

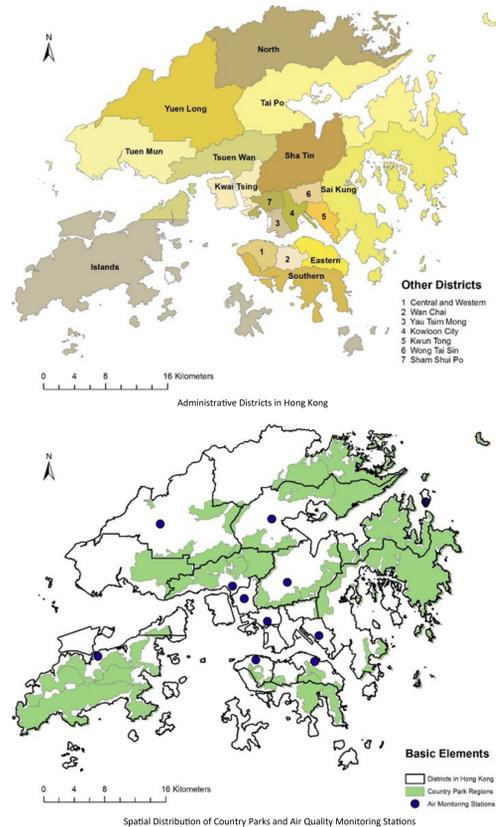
The Role of Country Parks in Air Quality

A Case Study in Hong Kong

Introduction

Hong Kong, known as a commercial city, is located in south part of China. As we know, air pollution is a common issue in big cities, and this situation happens in Hong Kong as well.

Hong Kong consists of mountainous lands or small islands. Urban area is clustered on both sides of Victoria Harbor, while new towns are located far away from urban area. Meanwhile, we notice that there are many large greenery places where they all seem to be totally undeveloped. Most of the area are called Country Park, managed by the authority.



District Name	District Area (km ²)	Country Park Area (km ²)	Area Ratio
Tsuen Wan	62.27	37.71	0.61
Tai Po	148.24	86.79	0.59
Sai Kung	136.45	71.32	0.52
Islands	178.21	91.43	0.51
Southern	39.61	17.63	0.45
Eastern	18.62	6.39	0.34
Sha Tin	69.08	22.69	0.33
North	137.52	42.43	0.31
Tuen Mun	84.41	24.53	0.29
Central and Western	12.45	3.06	0.25
Wan Chai	9.90	2.06	0.21
Wong Tai Sin	9.30	1.79	0.19
Yuen Long	140.16	26.65	0.19
Sham Shui Po	9.50	0.40	0.04
Kowloon City	10.09	0.21	0.02
Kwai Tsing	23.62	0.38	0.02
Kwun Tong	11.26	0.11	0.01
Yau Tsim Mong	6.93	0.00	0.00

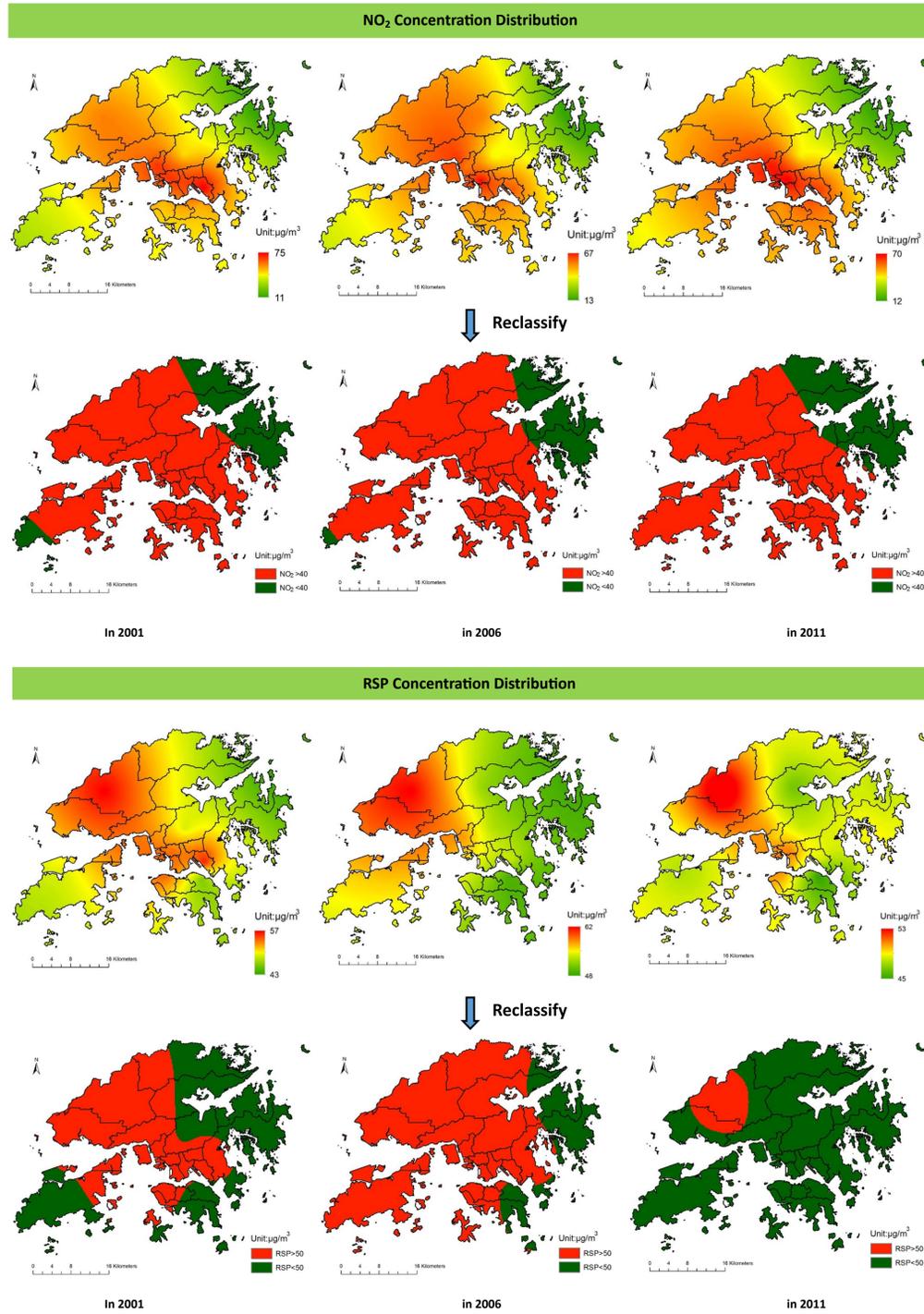
I am trying to find a relationship between country parks and air pollution. Two contaminants are selected: nitrogen dioxide (NO₂) and RSP (Respiratory Suspended Particles, also known as PM₁₀).

Nitrogen dioxide can be produced into the environment by natural causes, such as bacterial respiration, volcano explosion and lightning. But nowadays, all forms of burning fossil fuel are the most important reason of NO₂ production in cities, such as energy plant and internal combustion engine. Nowadays, many cities are suffering from NO₂ because the exhaust produces when people are driving cars. As for RSP, it refers to all microscopic solid or liquid matter suspended in the air. It can be pure dust, but often times dust can be combined with toxic substance. It causes serious toxic effect to our respiratory system when people realize that it can easily penetrate our "inner barriers" and circulate in human body.

Methodology

- Preparation:** (1) draw country park polygons and calculate their areas
(2) input annual concentration data of NO₂ and RSP in the attribute table
- Interpolation:** by using Kriging method, interpolate data of NO₂ and RSP in 2001, 2006 and 2011, and create raster files
- Reclassification:** (1) figure out that annual concentration limit of NO₂ and RSP is 40 μg/m³ and 50 μg/m³, respectively
(2) use reclassify tool to define area that is below the limit as "1" (green color) and "0" (red color) for the opposite situation
- Data Collection:** (1) collect the statistic in the attribute table, calculate the ratio for each pollutant in each year
(2) create line chart to show trend for the 10-year period

Results



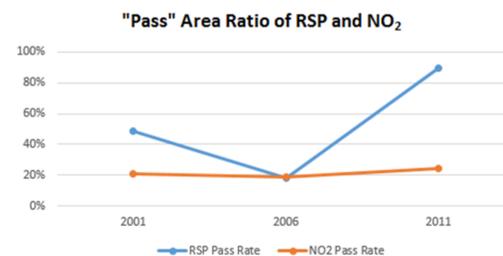
Raster consists of many small squares that carries specific information (either 1 or 0 in this case). After reclassification, each raster has collected data of squares in different colors. We can make estimation on the percentage of area that is below the concentration limit and define it as "Pass" Area Ratio.

$$\text{"Pass" Area Ratio} = \frac{\text{the number of squares represent "1"}}{\text{total number of squares}} = \frac{\text{the area that air quality is satisfying}}{\text{total land area in Hong Kong}}$$

Exact data is provided in tables below.

RSP	PASS(=1)	NOT PASS(=0)	PASS RATE
2001	13448	14238	48.57%
2006	4986	22700	18.01%
2011	24720	2966	89.29%

NO ₂	PASS(=1)	NOT PASS(=0)	PASS RATE
2001	5783	21903	20.89%
2006	5109	22577	18.45%
2011	6725	20961	24.29%



Conclusion

- We cannot guarantee the air quality always not exceeding the concentration limit only through the absolute area of country park in certain area or area ratio, but qualitatively speaking, if both parameters are high enough, the likelihood of satisfying air quality is larger.
- From these concentration distribution maps, we know the highest concentration mainly spread northwestern-southeastern direction, with the source near Kwai Chung, Sham Shui Po and Kwun Tong;
- Country Parks seem to be more effective for RSP removal than NO₂ removal. Throughout the time period, we can safely say that country parks have positive effects on air quality improvement to different extent depending on the pollutant.

Further Discussion

- Data Capacity: I find that there is usually only one air quality station in each district and some districts do not have air quality station, then the interpolation may not accurate enough, especially when we try to look into air quality in country park;
- Geographical and Metrological Conditions: most of the districts are clustered and many districts are usually far from each other, and as Hong Kong are surrounded by mountains, air pollution can be trapped within the urban area;
- The Role of Country Park: country park area usually means there is not much human activity, we cannot say air quality improvement only depends on the existence (or the area) of country park

Source

Cited source

David J. Nowak, Daniel E. Crane, Jack C. Stevens, Air pollution removal by urban trees and shrubs in the United States, In Urban Forestry & Urban Greening, Volume 4, Issues 3-4, 2006, Pages 115-123, ISSN 1618-8667, <https://doi.org/10.1016/j.ufug.2006.01.007>. Limitations, etc.

Further Information

- ESRI (Hong Kong) : air quality station point feature;
- Environmental Protection Department (HK): air quality monitoring data
- Agricultural, Fisheries and Conservation Department: country park map
- ArcMap Online: Hong Kong Region shapefile
- Projection Coordinate System: Hong Kong 1980 Grid

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Geographic Information System

