CITYNET

Low Carbon Cities Evaluation Toolkit

2024 CityNet Report

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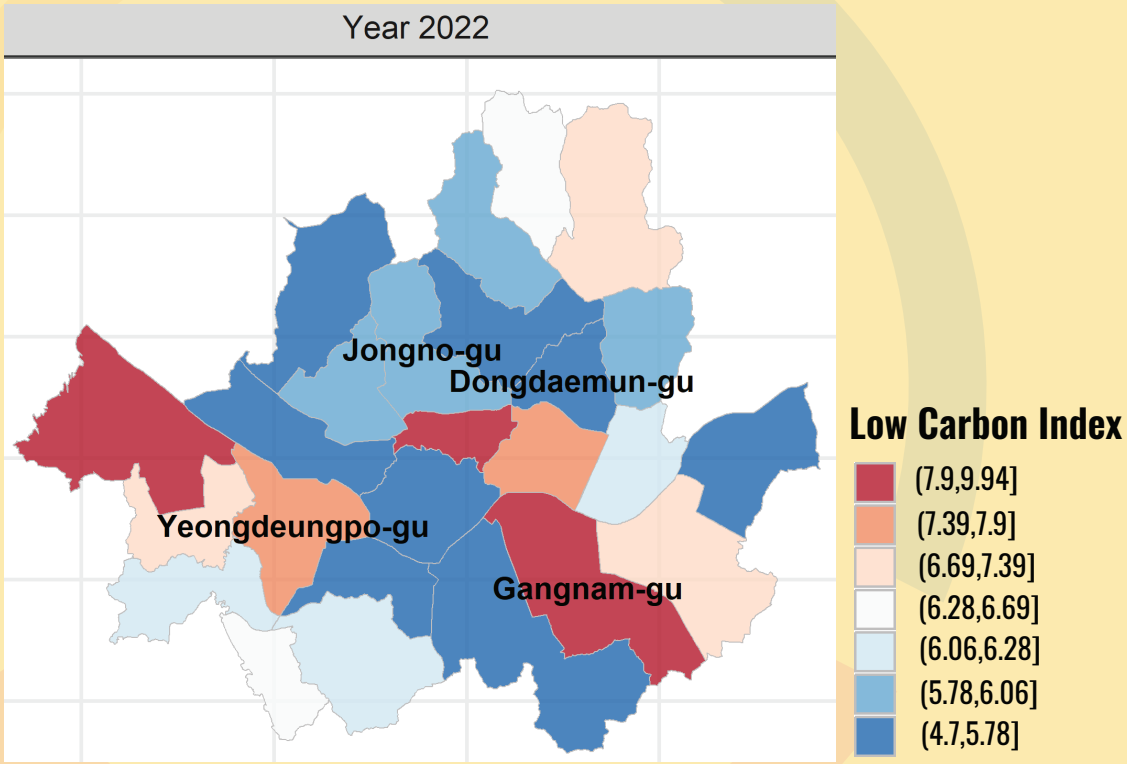

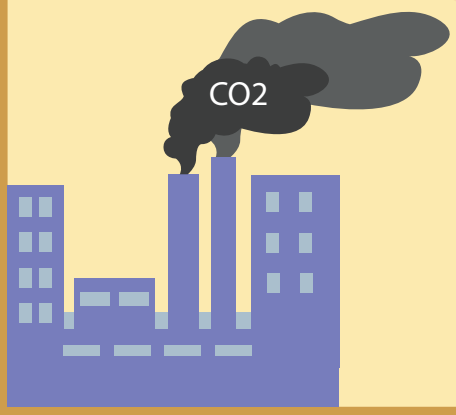

Background

The Republic of Korea has joined 124 countries by setting the ambitious goal to become carbon neutral by 2050[1] and has begun work on legislation to get there[2]. Simultaneously, the world has been urbanizing at a fast clip, and most of the world's population and economic activity can now be found concentrated in cities. Cities are the main driver of economic growth, so unsustainable cities can threaten the ability of a country to become carbon neutral. Therefore, for countries to hit carbon neutrality targets, cities must take the lead with innovative low carbon solutions.

The Urban SDG Knowledge Platform, created by CityNet, the Seoul Metropolitan Government, and UN ESCAP, supports city-to-city knowledge transfer of innovative best practices of sustainable urbanization and can serve as an appropriate platform to help cities cooperate to hit carbon neutrality targets. CityNet primarily serves cities in the Asia Pacific region, which is rapidly urbanizing, but the lessons on the Knowledge Platform may be applicable to cities globally. As many cities share developmental challenges and all cities are affected by the negative impacts of climate change, cities can and should collaborate to find innovative solutions for shared challenges.

Accurate data is required for climate change centered policies to be effective. There exist several inventories on measuring climate emissions of cities, most famously the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories, which famously states that, to reduce emissions, "you can't cut what you don't count.[3]" In many instances, the data required to understand where a city's emissions are coming from either doesn't exist or can be tough to access. In other instances, data can be inconsistent with other data or city departments responsible for compiling data can be siloed, preventing the unity of data required for a systematic approach to GHG reduction.

The Low Carbon Cities Evaluation Toolkit

CityNet partnered with the Kookmin University Low Carbon Green Growth Research Center to develop a new low carbon evaluation toolkit for cities to measure if their emissions vs. mitigation efforts have resulted in a low carbon city. Relying on city-fed data, this flexible toolkit uses a creative indexing system which can accommodate a custom number of variables. The concept behind the toolkit was to design the most practical and composite indices that reflect the most crucial areas to achieve low carbon cities. The toolkit's unit of study is based on the various administrative wards or districts of a given city. This focus on city wards breaks the city down into bite-sized pieces which can be added up to form the entire picture of the city's low carbon status. Data from the wards can also be compared, which can pinpoint areas of strength or weakness while introducing competition for the wards to improve.

The city of Seoul and its 25 wards were selected for the pilot for the toolkit. Seoul is a leader when it comes to open data that is available to the public, regularly updated, and in some cases, visualized. Some examples are Seoul Open Data Plaza, Statistical Geographic Information Service, and Korean Statistical Information Service. The data is combined with a unique Geo ID to identify that the data belongs to a particular ward in the database. The Geo ID, (i.e., a unique identifier of an administrative unit), allows the data to be joined to a geospatial data (such as a shapefile) to visualize the low carbon indices of each ward through a choropleth map, where differing shades of color represent

[1] Race to Net Zero: Carbon Neutral Goals by Country https://www.visualcapitalist.com/sp/race-to-net-zero-carbon-neutral-goals-by-country/
[2] Carbon Neutral Green Growth Framework Act to tackle the Climate Crisis
[3] Link to GHG Protocol for Cities https://ghgprotocol.org/ghg-protocol-cities

different data values[4]. The data from various years can be integrated as different layers to show change over time. The prototype map incorporates data from 2020, 2021, and 2022.

To create the toolkit's unique low carbon city index, a composite index was selected. The composite index allows us to compare relative performances across different regions and is well regarded as a useful tool in policy analysis. For example, one widely adopted in policy practice is the Townsend Deprivation Index, which is a measure of material deprivation introduced by Peter Townsend in 1987. Using a combination of four census variables (i.e., unemployment, overcrowding, non-car ownership, and non-home ownership), a Townsend score for each region can be calculated. Four variables are standardized (Z-score) and the sum of each Z-score of the variables comprises a Townsend score. Using quintiles of the Townsend scores, one can identify the relative deprivation of each region or municipality. The same principle was used to create the low carbon city index.

To rectify the disproportionate numerical data that is used to calculate each variable, the team employs a min-max normalization (i.e., feature scaling) which performs a linear transformation on the original data. That is, the indexing system rescales the data to create a min-max value, where no matter the scale of each variable, the number is reclassified to a simple value between 0 and 1. As outlined below, for some variables, a lower score is indicative of low carbon cities and in other cases, a higher score is preferable. When the index is computed by combining the variables, a higher score indicates a ward with greater carbon emissions, and variables representing low carbon practices help to reduce the score. Thus, wards with a lower index are rated as more "low carbon" than wards with higher index scores.

Category	Variable Name	Description	Direction	Remarks
Carbon Emission	Gas_Person	LNG use per person	-	The lower, the better
	Elec_Person	Electricity use per person	-	The lower, the better
	Heat_Person	Heat use per person	-	The lower, the better
	Ghg_Person	GHG emission per person	-	The lower, the better
Carbon Reduction	Green_Rate	Area of green / Total area	+	The higher, the better
	Green_Popden	Population density / Area of green	-	The lower, the better
	Housing30_Rate	The number of old houses (established more than 30 years ago) / Total number of houses	-	The lower, the better
	Recycle_Rate	The amount of recycling / the amount of waste	+	The higher, the better
	Airpollution_Per100k	The number of air pollutant emission facilities per 100,000 people	-	The lower, the better
	Wastewater_Per100k	The number of wastewater emission facilities per 100,000 people	-	The lower, the better

[4] https://energyinfo.seoul.go.kr/main/main provides a choropleth map for building energy use across Seoul's 25 wards

	Petro_Per100k	The amount of consumption of petroleum per 100,000 people	-	The lower, the better
	Driving_PerCar	The driving distance per each registered car	-	The lower, the better
	Non_motorized	Mode of transportation (walking and bicycling combined)	+	The higher, the better
	Public_transit	Mode of transportation (Public transit use combined (buses and subways))	+	The higher, the better
	Per_Park2020	Area of parks per person	+	The higher, the better
Capacity	Fiscalindep2020	Fiscal independence of each ward	+	The higher, the better
	Volunteering2020	Rate of active participation or volunteering	+	The higher, the better
Index	Index	Low-carbon city index (Calculated by the sum of min-max normalized values of each variable)		**The lower, the better**

After the index scores are calculated, the toolkit uses quintiles to categorize each ward into five evenly divided groups to rate their carbon level relative to the others. The cutoffs for the 5 quintiles are below:

Quintile	**Threshold**	**Category**
0.200	6.102	Lowest Carbon
0.400	6.557	Low Carbon
0.600	7.198	Medium Carbon
0.800	7.683	High Carbon
1.000	9.767	Highest Carbon

Based on the 2020 data, the toolkit measured the low carbon indices of the 25 wards of Seoul as follows:

Ward / 구	Index	Category
Yongsan-gu (용산구)	5.625	Lowest Carbon
Gangdong-gu (강동구)	5.775	Lowest Carbon
Gwangjin-gu (광진구)	5.813	Lowest Carbon
Gwanak-gu (관악구)	6.032	Lowest Carbon
Eunpyeong-gu (은평구)	6.089	Lowest Carbon
Seongbuk-gu (성북구)	6.105	Low Carbon
Dongdaemun-gu (동대문구)	6.108	Low Carbon
Mapo-gu (마포구)	6.173	Low Carbon
Jungnang-gu (중랑구)	6.299	Low Carbon
Dongjak-gu (동작구)	6.407	Low Carbon
Jongno-gu (종로구)	6.657	Medium Carbon
Seocho-gu (서초구)	6.670	Medium Carbon
Geumcheon-gu (금천구)	6.903	Medium Carbon
Seodaemun-gu (서대문구)	7.012	Medium Carbon
Dobong-gu (도봉구)	7.083	Medium Carbon
Yangcheon-gu (양천구)	7.371	High Carbon
Nowon-gu (노원구)	7.388	High Carbon
Guro-gu (구로구)	7.452	High Carbon
Gangbuk-gu (강북구)	7.571	High Carbon
Yeongdeungpo-gu (영등포구)	7.681	High Carbon
Jung-gu (중구)	7.690	Highest Carbon
Gangnam-gu (강남구)	8.212	Highest Carbon
Songpa-gu (송파구)	8.554	Highest Carbon
Seongdong-gu (성동구)	8.619	Highest Carbon
Gangseo-gu (강서구)	9.767	Highest Carbon

Figures

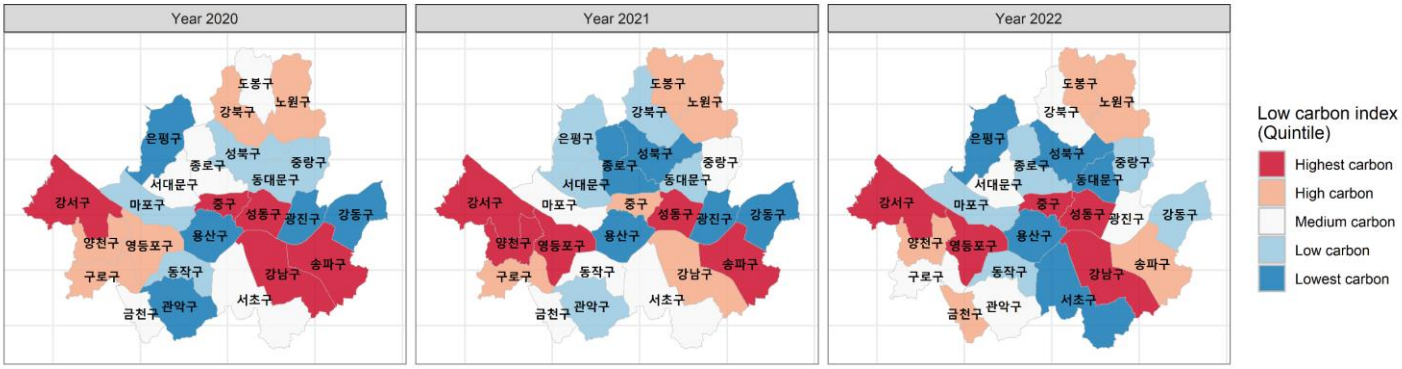

Figure 1: Low Carbon Index of Seoul's 25 wards by quintile for years 2020, 2021, 2022

These images show how each of Seoul's 25 wards compare within the established carbon quintile index from lowest carbon to highest carbon. Blue represents low carbon wards, white represents mid carbon wards, and red indicates high carbon wards.

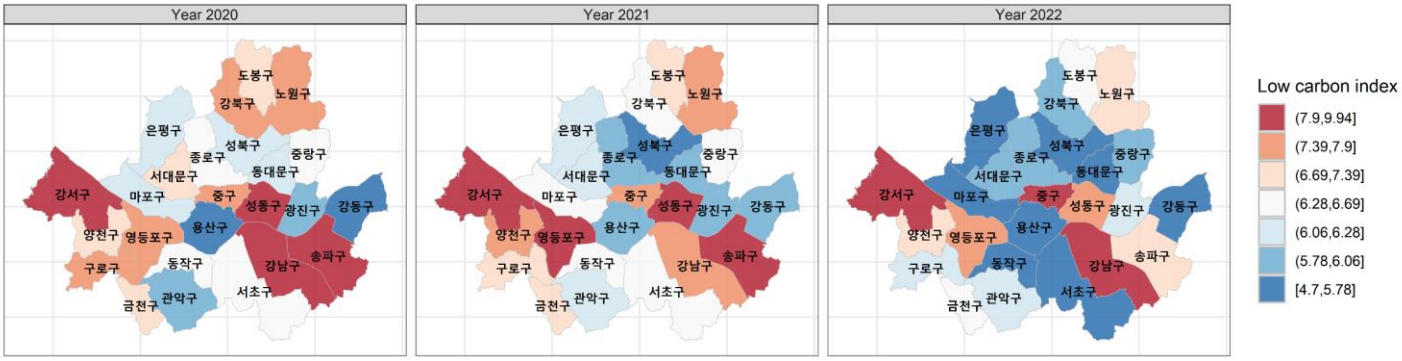

Figure 2: Low Carbon Index of Seoul's 25 wards on a 7-point scale for years 2020, 2021, 2022 pooled

Stretching the Low Carbon Index to a 7-point scale allows for a more nuanced view of the breakdown between Seoul's 25 wards. Blue represents low carbon wards, white represents mid carbon wards, and red indicates high carbon wards. According to the indexing system, in the short span of time from 2020 to 2022, many of Seoul's wards have transitioned to lower carbon status.

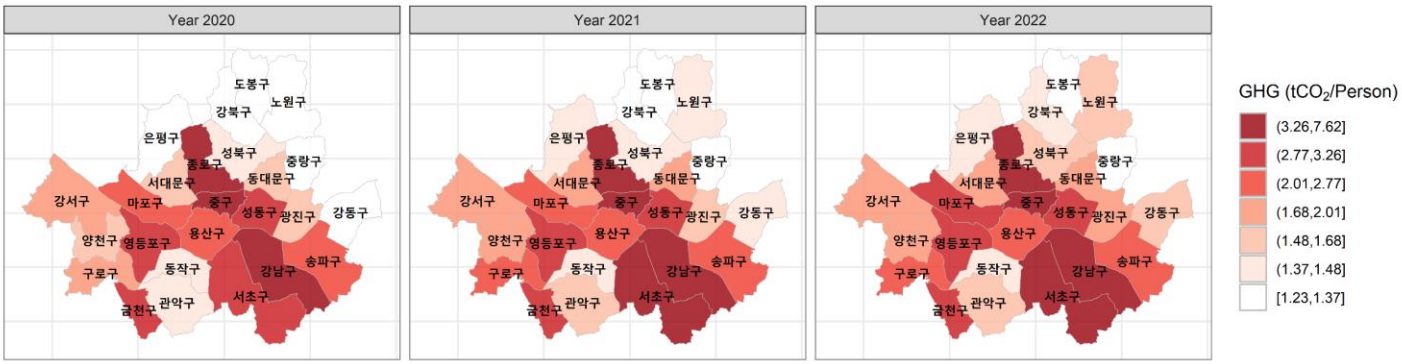

Figure 3: GHG emissions per person in Seoul's 25 wards for year 2020, 2021, 2022

These images calculate how many greenhouse gas emissions the average person in each ward is generating. The most populous wards of Seoul with more residential zoning show higher GHG emissions per person represented in red.

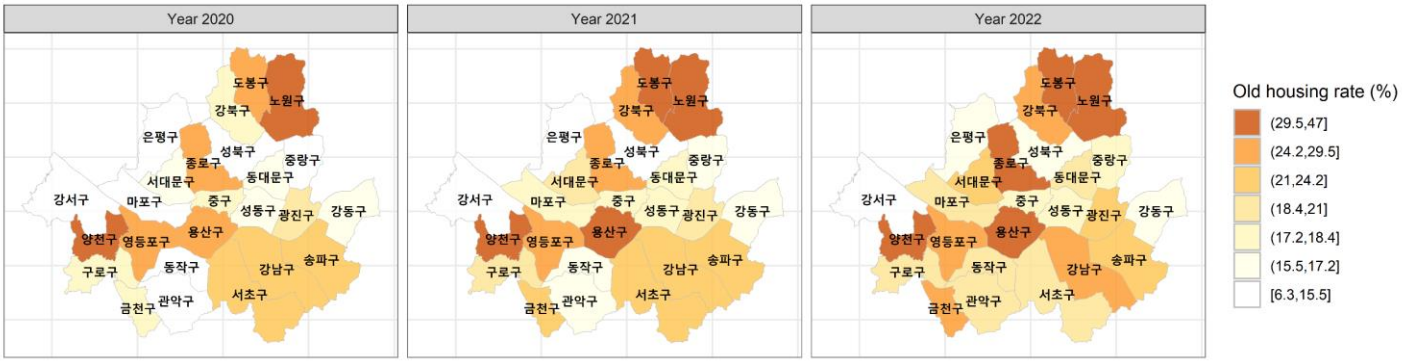

Figure 4: Rate of old housing in Seoul's 25 wards for year 2020, 2021, 2022

The maps show the percentage of houses in each ward that are more than 30 years old vs. the total number of houses. It is well known that newer housing units are built with regulations that make them less carbon emitting than older housing. Wards with a more yellow tint tend to have a higher rate of older housing units on average.

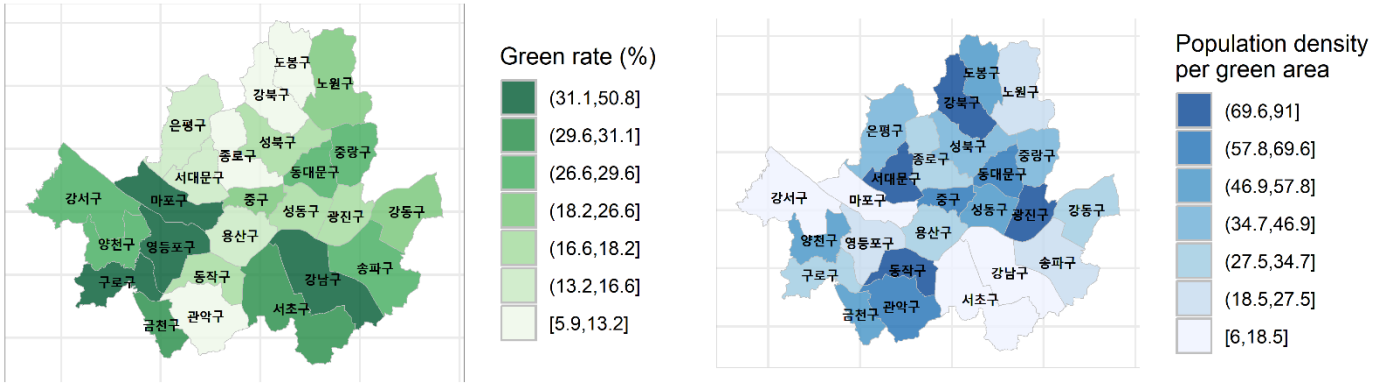

Figure 5: a) Green rate in Seoul's 25 wards for 2022; b) Population density per green area (1000 people) for 2022

Figure 5a) presents the rate of greenery per ward in 2022. It is calculated by the area of green zone divided by the total land area of each ward. Greener wards indicate a higher relative proportion of green areas than wards that are less green. Public parks and green areas help to capture carbon and can lead to alleviation of the heat island effect associated with rising temperatures due to climate change. Meanwhile, Figure 5b) shows the relative differences in population density per green area scaled by 1000 people. Wards with lighter blue colors indicate lower population density in relation to green area. One can identify that the southeastern part of Seoul including Gangnam-gu, Seocho-gu, Songpa-gu, and Gangdong-gu appears to have lower values in this measure, allowing their residents to enjoy the green with less crowdedness.

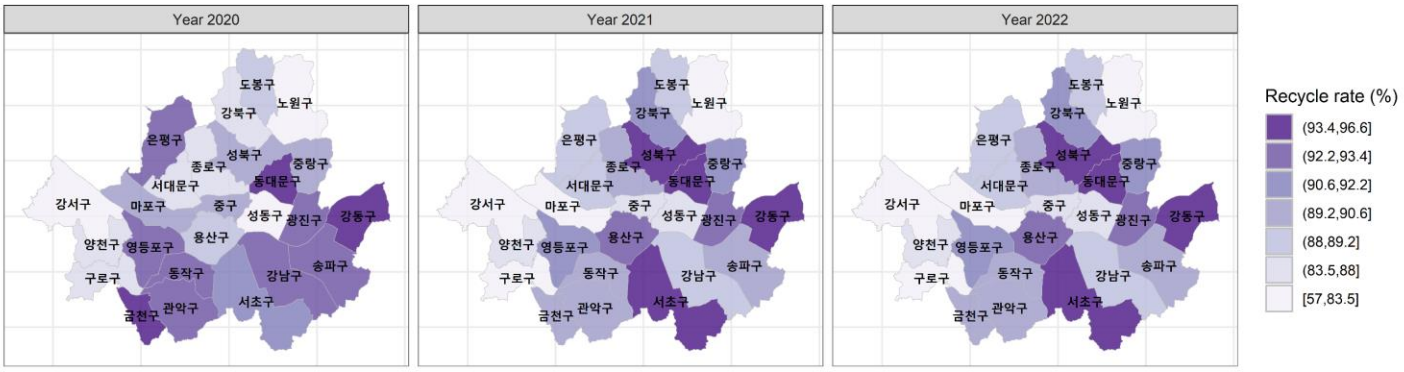

Figure 6: Recycling Rate in Seoul's 25 wards for year 2020, 2021, 2022

Seoul has strict regulations on waste management, mandating that citizens and businesses separate waste into different types at the source. Seoulites responsibly follow these guidelines, however wards that are more purple show more exceptional rates of recycling.

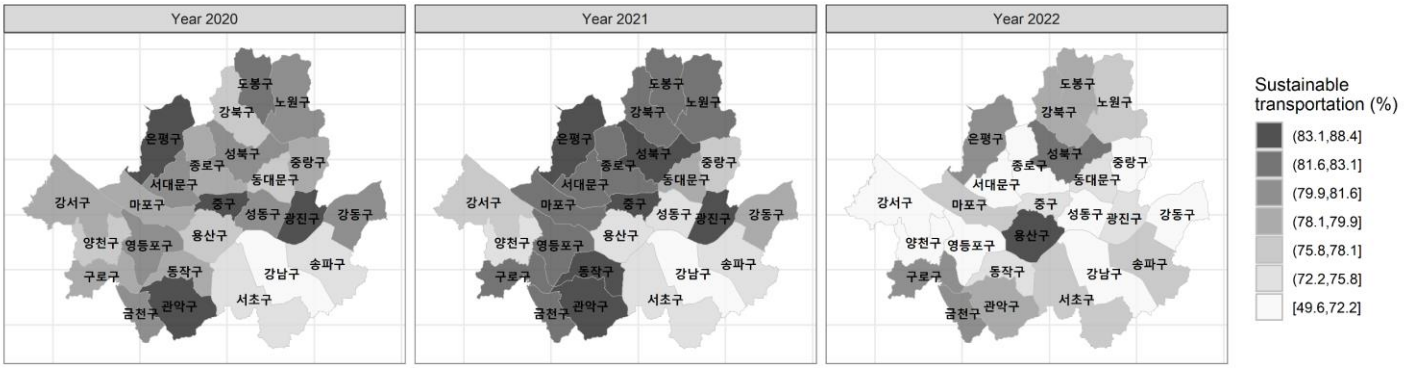

Figure 7: The use of sustainable public transport in Seoul's 25 wards for year 2020, 2021, 2022

The rates of sustainable public transportation use are combined and represented in the maps above. In addition to public buses and subway, cycling and walking are also factored into the equation. Darker regions boast more sustainable transport use and less reliance on private vehicles to get around.

Plans for the Low Carbon Cities Evaluation Toolkit

The toolkit results based on data from Seoul City's 25 wards is an example of what the low carbon city index can do with enough data. The toolkit can be adapted to fit any city, as long as the data is available. Each variable can be rescaled to fit the indexing calculation and the outcome would be easily combined with the city's shapefile, divided into wards, for visualization purposes. Cities may introduce or take out variables as needed but the process to determine the index will be consistent. The adaptability of the toolkit is its key strength. Its visual nature and ability to consolidate data from disparate sectors will be crucial to helping a city analyze the state of its carbon output and make plans to reach targets. The toolkit thus offers cities a clear evaluation of their progress in achieving carbon neutrality by simplifying otherwise complex data from multiple sources. The toolkit displays a city's results in a quantitative, visually understandable format, with strengths and weaknesses clearly labeled. Ideally, the toolkit output can provide a rationale and/or legitimacy for city officials to justify the selection and implementation of specific carbon neutral practices in their cities.

In the future, CityNet plans to engage more cities to use this toolkit as a low carbon evaluation metric. The city will provide the necessary data and CityNet and its partners at the Kookmin University Low Carbon Green Growth Research Center will transform it to create the low carbon index for the city. The output can be used during low carbon themed workshops and may eventually be combined to create an index for low carbon cities in the Asia Pacific region. As the output of the toolkit will be quite valuable for city planners and the use of the toolkit requires technical proficiency to handle large amounts of data, CityNet may request a fee from cities for this service.