GIS Based Carbon Dioxide Concentration Research in ITU Campus, Istanbul –Turkey

HayriHakan DENLI, Dursun Zafer SEKER and Sinasi KAYA, Turkey

Key words: Carbon dioxide, ITU Campus, GIS

SUMMARY

Clean air and clean water are the basic requirement of life. Getting fresh air in the developed areas especially in the megacities like Istanbul is more difficult than rural areas. The quality of fresh air inside buildings is essential component for health and wellbeing for the people who lives in. Hazardous substances emitted from buildings and vehicles like Carbon monoxide and Carbon dioxide may lead to a broad range of health problems. Thus, measuring and mapping of these parameters are extremely important to get precautions to increase the life quality.

In this study, Istanbul Technical University main campus was selected as study area. It is located near by the heart of the commercial area with the approximate population of 30K including students and stuff. At the 80's, the neighborhood of the campus was totally covered with the forestry areas and small buildings which wereconverted to skyscrapers later on. The area now is housing many national and international companies in these huge skyscrapers at the northern part adjacent with a road of high traffic intensity. The other parts of the campus are either surrounded by squatter's house or roads which can be classified as heavy traffic. As the indoor air quality is directly depend on to outdoor gas component. The study focused to find out the distribution of Carbon dioxide levels in and around the campus. GIS based distribution maps were realized using daily measured parameters in the campus on 30 stations. GIS based spatial analyses have been carried out to display the distribution level of the Carbon dioxide concentration.

GIS Based Carbon Dioxide Concentration Research in ITU Campus, Istanbul –Turkey

HayriHakan DENLI, Dursun Zafer SEKER and Sinasi KAYA, Turkey

1. INTRODUCTION

Air pollution can be described as the introduction ofchemicals, particulates, biological materials, or other harmful materials into the Earth's athmosphere, possibly causing disease, damage to other living organisms such as food crops, or the natural or built environment.
An air pollutant is a substance in the air that can have adverse effect on humans and the ecosystem. The substance can be solid particles, liquid droplets or gases. A pollutant can be of natural origin or man-made.

In the past, before the cities, nature's own systems kept the air fairly clean. Wind mixed and dispersed the gases, rain washed the dust and other easily dissolved substances to the ground and plants absorbed carbon dioxide (CO_2) and replaced it with oxygen (O_2).With increasing urbanisation and industrialisation, humans started to release more wastes into the atmosphere than nature could cope with.Since then, more pollution has been added to the air by industrial, commercial and domestic sources. As these sources are usually found in major cities, the gases that are produced are usually concentrated in the air around them.Air pollutants mainly occur as a result of gaseous discharges from industry and motor vehicles. There are also natural sources such as wind-blown dust and smoke from fires.

The aim of this study is to investigate the carbon dioxide and carbon monoxide (CO_2)level in the main campus at ITU.

2. OVERWIEW

Carbon dioxide is naturally present in the atmosphere as part of the Earth's carbon cycle (the natural circulation of carbon among the atmosphere, oceans, soil, plants, and animals). Human activities are altering the carbon cycle-both by adding more $CO_2$to the atmosphere and by influencing the ability of natural sinks, like forests, to remove $CO_2$from the atmosphere. While CO_2emissions come from a variety of natural sources, human-related emissions are responsible for the increase that has occurred in the atmosphere since the industrial revolution. The main human activity that emits CO_2 is the combustion of fossil fuels (coal, natural gas, and oil) for energy and transportationand cement production, although certain industrial processes and land-use changes (e.g. conversion offorestinto agricultural land) also emit CO_2(URL 2).The concentration of CO_2 in the atmosphere has risen from close to 280 partsper million (ppm) in 1800, at first slowly and then progressively faster to a valueof 367 ppm in 1999, and now to 398 ppm (Beck 2007, URL1)The outdoor concentration of carbon dioxide can vary from 350-400 parts per million (ppm) or higher in areas with high traffic or industrial activity. As CO_2 is also a product of humans respiration, CO_2 concentrations

indoors can vary from several hundred ppm to over 1000 ppm in areas with many occupants present for an extended period of time like classes or offices where outdoor air ventilation is limited (URL 3).

The level of CO_2indoors depends upon:

- the number of people present,
- how long an area has been occupied,
- the amount of outdoor fresh air entering the area,
- the size of the room or area,
- the outdoor concentration.

As the first four cases are difficult to change or modify, the indoor CO_2 concentration may only be controled with outdoor fresh air. The importance of outdoor fresh air with low CO_2 content lies here.

3. ITU CAMPUS AND ITS LOCATION

Istanbul Technical University, referred to as ITU is an international technical university located in Istanbul, Turkey. ITU was established in 1773, during the time of the Ottoman Sultan Mustafa III. With its original name "Muhendishane-i Bahr-i Humayun", The Royal School of Naval Engineering, its responsibility was to educate chart masters and ship builders. It is one of the world's oldestuniversities dedicated to engineering sciences, and is one of the most prominent educational institutions in Turkey. Now, the university has five different campuses in the heart of Istanbul with thirteen faculties and six research instituteswith about30K people including students and stuff.

Together with the main one, four campuses of ITU lie at the European site of Istanbul.The main campus area is surrounded by many national and international companies in huge skyscrapers at the northern part adjacent with a road of high traffic intensity. The other parts of the campus are either surrounded by squatter's house or roads with heavy traffic. Therefore some parts of the campus are expected to have higher level of carbon dioxide.

4. MEASUREMENTS

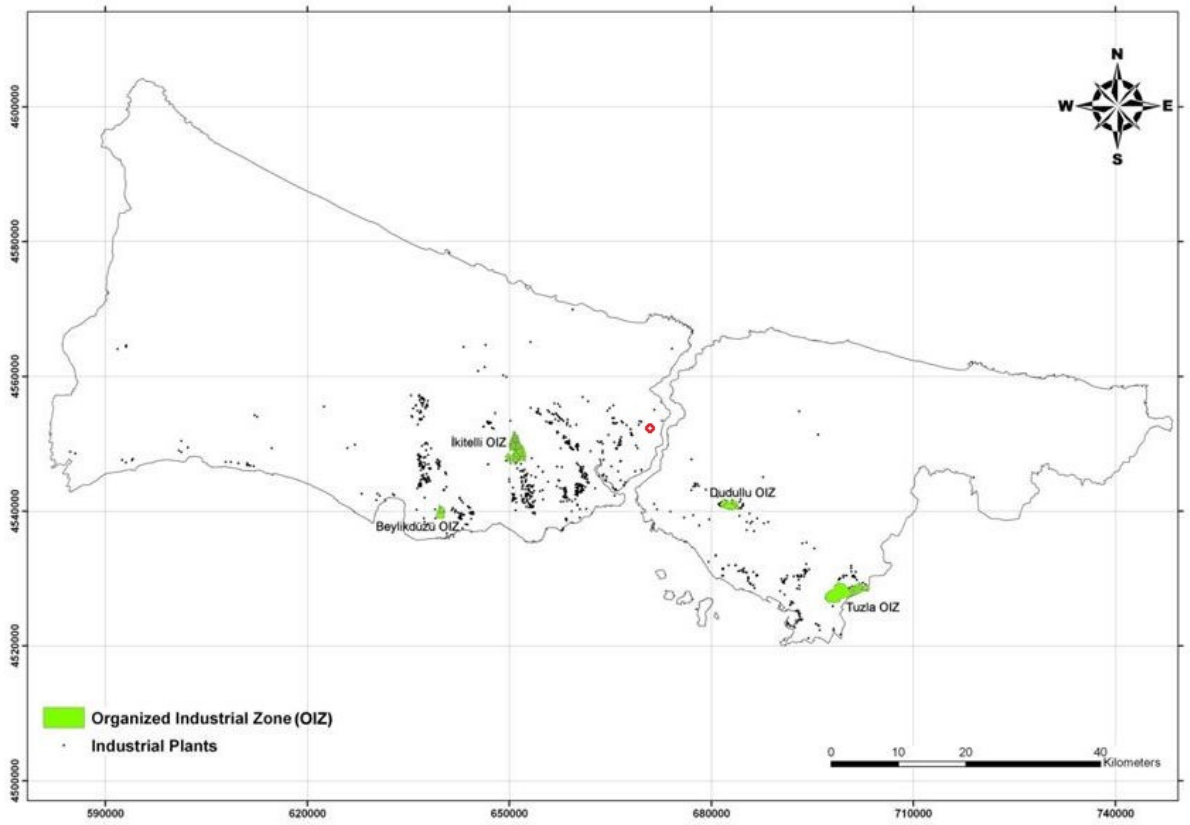
In this study, Istanbul Technical University main campus, having an area of1.69 km^2, was selected as the study area. The aim was to find out the carbon monoxide and carbon dioxide levels within the campus. Five measurement series on five different days has been carried out on 30 selected measurement points with a portable CO-CO_2measurement instrument of Delta Ohm. Inorder to find out the concentration correlations, the measurements have been carried out on different paths. Point of interest include student social center, campus residents, student dormitories, kindergarten, elementary school, high school,areas with dense trees, some randomly selected points and main entrances to the campus. Measurements have been tried to makeby the shortest time in order not to become time dependent CO_2

undulations.Thus, measurements have been performed on similar atmospheric conditionwith a temperature between 12 ^{0}C and 17 ^{0}C.

5. RESULTS AND DISCUSSION

Istanbul houses more than 850 number of industries mainly distributed to the south of ITU main campus (Figure 1). This means that north winds brings fresh or clean air to the city and ITU campus, and south winds will take the contaminated air from those industrial zones. This means that the wind direction plays important role for fresh air at parts of the city.

Figure 1. Locations of industrial plants and the organized industrial zones (URL 4).



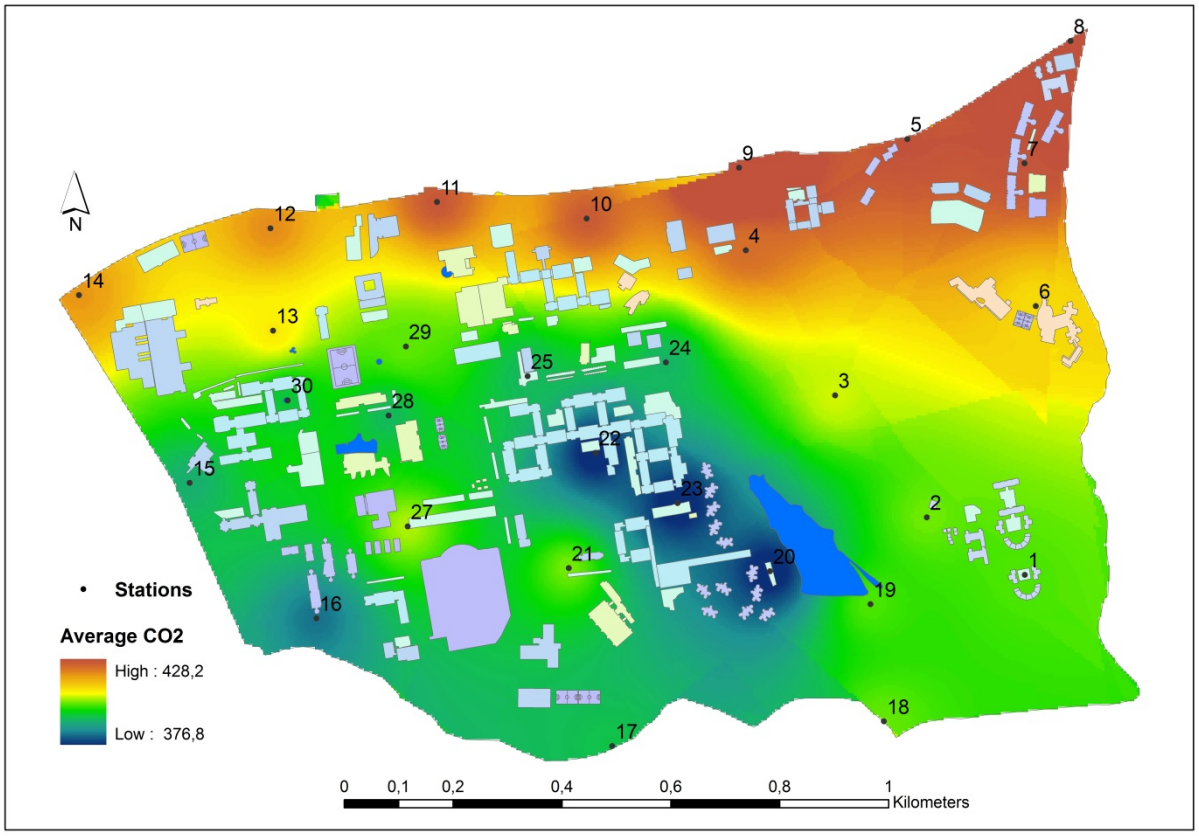
CO_2 concentration at ITU campus has been measured and analyzed at 30 points. Daily average and point average concentrations have been calculated. Daily campus averages varies between 389 ppm and 408 ppm. Point averages have instead a wider variation cycles between 377 ppm and 428 ppm. Highest average concentration has been captured at point 8. Actually this point lies at the end of the ITU property boundaries and very close to one of the main entrance of the university. This point can be seen as the most upright corner of the figure 2. ACO concentration of 2 ppm on one day has only been discovered at point 14. As stated before, atmospheric conditions have not been considered.Feature research will be done especially considering the wind power and direction.Seasonal changes because of respiration and photosynthesis or diurnal variations may also be considered.It will also be expanded with

measurement points lying outside the campus.

6. CONCLUSION

ITU campus has a CO2 concentration distribution decreasing from north to south. Orange collared highest concentrations have been found at the northeast of the campus, adjacent to a road of high traffic intensity. There are lying the main entrances to the campus (points 14, 12, 11, 10, 9, 5, 8), the institute of energy, KOSGEB laboratory and ari science park buildings (point 4, 5, 7) and the valley student housing area (point 7).

Figure 1. CO2 concentration distribution at ITU campus



The blue collared area shows lower concentration of CO_2. There is lying the faculty of chemical and metallurgical engineering (station 22), faculty of naval architecture and ocean engineering and lakeside student dormitory (station 23) and the second part of lakeside student dormitory (station 20). The light blue area at southwest part of the campus numbered 16 is also an area of Ayazağa student dormitory.

In future, measurements of the CO2 will be continue to present the daily, annual and seasonal changes of CO2 distribution at the main campus. If the meteorological data obtained for the simultaneous measurement, correlation between CO2 measurements and these parameters

will be established. Different geostatistical methods will be applied and the most proper distribution method will be determined.

REFERENCES

- Beck, E.G., 2007, 180 Years of Atmospheric CO2 Gas Analysis by Chemical Methods, Energy and Environment, Volume 18 No2, 258—282, Brentwood, Multi—Science Publishing Co. LTD.

- URL 1, Atmospheric CO2 measurements by the Scripps CO2 Program at the Mauna Loa Observatory in Hawaii, http://co2now.org/current-co2/co2-now/, last accessed on 11.03.2014

- URL 2, EPA, United States Environmental Protection Agency, http://www.epa.gov/climatechange/ghgemissions/gases/co2.html#Trends, last accessed on 11.03.2014

- URL 3, MDH, Minnesota Department of Health, http://www.health.state.mn.us/divs/eh/indoorair/co2/, last accessed on 11.03.2014

- URL 4, Istanbul Metropolitan Municipality, http://www.ibb.gov.tr/sites/airqualistanbul/Documents/emission.htm, last accessed on 11.03.2014

BIOGRAPHICAL NOTES

Associate Prof. Dr. HayriHakanDenli works at Faculty of Civil Engineering, Geomatics Division at Istanbul Technical University. He holds BSc Eng., MSE and a Ph. D. in Geodesy and Photogrammetry Engineering from Istanbul Technical University. His current research interests included deformation analysis and calibration of GNNS receiver antennas.

CONTACTS

Associate Prof. Dr. H. HakanDenli
Istanbul Technical University
ITU Civil Engineering Faculty, Department of Geomatics
34469 Maslak-IstanbulTURKEY
Tel. +902122856661
Fax + 902122856587
Email:denli@itu.edu.tr
Web site: http://akademi.itu.edu.tr/denli/

Prof. Dr. Dursun Zafer Seker
Istanbul Technical University
ITU Civil Engineering Faculty, Department of Geomatics
34469 Maslak-IstanbulTURKEY
Tel. +902122853755
Fax + 902122856587
Email: seker@itu.edu.tr
Web site: http://web.itu.edu.tr/~seker/

Associate Prof. Dr. Sinasi Kaya
Istanbul Technical University
ITU Civil Engineering Faculty, Department of Geomatics
34469 Maslak-IstanbulTURKEY
Tel. +902122856100
Fax + 902122856587
Email: kayasina@itu.edu.tr
Web site: http://akademi.itu.edu.tr/kayasina/