PERIODIC MONITORING OF URBAN OZONE FOR RISK MAPPING IN AND AROUND METROPOLITAN LAHORE

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ABSTRACT: The sustainable urban growth could only be shaped by making people live and work environmentally healthful. The reorientations of technology and risk management are essential tools in sustainable development. The prevailing traffic flow and other urban activities have alarming negative effects on the urban landscapes. They have an acute impact on the residential areas as well as on other land uses like educational institutions, parks, sub-urban areas, etc. The monitoring of O3 as pollutant and its spatial pattern is important to comprehend and forecast environmental pollution in and around the metropolitan areas of Lahore. In this context the study would contribute towards making future policy of the urbanization and planning in relation to the air pollution impacts in the city. The scope of this study is limited to the metropolitan area of Lahore (LDA). The main objective of this was to understand the impacts of urbanization and human induced activities on the air quality of Lahore Metropolitan area by providing ample evidences on various aspects of environmental degradation through the use of geo-spatial technologies. The focus of this study was to monitor, map and calculate the environmental concern of the urban functions on other urban activities. In addition, it would identify major risk areas of O3 in Lahore through cartographic assessment. The identification of risk areas and their spatial pattern would provide the baseline information to the decision-makers which would help to curb down this menace and will save lives and property through improved environmental techniques.

Key words: Urban land use, Periodic sampling, Ozone monitoring, Risk Mapping, Geo-Spatial Techniques.

INTRODUCTION

The developing countries give priority to rapid industrial development. This leads to improve the material quality of life which is resulting in serious environmental deterioration, if it is not carefully controlled. Pakistan is facing serious environmental degradation, especially in the big cities like Karachi, Lahore, Rawalpindi, Peshawar, etc. In Lahore the quality of air is declining to the extreme level, which is badly affecting the citizen's health. Besides job opportunities, Lahore provides lot of facilities, like economic, commercial, industrial, educational, recreational, social and cultural, etc. Hence there is a mobility of huge population towards this city being the capital city of Punjab province as well as second largest city of the country. Eventually, an increased effect is estimated in the quantity of pollutants adding to our environment daily. So, at the cost of economic growth, the quality of life is deteriorating. This serious problem highlights certain issues regarding traffic mismanagement, deteriorating urban land use and emission of air pollutants especially O3. The city is mostly suffering from the inappropriate development in the areas of industry, vehicles traffic and unplanned housing schemes. There is an urgent need to find out the ways and means to manage and control the existing environmental pollution. The core areas of the city are mostly occupied by commercial and residential land uses which have an extra pressure on the adjoining areas. The haphazard industries like marble cutter near Ichrra, shoe factories within the walled city, paint and plastic manufacturing near bund road, vehicular traffic, and slumps are the damaging factors for the current environments of the Lahore metropolitan. The seasonal data of O3 was managed by using ArcGIS 9.3 (ESRI, USA). The gas molecules are collected on an impregnated filter or an absorbent material. "In Portugal during summer and spring seasonal studies showed high contamination of ozone (O3) levels in the air. For the monitoring of Ozone the passive samplers (148 diffusive tubes, one-week exposure) and also the mobile monitoring stations were used" (Monjardino et al, 2007). It is a method for separation of particulates or gases from an air-stream by abrupt collision against a flat surface forming the basis of this method. These sites are selected on the basis of land use or different geographical conditions.

MATERIALS AND METHODS

In this study surveys were conducted periodically (pre-monsoon, monsoon, post-monsoon) and ambient air quality data at various sites of geographical conditions were collected in and around Lahore

metropolitan area fair pollutant (O3) along with relevant meteorological data, *e.g.,* maximum and minimum temperature, absolute humidity, wind velocity, wind direction and sunshine hours. The contamination of O3 was examined through geo-spatial modeling techniques in and around metropolitan Lahore with multidisciplinary components, where the potential state of the risk of air pollution and its agglomeration was offshoot of dynamics in land use and land cover (especially, vegetation, water, open spaces, settlement pattern), population and urban dynamics such as population density, traffic agglomeration, concentration of industries, traffic generators were studied. Air sampling was carried out through WHO certified monitors installed all the year round at main road crossings, residential areas, educational institutions, industrial locations, hospitals, parks and sub-urban places to gather pre-monsoon, monsoon and post-monsoon observations of primary air pollutants such as Ozone. The risk areas were calculated according to the weights and then converted into a vector file through Inverse Distance Weighting (IDW) interpolations. Other interpolation methods were also evaluated like Spline and Kriging for the interpolation. Nevertheless, IDW techniques are meaningful and compact for the true representation of the weights to identify the hotspot areas of the pollutant. The final risk map with spatial characteristics was also considered accordingly.

The potential environmental conditions of Lahore metropolitan areas were identified. Data was adjusted to the logic and spatial distribution of above mentioned each scenario. The projected seasonal (pre-monsoon, monsoon, post-monsoon) emissions data of Ozone was highlighted using GIS platform with IDW techniques. To calculate the true analysis of Lahore metropolitan air pollutants meteorological data fields (sunshine hours, wind velocity, wind direction, humidity, maximum and minimum temperature) of same days were also monitored. In the table no.01 are the mean values of Ozone of each geographical location of the Lahore metropolitan area during the year 2006 with respect to seasons.

RESULTS AND DISCUSSION.

The environmental monitoring system provided not only the short- range but also long-range trends in the air pollution of an urban place. All the record and information regarding air sampling network was useful and helpful in evaluating the proficiency of control measures which exist in air pollution abetments programs at city level. Air pollutant data from monitoring system regarding different seasons and different geographical conditions was very essential for setting future standards of the Lahore metropolitan areas.

Table1. Showing mean values of Ozone (O3) monitored during different seasons (Pre-monsoon, Monsoon, and Post-monsoon) in and around metropolitan areas of Lahore.

Locations	Pre Monsoon Mean	Monsoon Mean	Post Monsoon Mean
Main Road Crossing			
Chouburji chowk	42.80	49.14	**57.42**
GPO chowk	43.88	50.65	**59.32**
Chearing cross	45.17	52.28	**60.29**
Niazi chowk	52.40	59.23	**66.94**
Ghari Shahu	60.50	59.24	**67.07**
Bhatti chowk	44.72	51.30	**60.64**
Shalimar chowk	42.87	49.21	**58.71**
Railway station	50.97	57.25	**65.21**
Multan Chunghi	42.90	49.27	**67.19**
Rang Mahal	44.88	51.20	**69.31**
Defence chowk	49.97	56.25	**64.28**
Kalma chowk	42.23	48.57	**57.60**
Akbar chowk	41.74	48.67	**57.43**
Thokar	41.59	49.24	**64.49**
Yateem Kahna	43.14	52.04	**66.89**
Muslim town	44.00	52.37	**60.94**
Campus bridge	47.52	56.18	**65.24**
Kanchi	49.48	58.28	**67.41**
Fortress stadium	49.31	58.24	**67.42**
Yadgar	46.67	48.82	**57.13**
Educational Institutions			
FC College	61.45	68.14	**76.29**
GC U/Nasir bagh	56.36	61.16	**67.76**
UET	54.54	61.33	**72.01**
GC Edu College TS	53.90	60.47	**77.97**
F J college	58.64	65.87	**74.75**
Hospitals			
Shalimar hospital	64.36	70.37	**81.06**
Children hospital	65.65	71.90	**82.14**
Jinnah hospital	67.90	74.57	**84.44**
Mayo hospital	61.35	67.66	**75.87**
Industrial			
CCL/ASSMY	62.28	71.31	**81.43**
Residential			
Shahdara town	66.31	73.18	**81.86**
Faisal town	65.49	72.24	**83.10**
Model town	65.96	72.36	**82.69**
Ichra	63.93	68.76	**76.73**
Johar town	71.00	76.59	**84.68**
Wapda town	81.34	82.46	**86.60**
Sant Nagar	62.59	69.40	**78.58**
Bagh ban pura	62.64	69.48	**78.85**
Parks			
Ghazhafi stadium	67.56	73.57	**81.77**
Bagh-e-Jinnah	47.67	54.64	**64.31**
Shahi fort/Hozoribagh	49.85	56.61	**66.72**
Shalimar bagh	52.66	59.73	**69.46**
Gulshan-e-Iqbal	44.68	51.89	**61.34**
Model town park	49.67	56.63	**66.59**
Race course	47.38	54.27	**63.64**
Jahangir tomb	77.40	83.83	**93.45**
Begum kot	77.69	83.45	**92.91**
Harbanspura	73.06	78.93	**88.51**
Shauket Khanum	79.58	84.61	**95.09**

Pre-monsoon variations of O3: In pre-monsoon season (15th April to 30th June) the lowest concentrations of the mean of O3 values were found during the year in the metropolitan areas of Lahore. The highest concentrations of O3 were found, i.e., 81.34 ppb in Wapda Town and 79.58 ppb in and around Shauket Khanum. As we observed the extremely high cluster of O3 around these sites (sub-urban places of Lahore) as shown in Fig. 1 and reported in Table. 1. The lowest concentrations near main road crossings, i.e., 41.59 ppb near Thokar and 41.74 ppb near Akbar Chowk were monitored and were observed/ highlighted in extremely low to low contamination zones.

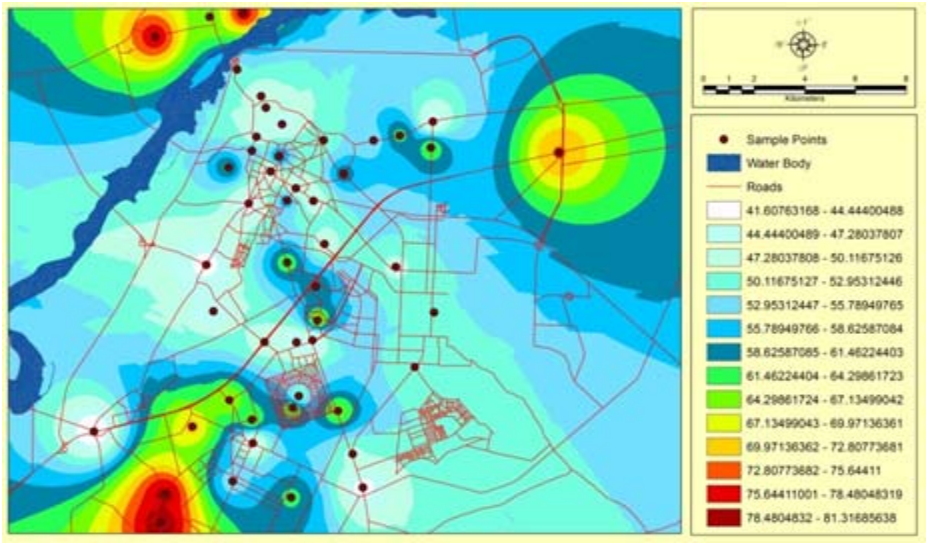

Figure 1. Showing pre-monsoon variations of O3 around sample sites

Monsoon variations of O3: In monsoon season (01st July to 31 August) the lowest to moderate contamination of O3 during the year in the urban air of Lahore was found. During monsoon the highest concentration of O3 was found at Suburban areas, i.e., 84.61 ppb near Shauket Khanum and 83.83 ppb in and around Jahangir Tomb. As we observed the extremely high cluster of O3 around these sites (sub-urban places of Lahore) are shown in Fig. 2 and reported in Table. 1. The lowest concentration of O3 was found at Kalma Chowk, i.e., 48.57 ppb and 48.67ppb near Akbar Chowk and could be observed/highlighted in extremely low to low contamination zones.

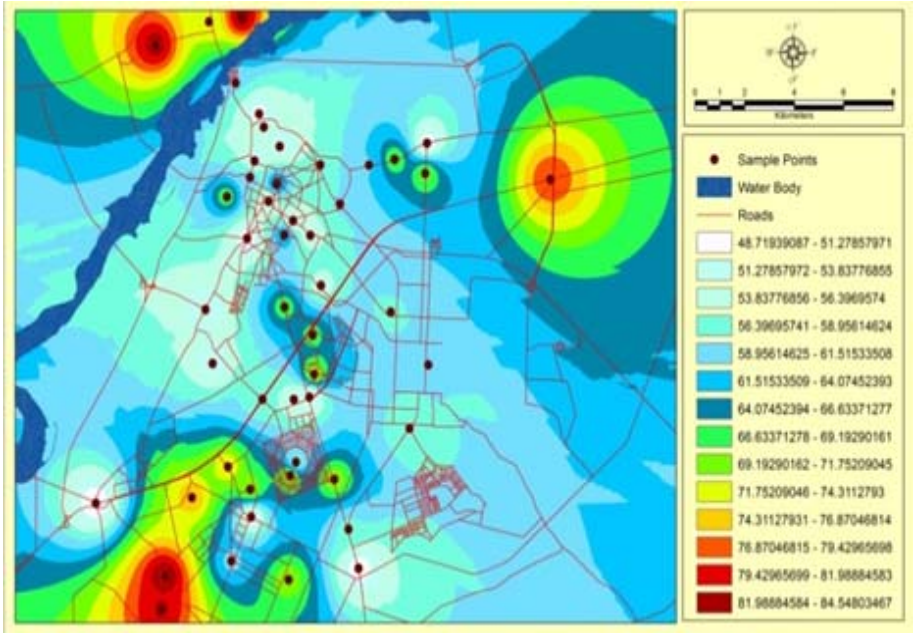

Figure 2. Showing Monsoon variations of O3 around sample sites.

Post – monsoon variations of O3: During post-monsoon (01st September to 31st October) the moderate to highest concentration of O3 in the season as well as in the year in the metropolitan areas of Lahore was found. The highest was observed at Shuaket Khanum i.e., 95.09 ppb and 93.45 ppb near Janghir Tomb, which were the sub-urban areas of Lahore. As we observed the extremely high cluster of O3 around these sample sites as shown in Fig. 3 and reported in Table.01. The lowest concentration was found at Yadgar, i.e., 57.13 ppb and 57.43 ppb in and around Akbar Chowk, which were the main road crossings of Lahore monitored and observed/highlighted in extremely low to low contamination zones.

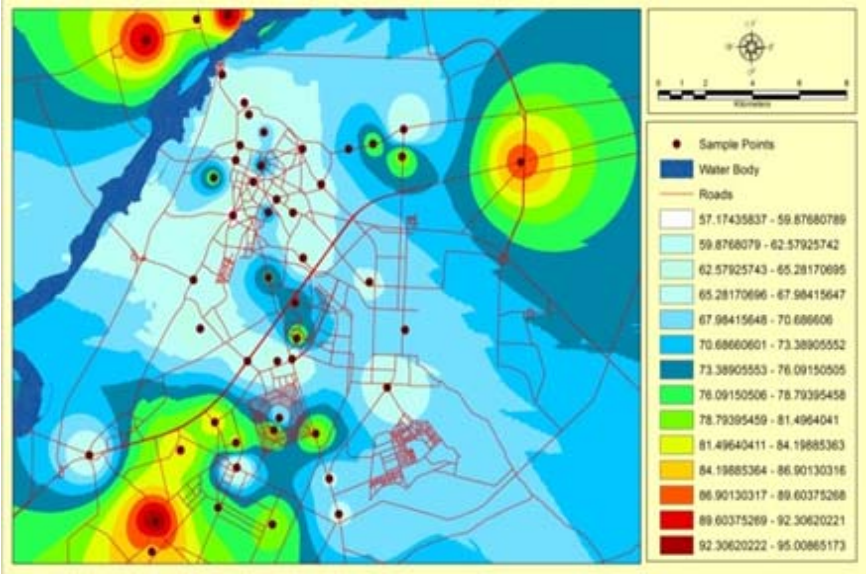

Figure 3. Showing post-monsoon variations of O3 around sample sites.

In present study during 2006 monitoring system was selected with respect to the seasons, i.e., pre-monsoon, monsoon, and post-monsoon for the survey of air pollutant.

- It was concluded that these data systems gave meaningful information technology of ArcGIS 9.3 with the mapping component of IDW for the assessment of air quality. The study also highlighted that the digital mapping of air pollutants exposing the pollution impact analysis also included a dimension to the influenced areas and population.
- This study also provides a foundation for traffic planning and urban developmental projects and also for the sustainable urban environment.
- The purpose of the study was to lay the foundation for the Lahore urban areas air quality information, mechanized management system and future environmental models which could be helpful or useful for local and regional authorities for urban management and planning, as well as other areas of future strategies.

This study has created a baseline for the issue of visibility by conducting air pollutant surveys with respect to seasons. In 2002 the result concluded that pregnant women exposed to high levels of ozone and carbon monoxide were ten times more likely to give birth to infants with serious heart defects. The monitoring of air quality was crucial for the control of air pollution on effective grounds. “In Asian cities, it was analyzed that in general, SO2, NO2, O3 and Particulate Matter (PM) are urban pollutants responsible for most of the potential damage” (WHO, 1992).The main goal of this environmental monitoring system was to establish the standards for the accurate record and information on selected air contaminants for the stakeholders both public and private sectors to avoid a general catastrophe. A sustainable community was characterized by the habits and traits it keeps, so these were the indicators of a sustainable community development. In previous research conducted by (Lodhi 2007) reported, “diurnal variations of pollutants and traffic density at different geographical locations were monitored during the seasons. The study covered by measuring values on 48 hours basis, on each averaged value for 24 hours and maximum average concentrations were compared with the standard limits. Similarly, such studies were also conducted at Karachi (Kazmi, et al., 2010 and Arsalan, 2003).

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