# OBSERVE COMPETITION

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**www.observe-fp7.eu**

We hereby accept the rules of this competition as contained in the OBSERVE website (http://www.observe-fp7.eu).

## Research of NO2 pollution in Europe

### 1. Introduction

This paper was conducted for the purposes of the Observe competition "Promoting use of Earth Observation Data for the social benefit of the Balkans". The programs that were used are Panoply, ArcMap 10 and ERDAS 2011. The data that was given was multidimensional tables in NCDF format for each day and hour for the years 2007-2011 showing the concentrations of NO2, O3 and Particulate Matter(PM).

### 2. Data

The data used was multidimensional tables (NCDF files) and their derivatives obtained from Panoply (maps in png format). Indicatively, those maps that were selected to be studied were those that shown NO2 emissions for each Wednesday in March 2010 for the 12th hour, due to the possibly higher concentration of pollutants in the middle of a workweek.

Nitrogen dioxide (NO2) is very toxic by inhalation. It is mainly produced by vehicles, has a bad odor and is responsible for the reddish color of the city's atmosphere. (Wikipedia and "Notes on pollution and chemistry of the atmosphere" – Dr. Zanis Prodromos Geology department A.U.TH.)

### 3. Data processing and products

At first, according to the instructions given by the competition, Panoply was used to create images in .png format of the chosen days and hour. Then, with the command Surfacing Tool in ERDAS 2011, the png(RGB) image files were transformed in raster files in grayscale, so that ArcMap can read them as attribute tables with x, y, z columns, where x and y shows the position of pixels and z indicates their value in the grayscale. Then, images were scaled in GGRS '87 according to length measures taken from Google Earth. Finally, the pixel values were classified in 8 classes, according to their intensity in grayscale, contours were created and their area was calculated, as well as the main centers of pollution were identified. Detailed steps are presented below:

3.1. Data collection and Panoply

− Data collection - downloaded data from the Observe server (http://www.observe-fp7.eu/).
− Opening the NCDF files in Panoply, selection of pollutant (NO2), day, time and European coordinates according to the instructions of the competition.

- Selection of grayscale for the indications of pollution. Removal of the European coastline and meridians that were unnecessary information. Although the images were in grayscale, they remained in RGB format.
- Export image in png file.
- Export an image without any indication of pollution with only borderlines and coastlines to use it as a background.

## 3.2. ERDAS 2011

- Input png files into ERDAS via the command "Terrain->Terrain Preperation-> Surfacing Tool->Read New Data" in order to construct a table with x, y, z columns.
- Use of "Perform Surfacing" command by Linear Rubber Sheeting in order to convert the table that was constructed into a raster file.

## 3.3 Arc Map 10

- Input of raster into ArcMap and perform a classification (8 classes) from Properties -> Sympology ->Classified.
- Goreffering of background to GGRS '87 using measurements of length and width (km) from Google Earth.
- Goreffering raster images according to background to GGRS '87
- Creation of contour lines with the tool Contour (3D Analyst) for each raster with Contour Interval 30 (change in grayscale - 255/30≈8 classes). Contour Interval 30 was selected due to the fact that the scale meter in Panoply had 16 different colors/classes but that would produce too many contours, so by choosing 8 classes the amount of contours was halved. In the end, though, the scale meter in Panoply didn't have stable width, so the exactly value of the contours couldn't be accurately calculated.
- Removal of unnecessary contours manually (low values)
- Calculation of the areas of contours in the Attribute table for each shapefile via the command Calculate Geometry.
- Identification of contours' centers into a point shapefile. (Fig. 1-5)
- Joining the centers with line and creating of three Graduated Symbols to highlight the three centers.  (Fig.6)
- Clip the background with the tool Clip (Data  Management) in order to keep only the map (removed title and scale meter)
- Creation of final map with title, legend etc. and exportation of it to png.
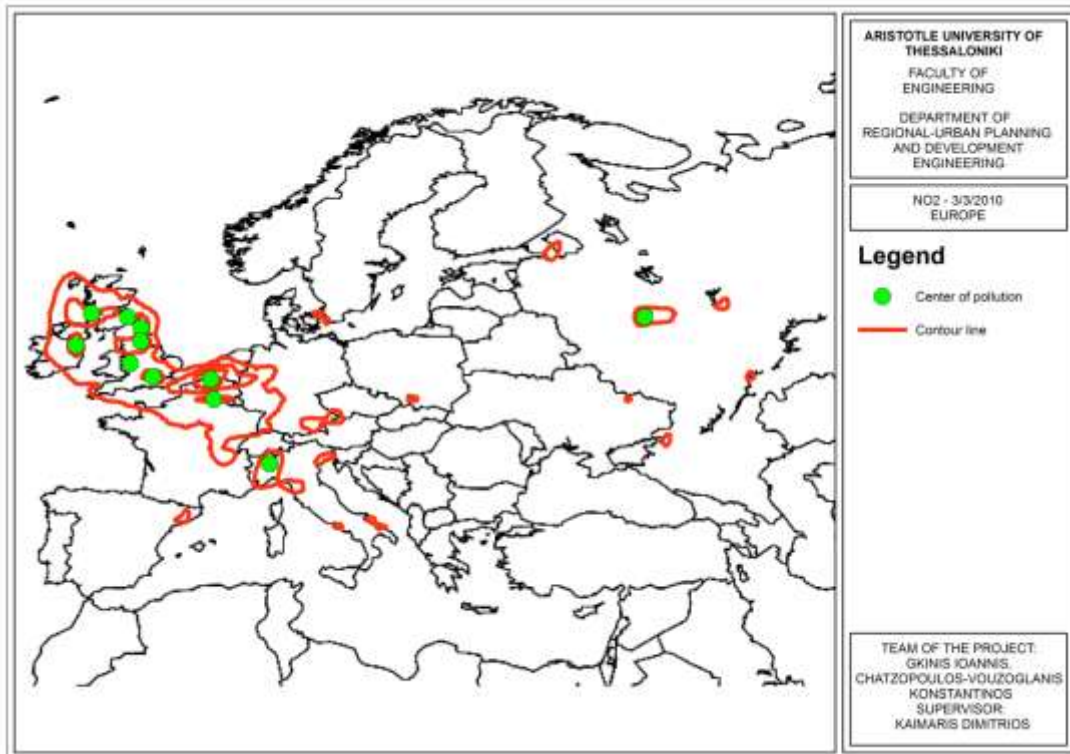
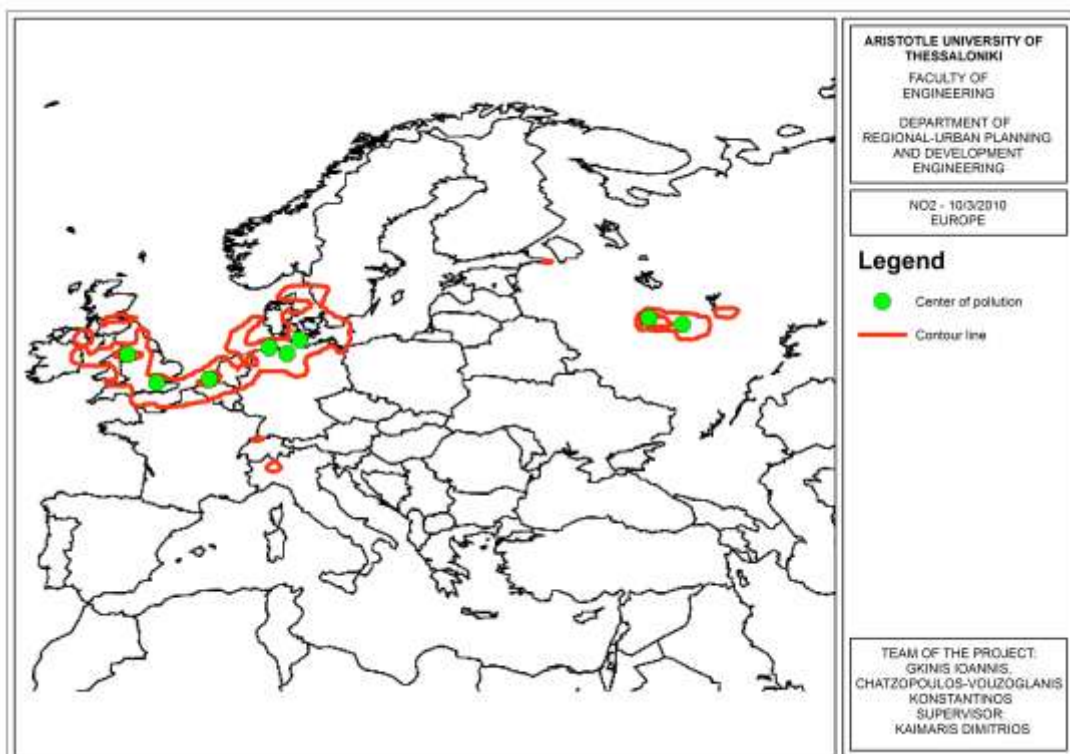Fig.1. Map of Europe, 03/03/2010, NO2 pollution



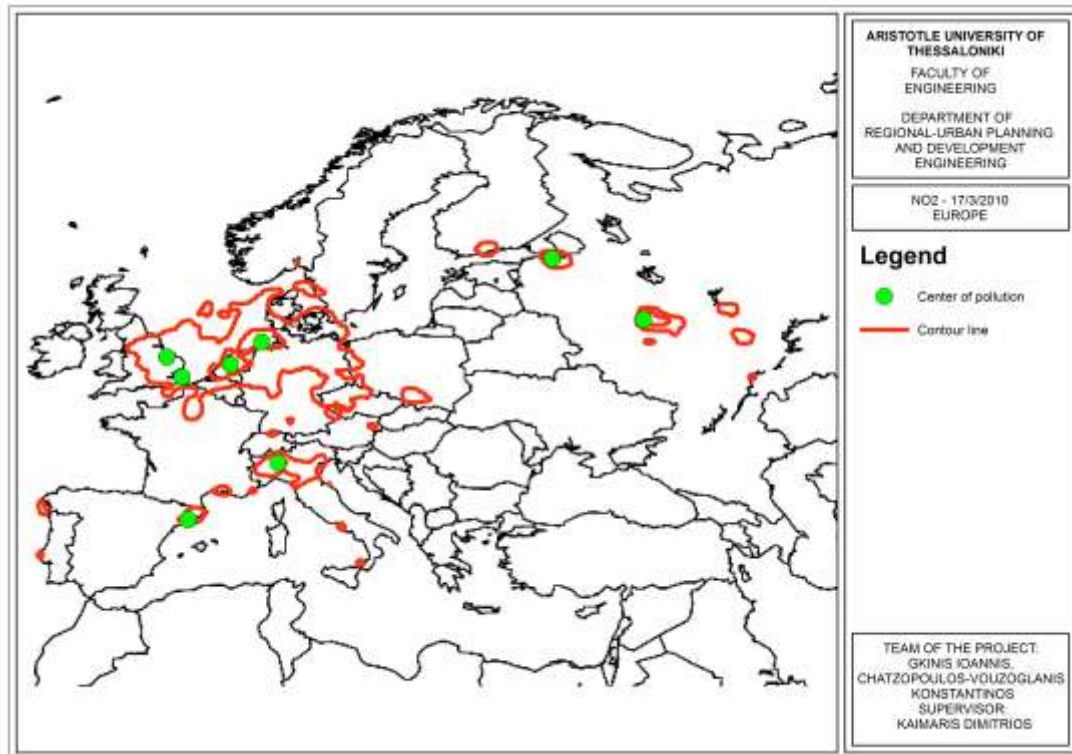Fig.2. Map of Europe, 10/03/2010, NO2 pollution

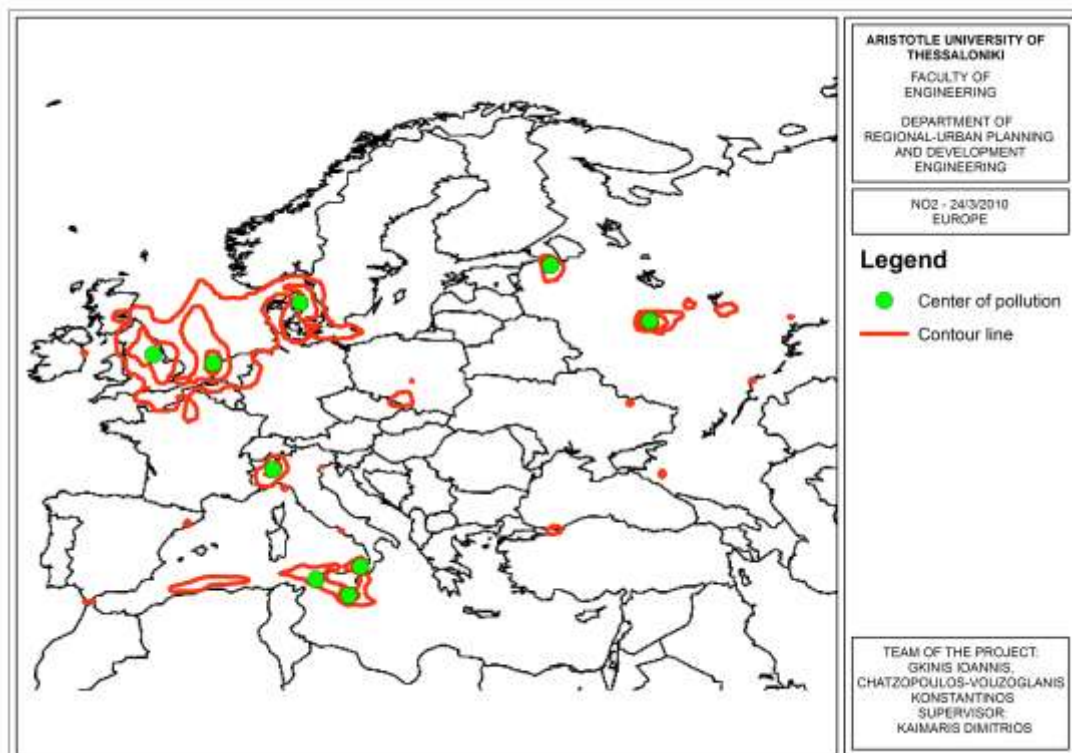Fig.3. Map of Europe, 17/03/2010, NO2 pollution
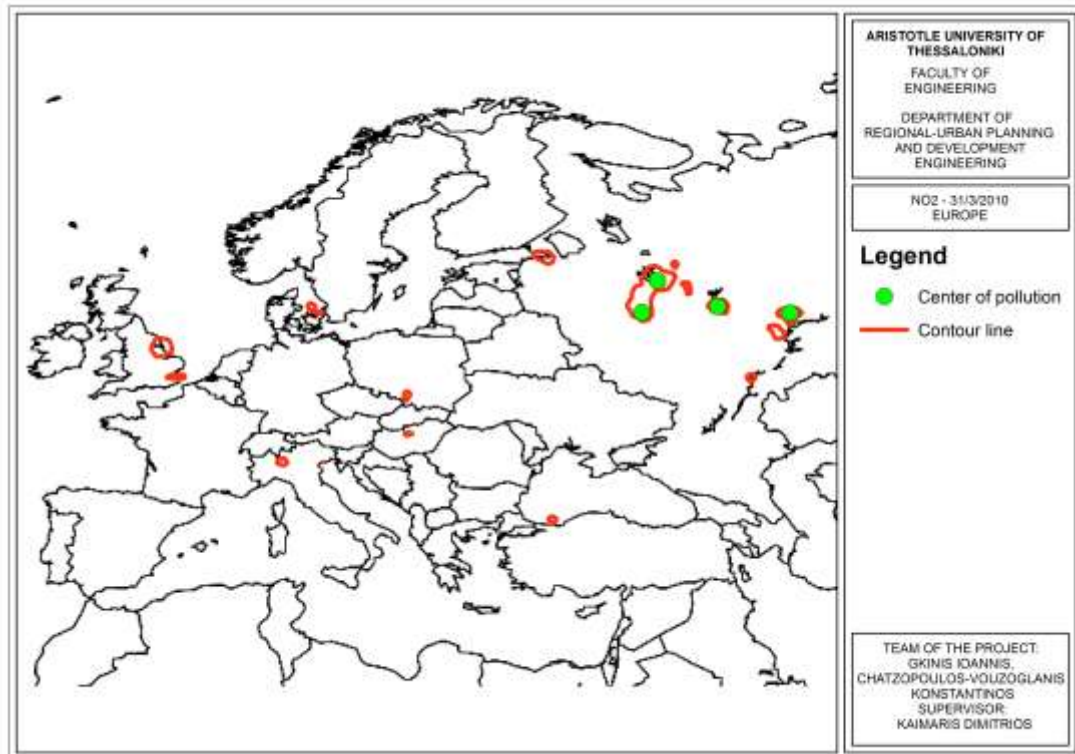


Fig.4. Map of Europe, 24/03/2010, NO2 pollution
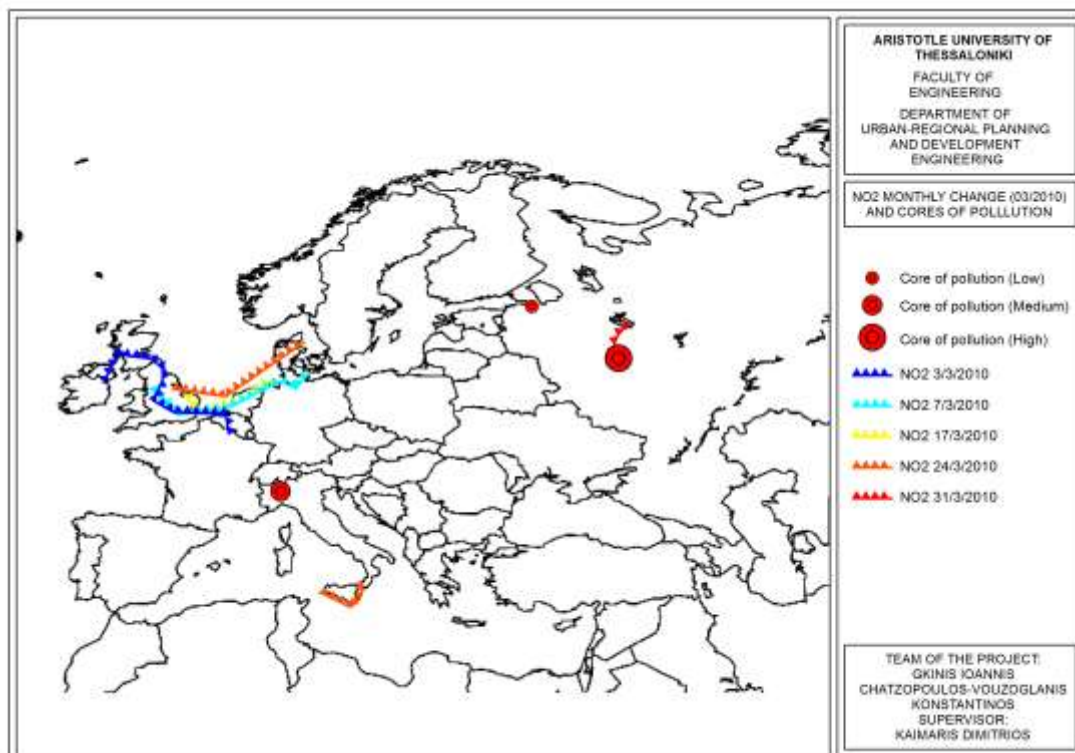
Fig.5. Map of Europe, 31/03/2010, NO2 pollution



Fig.6. Map of Europe, Cores of pollution, All the Wednesdays of March for the year 2010

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Table 1. Over time area change in polluted areas in European countries and cities

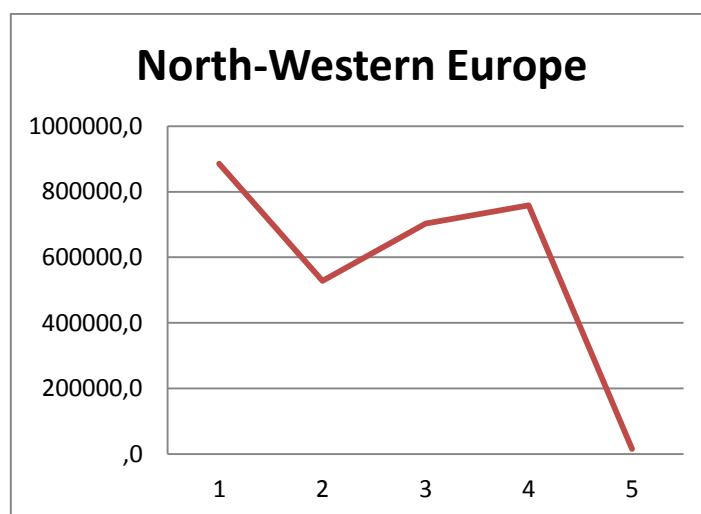| | Km$^2$ per day | | | | |
|---|---|---|---|---|---|
| | 3/3/2010 | 10/3/2010 | 17/3/2010 | 24/3/2010 | 31/3/2010 |
| North-West Europe | 885.536 | 528.204 | 702.551 | 758.110 | 15.789 |
| North Italy | 49.898 | 3.477 | 58.388 | 30.683 | 0 |
| Moscow | 26.080 | 71.052 | 38.287 | 36.553 | 59.269 |
| Nizhny | 0 | 8.306 | 0 | 0 | 9.842 |
| St. Petersburg | 8.298 | 712 | 16.574 | 19.851 | 7.382 |
| Sicily | 0 | 0 | 0 | 78.332 | 0 |
| Franco-Spanish borders | 0 | 0 | 13.796 | 0 | 0 |



Chart 1. Areas of NO2 pollution in Km$^2$ in North-Western Europe per Wednesday
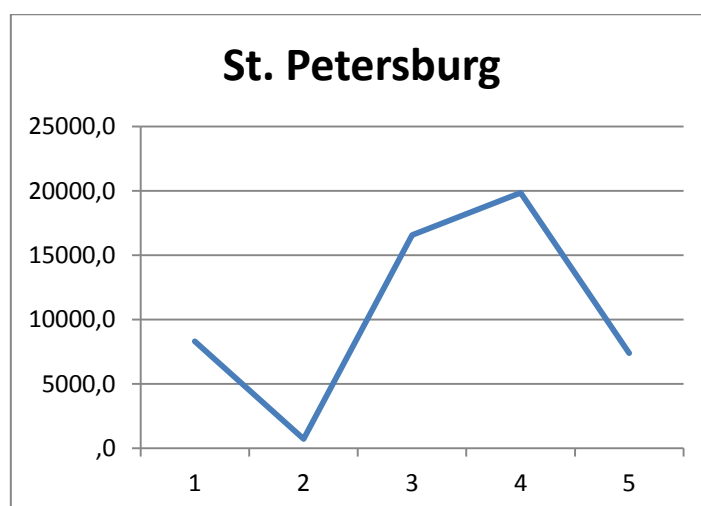


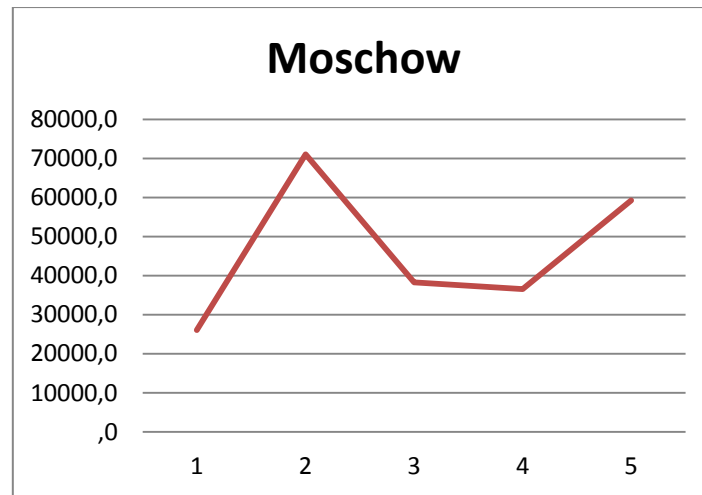Chart 2. Areas of NO2 pollution in Km$^2$ in St. Petersburg per Wednesday

**Moschow**

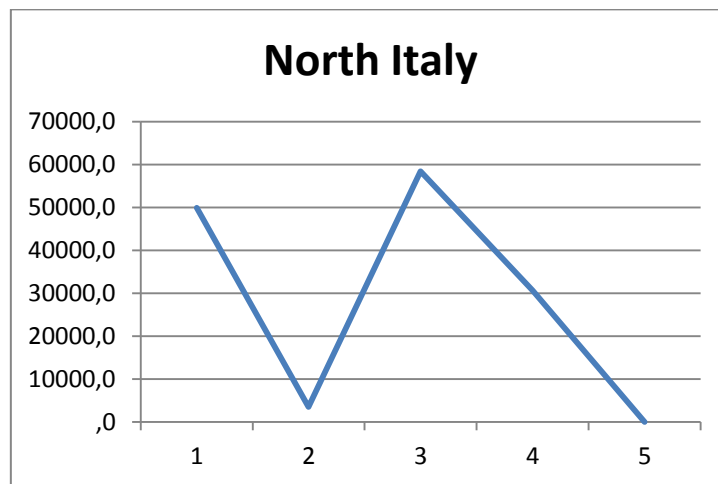Chart 3. Areas of NO2 pollution in Km$^2$ in Moscow per Wednesday

**North Italy**

Chart 4. Areas of NO2 pollution in Km$^2$ in North Italy per Wednesday

## 4. Conclusions

The conclusions extracted by studying the maps (Fig. 1-6), are that there are areas where NO2 concentrations are changing spatially over time, while there are areas where static cores are spotted.

More specifically, the zones of influence of NO2 in Western Europe are moving eastward over time, with the most important cores in Southeast England, the Benelux countries and Northern Germany and Denmark. Indications for England remain stable throughout the month.

Furthermore, in Northern Italy and Russia (Moscow and St. Petersburg) the concentrations appear not to follow any particular direction, but create static cores,

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perhaps due to the increased industrial activity of the Italian North and Moscow and the port of St. Petersburg.

Finally, there is an increase of NO2 areas in St. Petersburg and Moscow, while in North-West Europe and Italy are being reduced over the weeks.

## 5. Acknowledgement