permissible standards and concentrations due to wind direction are getting accumulated in the south-west side. Concentration of PM 10 as high as 495.15 μg/m^3 in area near plant due to movement of vehicles on the internal roads and hence if conditions of roads are improved in future the fugitive emissions could be controlled.

As per design standards at 10 MTPA, the PM 10 concentration are within permissible standards and if efficiency of design operating conditions are high then particulate concentration from stacks will be less. A future scenario shows that if all internal roads are paved then PM 10 as re-suspension dust can come under permissible standards. With all the external major roads in the study region paved, the PM 10 concentration because of vehicle movement can be reduced by 70% and areas like Pen, Vadhkal can be brought under permissible standards of PM 10 on the other side the region will continue to have high PM 10 concentration even if roads are paved as well.

The future scenarios simulated for the region shows that any additional future development needs pre assessment of pollution loads in the air environment as even after best efficiency to be brought in mitigating the pollution, the PM

10 concentrations will remain high.

5. Conclusions

In this study, assimilative capacity of air environment was assessed through estimation of Ventilation Coefficient (VC) and using AERMOD dispersion model. The estimation of VC values showed that region has less assimilative capacity in months of February and April as VC values are quite low while in month of October the assimilative capacity is more because of high VC values. The assimilative capacity assessed using dispersion model reflected that the major contributions were due to vehicular movement, and it was clear that high pollution load in the region is because of fugitive dust i.e. resuspension of dust due to movement of vehicles. From this study, it was concluded that for assessing the assimilative capacity of any region for air environment upper air atmosphere study should be conducted. This will help in utilizing the natural benefits to mitigate air pollution and thus protecting public health. The fugitive emissions during construction should be accounted while estimating pollution potential of any region. The use of these two ways will help in attributing reasons for poor air quality and will help in defining the duration for which it will continue. This will also help regulatory bodies for managing the air environment in any region.

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