Group 3: ***Geography***

Extended Essay

The Environmental Consequences of Central Business District Development around Jinji Lake, Suzhou, China

(Word count: 3996)

Table of Contents

1 Introduction

1.1 Geographical Context

Suzhou, a 3000-year-old antique city, is now China's strongest industrial city, and the most economically developed prefectural-level city with more than 2270 billion yuan of Gross Domestic Product (GDP) in 2021[1]. Since 2000, when China and Singapore government signed a contract to start developing Suzhou Industrial Park (SIP), the GDP increased by 2120 billion yuan. And part of the increment in GDP is due to the development of Central Business District (CBD) around Jinji Lake in SIP. See the maps below.

Fig. 1.1, Map of China (Suzhou labeled)[2]

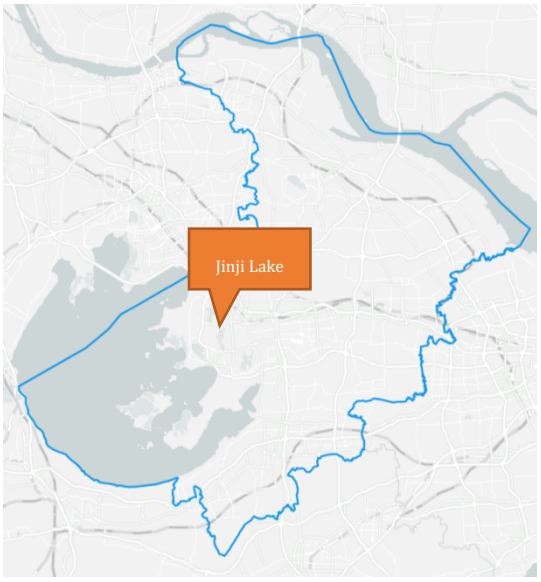


Fig. 1.2, Map of Suzhou (Jinji Lake labeled)[3]

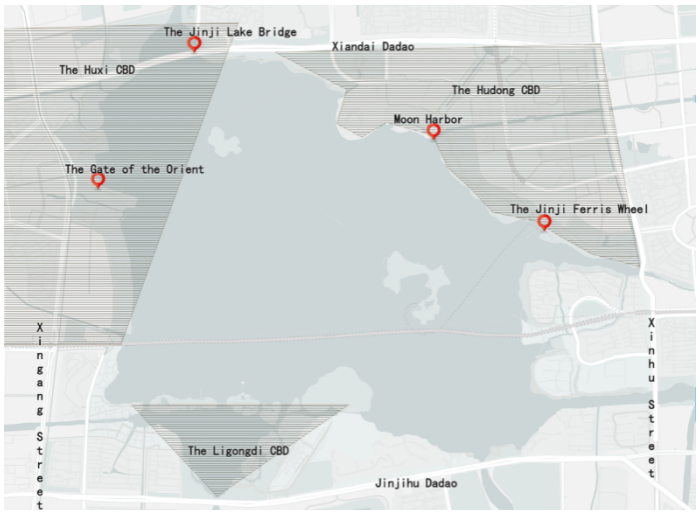


Fig. 1.3, Map of Jinji lake and its CBD in the center of Suzhou Industrial Park[4]

[1] Zhongjing Statistics, "GDP of Suzhou City," accessed February 22, 2023, https://ceidata.cei.cn/new/ShowTabsByInterface?from=ceidata&key=%E8%8B%8F%E5%B7%9E.
[2] Author, *Map of China (Suzhou Labeled)*, n.d., n.d.
[3] Author, *Map of Suzhou (Jinji Lake Labeled)*, n.d., n.d.
[4] Author, *Map of Jinji Lake and Its CBD in the Center of Suzhou Industrial Park*, n.d., n.d.

1.2 Development of CBD

In 1992, the Chinese and Singaporean Government signed a contract that Singaporean would help the development of a new district that is known as SIP. The first stage development of the district started off in 1994, while the general development of the CBD around Jinji Lake started off in 2004 for Huxi (West of the Lake) and 2008 for Hudong (East of the Lake). In 2009, government transformed the 100-years-old Ligongdi (The Dyke of Sir Li) into a 1400-meter-long business street. In 2010, the world's largest Sky Screen launched in Time Plaza, along with a complete set of shopping malls and parking lots. In 2018, most of the CBD had finished its construction, including The Gate of the Orient and Suzhou Center in Huxi. In 2020, the 450-meter-tall Suzhou International Financial Center (IFS) finished construction. Now, in 2022, we can say that the CBD has finished its construction.

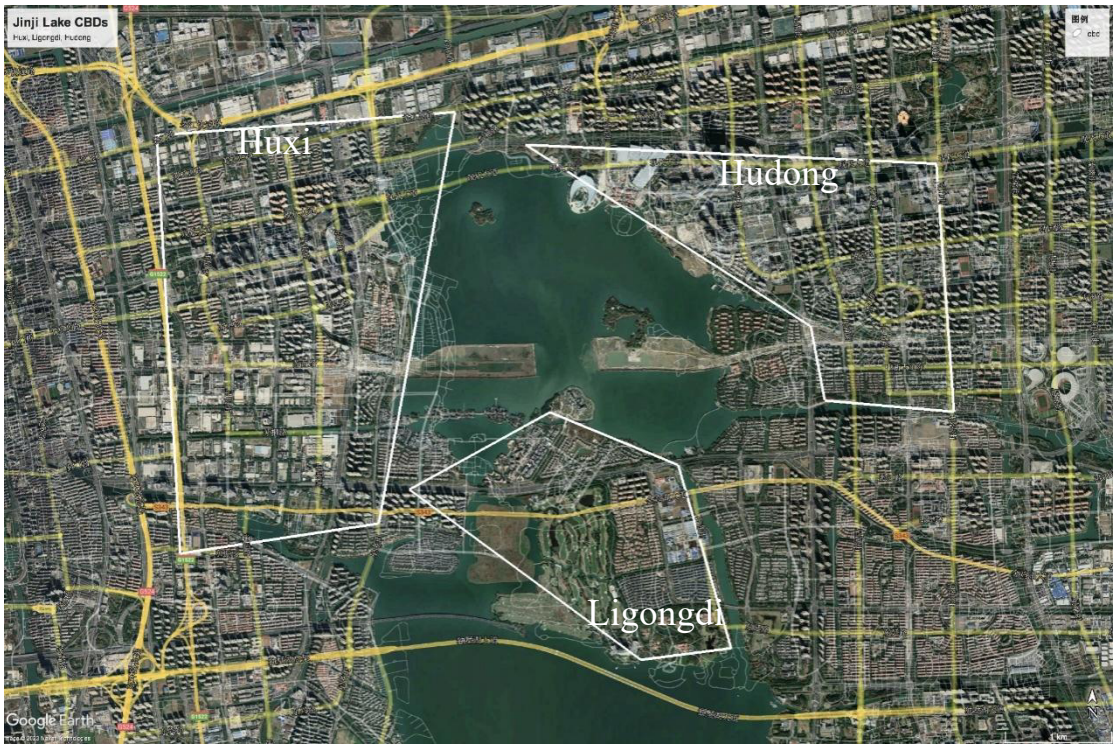


Fig. 1.4, Satellite Map of Jinji Lake CBDs[5]

[5] Google Earth, *Satellite Map of Jinji Lake CBDs*, accessed February 22, 2023, https://earth.google.com/web/.

Fig. 1.5, the Satellite image of Jinji Lake in its early stage of development in 2003[6]

To simplify the word usage in this investigation, we can mainly divide the Jinji Lake CBD into three minor sections, including Ligongdi (L), Huxi (X), and Hudong (D), in the sequence of modernized development.

Fig. 1.6, Huxi CBD (X)[7]

Fig. 1.7, Ligongdi CBD (L)[8]

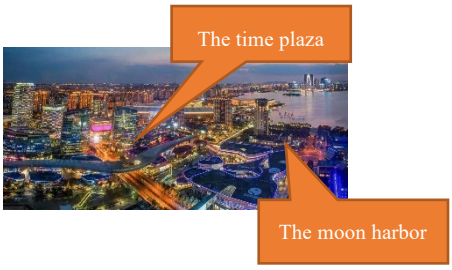


Fig. 1.8, Hudong CBD (D)[9]

[6] Google Earth, *The Satellite Image of Jinji Lake in Its Early Stage of Development in 2003*, accessed February 22, 2023, https://earth.google.com/web/.
[7] Suzhou Industrial Park Administrative Committee, *Photo of Huixi CBD*, n.d., n.d., https://suzhou.news.fang.com/2015-11-06/18005903.htm.
[8] Suzhou Industrial Park Administrative Committee, *Photo of Ligongdi CBD*, n.d., n.d., https://suzhou.news.fang.com/2015-11-06/18005903.htm.
[9] Suzhou Industrial Park Administrative Committee, *Photo of Hudong CBD*, n.d., n.d., https://suzhou.news.fang.com/2015-11-06/18005903.htm.

1.3 Aim of Research

As a Suzhou people, I returned to Suzhou in 2007 when I was 3, and I was shocked by the constructing tall buildings that I had never seen in the suburban Nanjing. 15 years later, the buildings that were under construction are now popular places for local people and tourists to go to. But it is also notable that the green space is depleting, more noise pollution is harming local citizens. The development surely still has some negative effects. In this investigation, I wonder how badly the environment is harmed or how good it is preserved during the planned city development.

Research Question:

What environmental consequences does the development of central business district around Jinji Lake have on itself and Suzhou Industrial Park?

1.4 Extent of Environmental Consequences

In this investigation, I will investigate in the change in air quality (AQ), water quality (WQ), and biodiversity and forest coverage rate (FCR) since the development of SIP CBD. Present data will be collected and analyzed by myself, while past data is collected from the documentations of SIP government stored or publicized in SIP Administrative Committee (SIPAC) or on SIPAC websites, or documentations of Suzhou Government on its official websites.

1.5 Hypotheses

Note that the SIP government, ever since the development of SIP in 1994, starts its efforts to help conserve the environment. Therefore, it is hypothesized in this essay that:

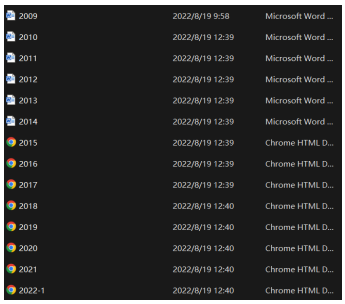
1. The environment is **NOT** degraded very much, or even **IMPROVED**;
2. we can see **IMPROVEMENTS** in certain **AQ** and **WQ** aspects;
3. the larger and earlier the buildings at one sampling point, the **WORSE** the **AQ** and **WQ** there.

2 Methodology

In this investigation, the only independent variable is time (year of data collection), whereas **air quality (AQ)**, including carbon dioxide concentrations and PM2.5, **water quality (WQ)**, including pH, TDS, EC, BOD values, dissolved salt concentrations (nitrate, nitrite, and ammonium) and transparency, and **forest coverage rate (FCR) and biodiversity**.

Name of Data	Type of Data	Type of Collection	Apparatus picture
PM2.5/10	First-hand & Second-hand	Electric PM2.5/10 measurer	
CO concentrations	First-hand & Second-hand	Electric CO measurer (same module as PM2.5/10 concentration)	
CO_2 concentrations	First-hand & Second-hand	Electric CO_2 measurer	
pH	First-hand & Second-hand	Electric pH measurer	

TDS	First-hand & Second-hand	Electric TDS measurer (same module as EC)	
EC	First-hand & Second-hand	Electric EC measurer (same module as TDS)	
BOD	First-hand & Second-hand	BOD test kit	
Dissolved salts	First-hand & Second-hand	NO_3^-, NO_2^-, NH3-N test kit	

Transparency	First-hand & Second-hand	Secchi disk	
Biodiversity and FCR	Second-hand	Government documentation[10]	
Water Sample	First-hand	Water collector	
Water temperature	First-hand	Thermometer	

Spr. 2.1, All Measurement Equipment[11]

[10] Suzhou Environmental Protection Bureau, Suzhou Environmental Condition Publication (Suzhou Environment Bulletin) 2009 to 2022, June 2010 to July 2022

[11] All equipment is purchased online in the period of Jun. 2022 to Jul. 2022 via jd.com

Below describes all the data collection methodologies for current AQ and WQ data.

For both AQ and WQ, stratification is used. The Jinji Lake CBD is divided into three sections as mentioned in *section 1 Introduction,* in which only Hudong and Huxi sections will be measured due to policy issues in Ligongdi later explained in *section 5 Evaluation*. For each section, there are two data collection locations.

The map below shows the four data collection locations.

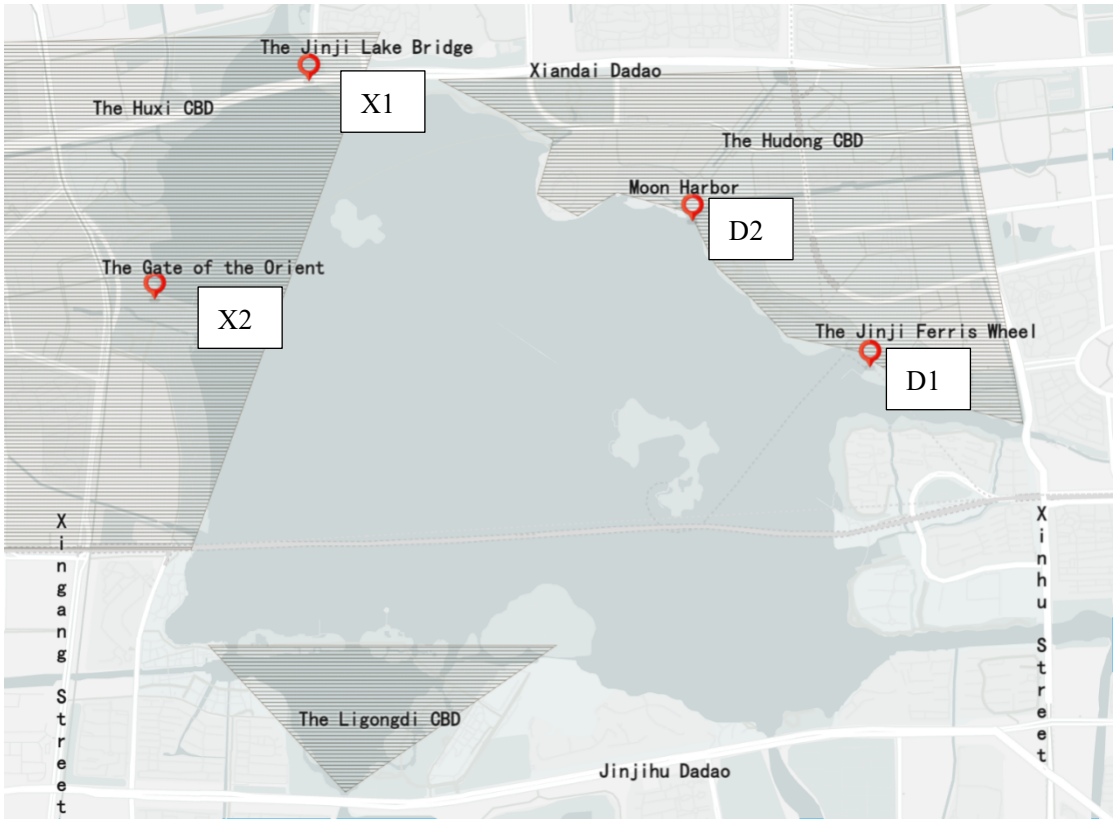


Fig 2.2, Map of SIP CBD with sampling points[12]

For the investigation, stratification is used to find out the averaged AQ and WQ in the SIP Jinji Lake CBD.

In the Hudong CBD, two representative locations are chosen. The Jinji Ferris Wheel is one of the oldest buildings in Hudong and is near the entrance to the lake of a tributary of Qingqiupu, a river from north to south. While the Moon Harbor is the closest lakeshore from Time Plaza, Eslite Bookstore and IFS and is itself one of the oldest constructions in the Hudong CBD.

In the Huxi CBD, two representative locations are chosen. On the north of the Jinji Lake Bridge is a residential area, while on the east and west are two CBDs, obviously the bridge is the connection between east and west. While the Gate of the Orient is the representative building in Suzhou, even in Jiangsu, and around it there are Suzhou Center Shopping Mall,

[12] Author, *Map of SIP CBD with Sampling Points*, n.d., n.d.

Phoenix Bookstore, three grand hotels, a street of business buildings and Wanghuge Harbor (Pavilion to See the Lake).

Fig. 2.3, Image of Jinji Lake Bridge and the Huxi CBD[13]

Fig. 2.4, Image of Moon Harbor[14]

[13] Suzhou Industrial Park Administrative Committee, *Image of Jinji Lake Bridge and the Huxi CBD*, n.d., n.d., https://suzhou.news.fang.com/2015-11-06/18005903.htm.
[14] Unknown Photographic Competiton Competitior, *Photographic Image of Moon Harbour*, n.d., n.d., http://t.dianping.com/zenus/travel/spu/spuPcDetail?spuId=57081.

Fig. 2.5, Image of the Ferris Wheel[15]

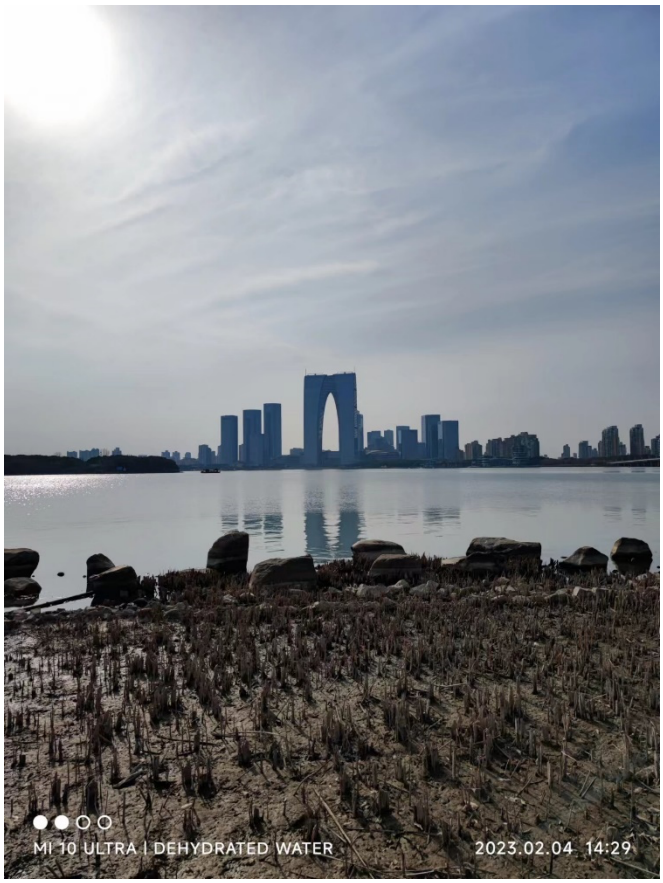


Fig. 2.6, Shot at the wetland protecting area as introduced in section 3.3[16]

[15] Unknown Photographic Competiton Competitior, *Image of the Ferris Wheel at Suzhou Ferris Wheel Park*, n.d., n.d., http://t.dianping.com/zenus/travel/spu/spuPcDetail?spuId=57081.
[16] Author, *Photograph of the Wetland Protecting Area*, n.d., n.d.

3 Data Analysis and Comparison

Here lists the data collected from my fieldwork.

Using the following legend,
D1: The Jinji Ferris Wheel (Youan Street)
D2: Moon Harbor
X1: The Jinji Lake Bridge (Jinji Hu Daqiao)
X2: The Gate of the Orient

Current Data (collected August 18th, 2022)

Location	CO_2 (ppm)	CO (mg/m^3)	PM2.5 ($\mu g/m^3$)	Air Temperature (C°)	NO_3^- (mg/L)	NO_2^- (mg/L)	NH3-N (mg/L)
D1	806	0.95	44	35.6	0	0	0.1
D2	729	0.88	41	35.1	0	0	0.2
X1	707	1.23	48	31.7	0	0	0.05
X2	724	1.30	44	40.2	12.5	0.150	0.6
Location	pH	PM10 (mg/m^3)	BOD (ppm)	TDS (ppm)	EC (mS/cm)	Trans-parency (cm)	Water Temper-ature (C°)
D1	8.69	0.051	0	222	445	85	32.8
D2	8.42	0.068	0	219	434	102	32.6
X1	8.31	0.082	100	214	430	13	31.9
X2	8.36	0.056	300	223	452	10	32.4

Spr. 3.1, Current data collected in Aug. 2022

By taking average, the current WQ and AQ data in the Jinji Lake CBD can be calculated.

Average data

AVGs	Data
CO_2 (ppm)	741.5
CO (mg/m^3)	1.09
PM2.5 ($\mu g/m^3$)	44.25
Air Temperature (C°)	35.65
NO_3^- (mg/L)	3.125
NO_2^- (mg/L)	0.0375
NH3-N (mg/L)	0.2375
pH	8.445
PM10 (mg/m^3)	0.06425
BOD (ppm)	100

TDS (ppm)	219.5
EC (mS/cm)	440.25
Transparency (cm)	52.5
Water Temperature (C°)	32.425

Spr. 3.2, Averaged data

Historical data is collected from the government websites.

Historical Data

Year	CO (mg/m^3)	PM2.5	EI	WQ Level	Ambient Air Pollution Index	PM10 ($\mu g/m^3$)	O_3 ($\mu g/m^3$)
2005	N/A	N/A	N/A	V-	N/A	100	N/A
2006	N/A	N/A	N/A	V-	N/A	92	N/A
2007	N/A	N/A	N/A	V-	N/A	90	N/A
2008	N/A	N/A	N/A	V-	73	100	N/A
2009	N/A	N/A	66.1	V-	69	88	N/A
2010	N/A	N/A	66.8	V	69	90	N/A
2011	N/A	N/A	65.5	V	70	88	N/A
2012	N/A	N/A	N/A	V	64	79	N/A
2013	N/A	69	N/A	V	N/A	95	N/A
2014	0.92	66	N/A	V	N/A	86	95
2015	0.92	58	N/A	V	N/A	80	96
2016	1.5	46	65.8	V	N/A	72	167
2017	1.4	43	65.7	IV	N/A	66	199
2018	1.2	42	64.5	IV	N/A	65	173
2019	1.2	36	64.4	IV	N/A	62	173
2020	1.1	31	64.1	IV	N/A	50	166
2021	1	28	64.5	IV	N/A	48	162
2022 (Jan. to Jun.)	0.9	36.8	N/A	IV	N/A	52.7	176

Spr. 3.3, Historical data, changes in AQ, WQ and EI[17]

In Chinese Lake WQ Level Rating System, Level V indicates that the waterbody has a NH3-N of at least 2 mg/L, BOD5 of less than 10, pH of 6-9, and nitrate of 10 mg/L; Level IV indicates that the water body has a NH3-N of at most 1.5 mg/L, BOD5 of less than 6, pH of 6-9, and nitrate of 10 mg/L. Level V- indicates that the water quality is worse than the threshold of Level V[18].

[17] Ministry of Ecology and Environment of the People's Republic of China, "Environmental Quality Standards for Surface Water," accessed February 22, 2023, https://www.mee.gov.cn/ywgz/fgbz/bz/bzwb/shjbh/shjzlbz/200206/t20020601_66497.shtml.

[18] National Environment Bureau, Surface Water Environment Quality Standards, People's Republic of China National Standards, GB3838-2002, April 28th, 2002

3.1 Change in Air Quality

Spatial Comparison

To make sense of the raw data and to make comparison between the locations, a this-essay-specific AQI that is known as the Air Pollution Index (API) is developed:

$$API = \left(\frac{CO_2\ in\ ppm}{1000} + CO\ in\ mgm^{-3}\ + PM2.5\ in\ \mu gm^{-3} + PM10\ in\ \mu gm^{-3}\right) \times Temperature\ in\ ℃$$

in which the higher the API, the worse the air quality.

By applying this formula, the following results is conducted.

Location	API
D1	3444.514
D2	3882.376
X1	4182.403
X2	4101.365

Spr. 3.4, API calculated

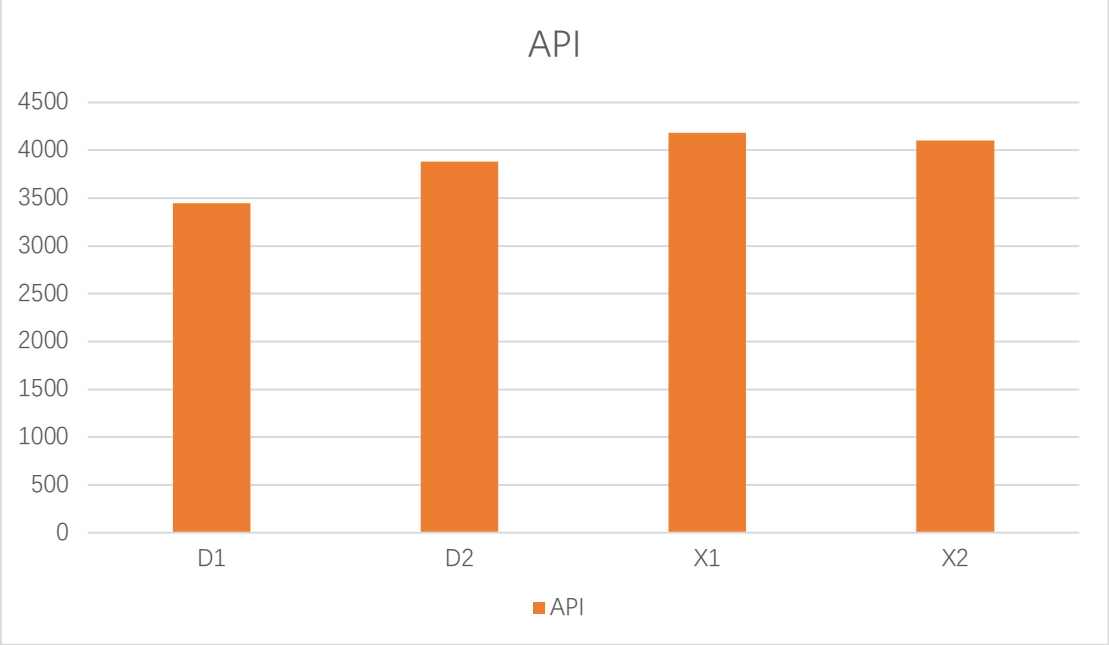


Fig. 3.5, Visual presentation of API

We can see that the air at X1 is most heavily polluted due to its high amount of PM2.5 and PM10. The air at X2 is the second heaviest polluted because of the tall buildings around it, including the Gate of the Orient, Huanqiu 188 Plaza (Around the Globe 188 Plaza) and business buildings of various banks. The air quality around D2 is better than that of X1 and X2, despite the building density around D2 is not less than X2. This can be because of that D2

is constructed years later X2 is constructed, therefore better air ventilation system design and more eco-friendly building materials can be applied so that D2 performs better than X2 do. The air quality is best at D1 because D1 is still partially under-construction.
From the details in spatial aspects, we can look at D1, D2, X1 and X2.

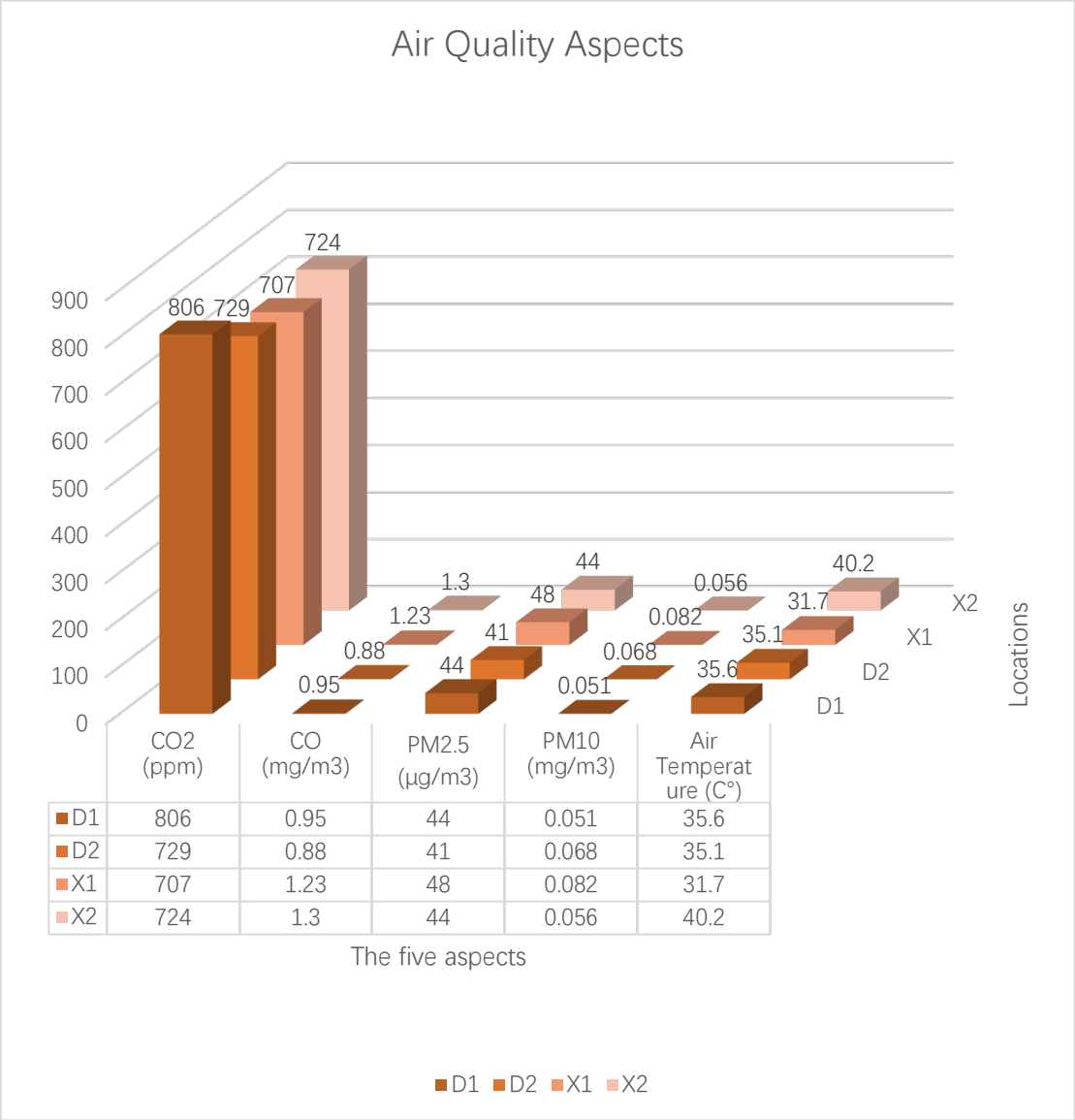


Fig. 3.6, Air Quality Aspects

In this overall graph for all five aspects of air quality, an overview of the five aspects is shown in comparison to the four locations, including D1 as The Ferris Wheel, D2 as Moon Harbor, X1 as The Jinji Bridge, and X2 as The Gate of the Orient.

First look at the air temperature. X1 has the lowest air temperature while X2 has the highest air temperature, D1 and D2 have similar air temperatures. Since at X1 the air temperature is sampled under a bridge, the temperature being low is normal. For D1 and D2 are both on open air grounds near water, the air temperature is medium high in comparison to the air temperature measured at X2, which is nearby dozens of tall buildings. The reason why X2

has a very high temperature is because of Urban Heat Island effect (UHI). In general, the UHI increases the temperature around tall buildings[19].
Secondly, for PM2.5 and PM10, both have the highest reading at X1, probably because of the large traffic flow on the bridge. PM2.5 are the same for D1 and X2, and they have similar PM10 values. D2 has the lowest PM2.5 value while the second highest PM10 value. AQ cannot be justified from these two data.

Thirdly, for carbon dioxide and carbon monoxide, we can see that D1 has the highest value of carbon dioxide while X2 has the highest value of carbon monoxide. Still, AQ cannot be justified.

Partially concluding the difference between air quality in these locations, we can see that **newer buildings and construction plans result in lower API and thus better AQ**. This can reflect all the buildings in the Jinji CBD that the government learned from past experiences to improve the internal design of the CBDs that are newly built.

Temporal Comparison

As we can see from the four graphs showing the changes in air quality in the measure of carbon monoxide, PM2.5, PM10 and ozone. In general, the higher all the four aspects, the worse the air quality[20]. Now, we can see all the air aspects divided and give detailed descriptions of the potential reasons in deterioration or optimization of related air aspects.

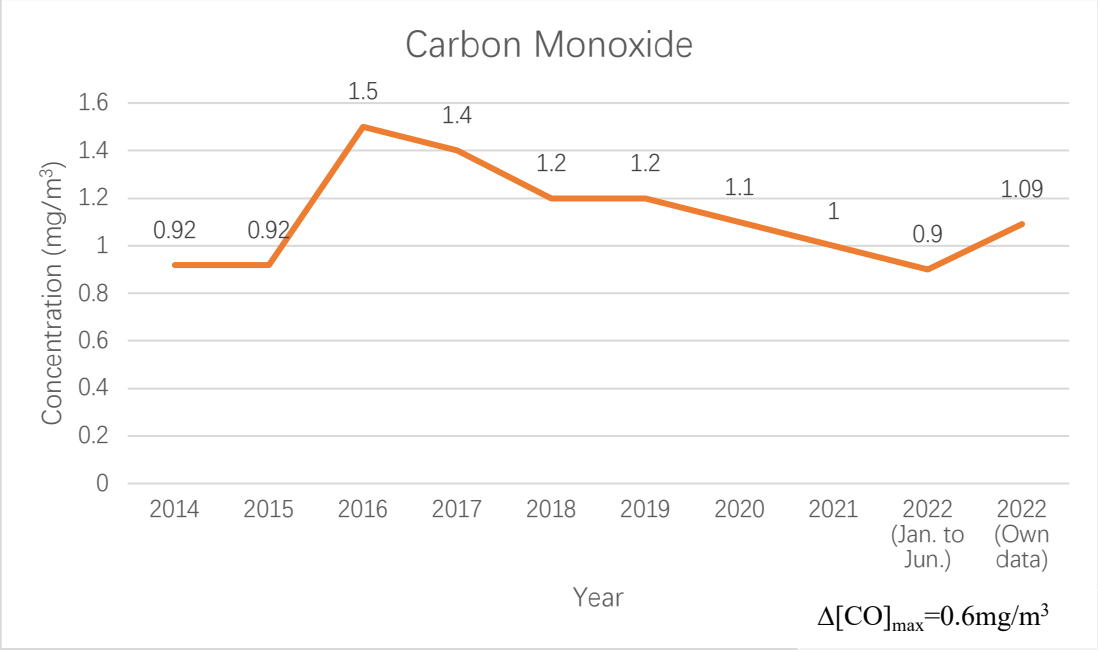


Fig. 3.7, CO concentration through 2014 to 2022

[19] Gabriel Perez and Katia Perini, *Nature Based Strategies for Urban and Building Sustainability*, 1st ed. (Butterworth-Heinemann, 2018), https://www.elsevier.com/books/nature-based-strategies-for-urban-and-building-sustainability/perez/978-0-12-812150-4.
[20] "Carbon Monoxide's Impact on Indoor Air Quality | US EPA," accessed February 22, 2023, https://www.epa.gov/indoor-air-quality-iaq/carbon-monoxides-impact-indoor-air-quality.

In the carbon monoxide graph, we can see there is an improvement in reducing the amount of carbon monoxide since reaching a new high of 1.5 mg/m^3 in 2016 and reached new low in 2022 (Jan. to Jun.). However, in my current data collection, the average carbon monoxide concentration in the four locations is 1.09, showing an increment in the concentration. There could be a few reasons for that change. First, the carbon monoxide concentration values from the government are annual averages while my data collection happens only on August 19th, 2022. Second, due to the way the CO-meter collects data from air, the higher the temperature means the higher the kinetic energy of molecules in air thus the higher the frequency, potentially, of the carbon monoxide molecules to flow through the CO-meter, thus the higher the CO concentration is read. Third, there is a deterioration of air quality in the Jinji Lake in this summer.

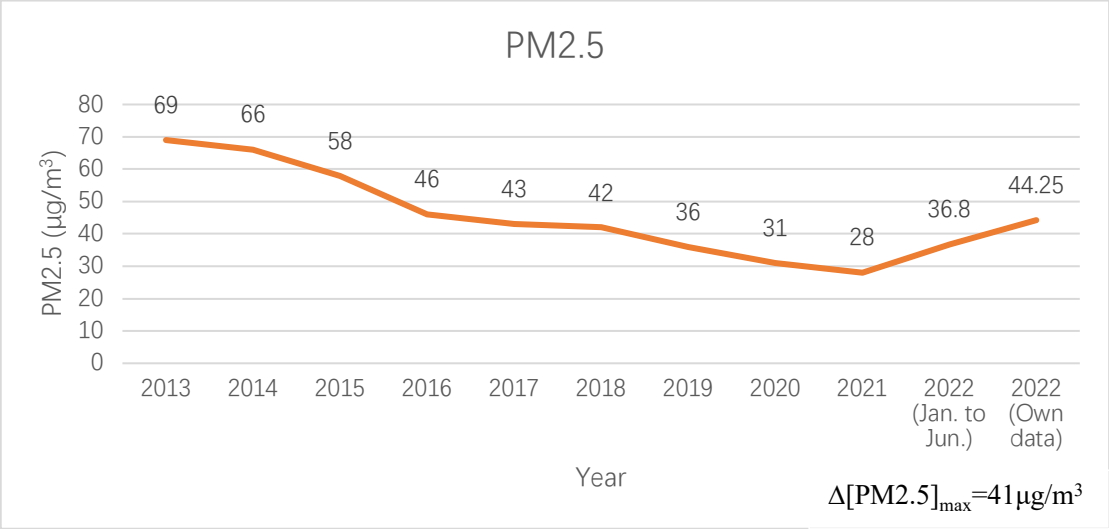


Fig. 3.8, PM2.5 concentrations

In the PM2.5 graph, we can see that there is a decrease in PM2.5 since 2013 until reaching its new low in 2021. This represents that the effort SIP government paid to control the PM2.5 in air paid off. However, there is an increase in the amount of PM2.5 in 2022 as shown both by the government data and my own data. This represents that the air quality has worsened in 2022 and requires further effort for the government to control air quality. It is obvious of a optimizing trend in PM2.5 until 2021, and the optimization can be the result of the implication of "Green Turning" project in Suzhou[21]. However, there's an increase in the amount of PM2.5 in 2022, and that could be a result of increasing pollution in China since Oct. 21, 2021.

[21] Suzhou Ecology and Environment Department Official Media, "Focusing on Alternating the Source, Improving Air Quality Suzhou Industrial Park's Progress in 'Green Turning'," accessed February 22, 2023, https://weibo.com/ttarticle/p/show?id=2309404808836438426175.

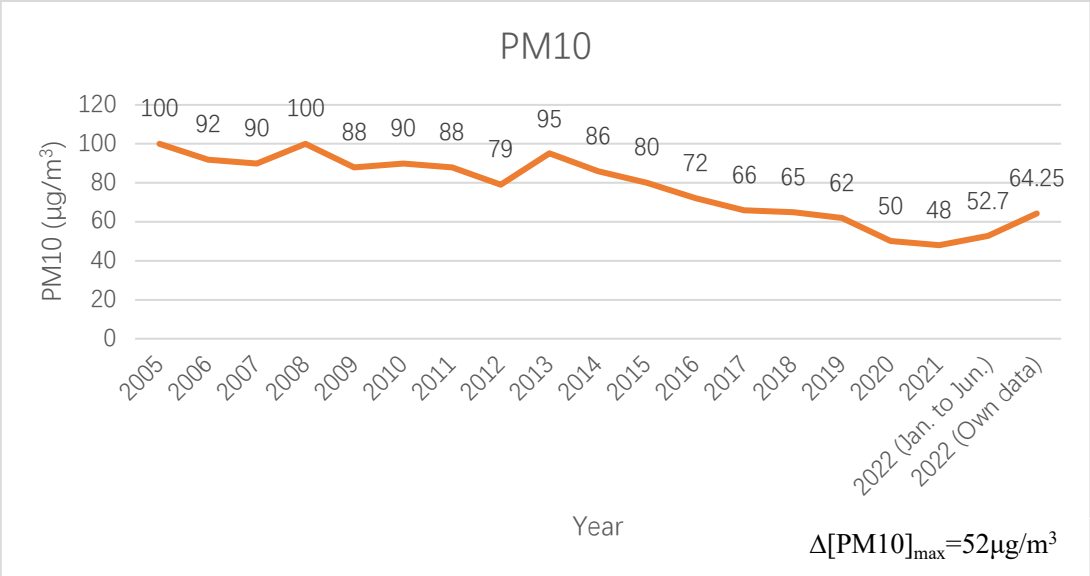


Fig. 3.9, PM10 concentrations

PM2.5 is the only aspect of air quality that the SIP government kept tracking since the early stages of the development of CBD around Jinji Lake. We can see that since the development of Huxi CBD in 2004, the PM10 decreased from 100μg/m³ in 2005 to 90μg/m³ in 2007. However, since the development of Hudong CBD in 2008, the PM10 increased to 100μg/m³ again, and decreases by 12μg/m³ the next year. There is an increase in PM10 in 2013 and followed a steady reduction in PM10 values until reaching a new low in 2021 at 48μg/m³.

However, just like the PM2.5 values, the PM10 value increases in 2022 in both the government data and my own data. Despite the reasons that in hot temperatures air molecules impact the PM-meter with a higher frequency, we can see that there is a deterioration in air quality in 2022. The results of PM10 suggests similar conclusions as PM2.5.

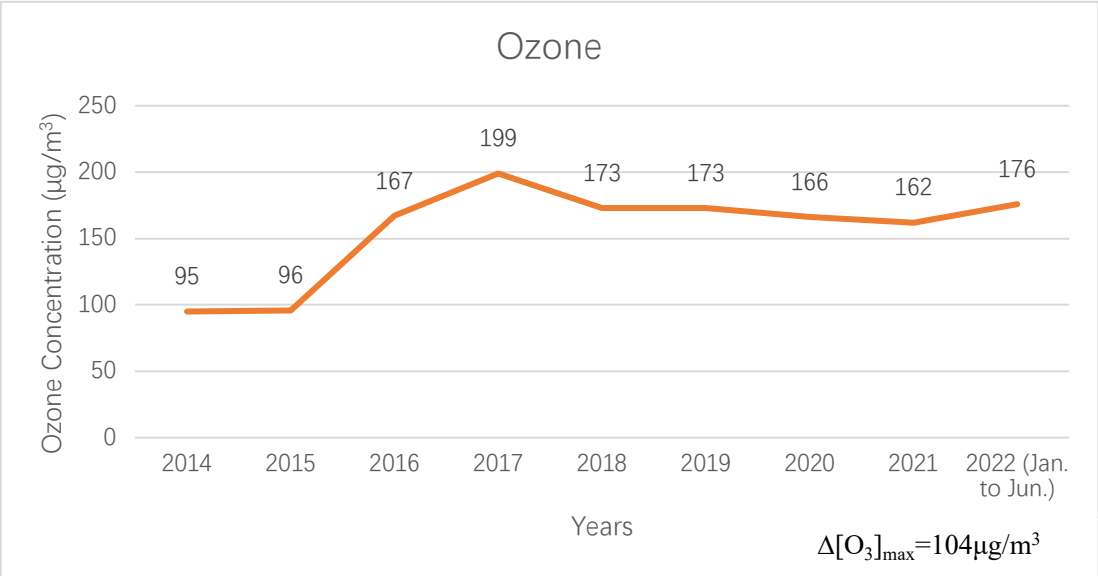


Fig. 3.10, Ozone (O_3) concentrations

In the ozone graph, we can see that the ozone concentration raised from 95μg/m^3 to 96μg/m^3 in 2014 to 2015 to more than 160μg/m^3 in 2016 and never dropped back to previous values. The ozone concentration reached new high in 2017 at nearly 200μg/m^3, and, from this data, we can also see that there is a deterioration in air quality in 2022 as the ozone in this case is bad ozone.

There can be several reasons for the increasing concentration of ozone from 2021 to 2022, and, since the results of the ozone concentration was measured in the first 6 months of 2022, the reason is possibility that there is "a natural influx of ozone from the stratosphere to the troposphere, peaking normally in the spring months when the vertical air movement reaches its maximum in the northern hemisphere"[22].

Periodically concluding the change in air quality in SIP since 2005, we can see that the SIP government's effort in reducing pollution and improving the air quality do pay off.

In conclusion, the changing in the air quality aspects around Jinji Lake and SIP as a whole can be described as **improved** over time but has a **trend** to **deteriorate** again.

[22] Junfeng (Jim) Zhang, Yongjie Wei, and Zhangfu Fang, "Ozone Pollution: A Major Health Hazard Worldwide," *Front Immunol* 2019.10, no. 2518 (October 31, 2019), https://doi.org/10.3389/fimmu.2019.02518.

3.2 Change in Water Quality

Spatial Comparison

A this-essay-specific water quality index can be created to conclude the water pollution aspects of the locations as water pollution index (WPI):

$$WPI = (Total\ Nitrogen\ Content \times 10 + BOD + TDS + EC + Transparency + pH) \times Temperature$$

Location	WPI
D1	25774.24
D2	25740.96
X1	25181.86
X2	37256.76

Spr. 3.11, WPI calculated

Now we can see WPI in a spatial way.

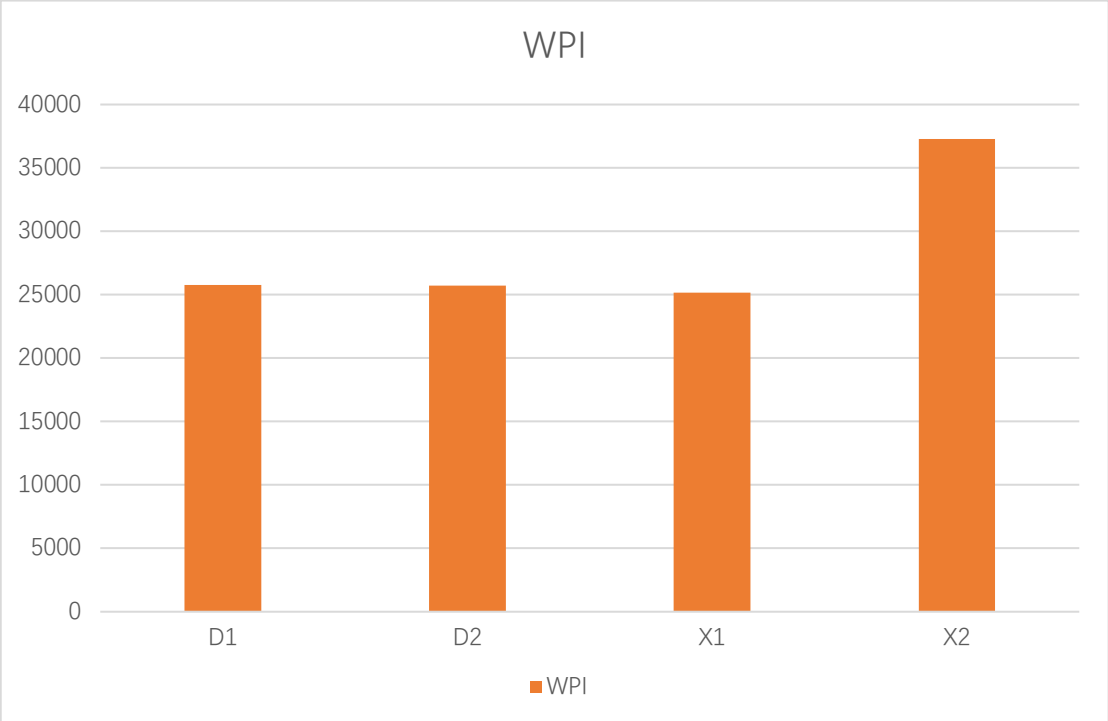


Fig. 3.12, Visual presentation of WPI

From this WPI, we can see that the water is the heaviest polluted at X2. The reason might be the amount of civil engineering projects around the location. Around that location, there are the newly finished Gate of the Orient, the Suzhou Center, and earlier finished Music Fountain of Jinji, Suzhou Lamborghini Hotel, and a series of travel related projects. All these contributes to the deteriorating water environment in X2.

Further analysis on time specific water quality aspects is also included.

As we can see the water quality level changes very little since the grading started in 2005, we can draw the following graph.

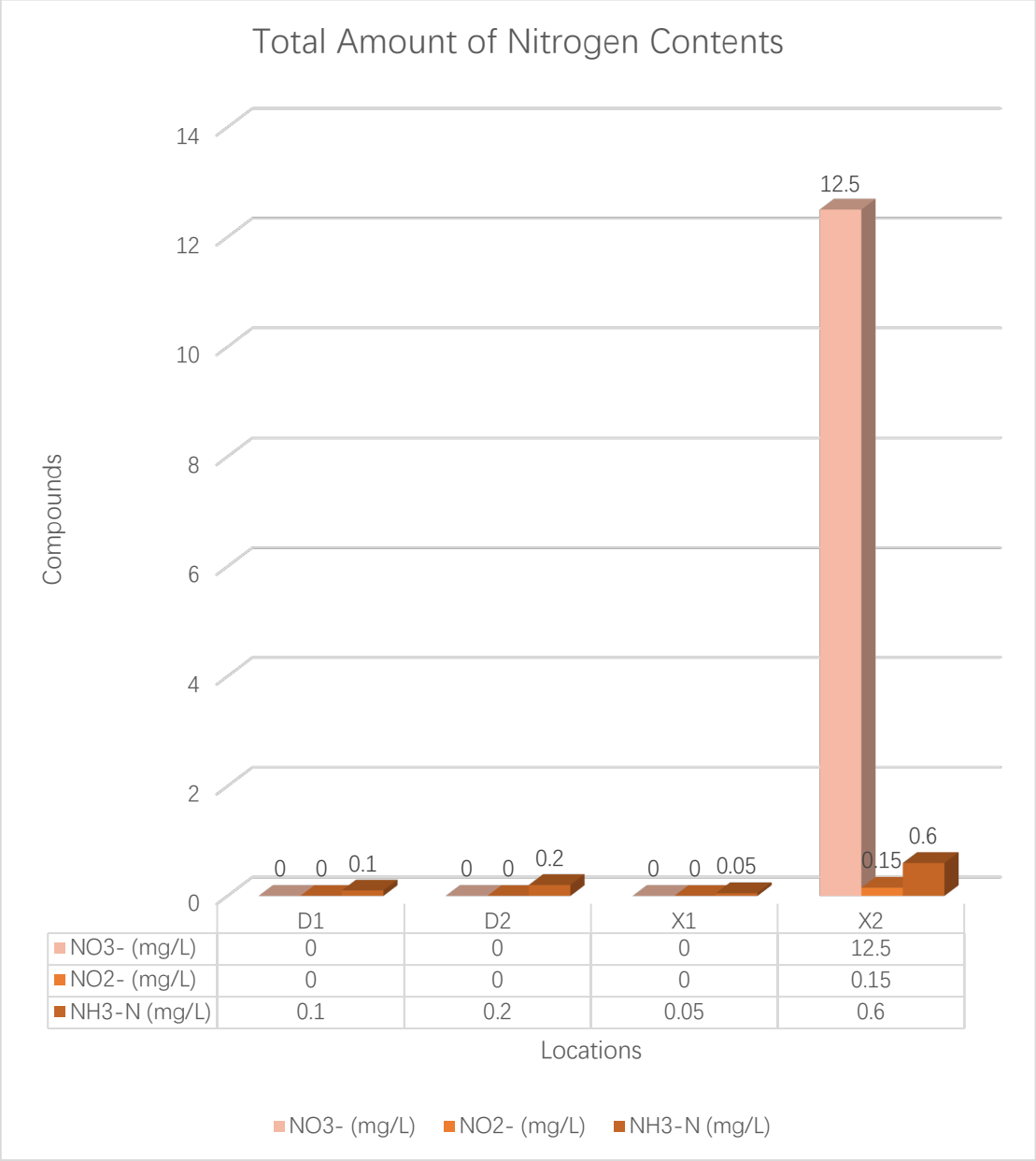
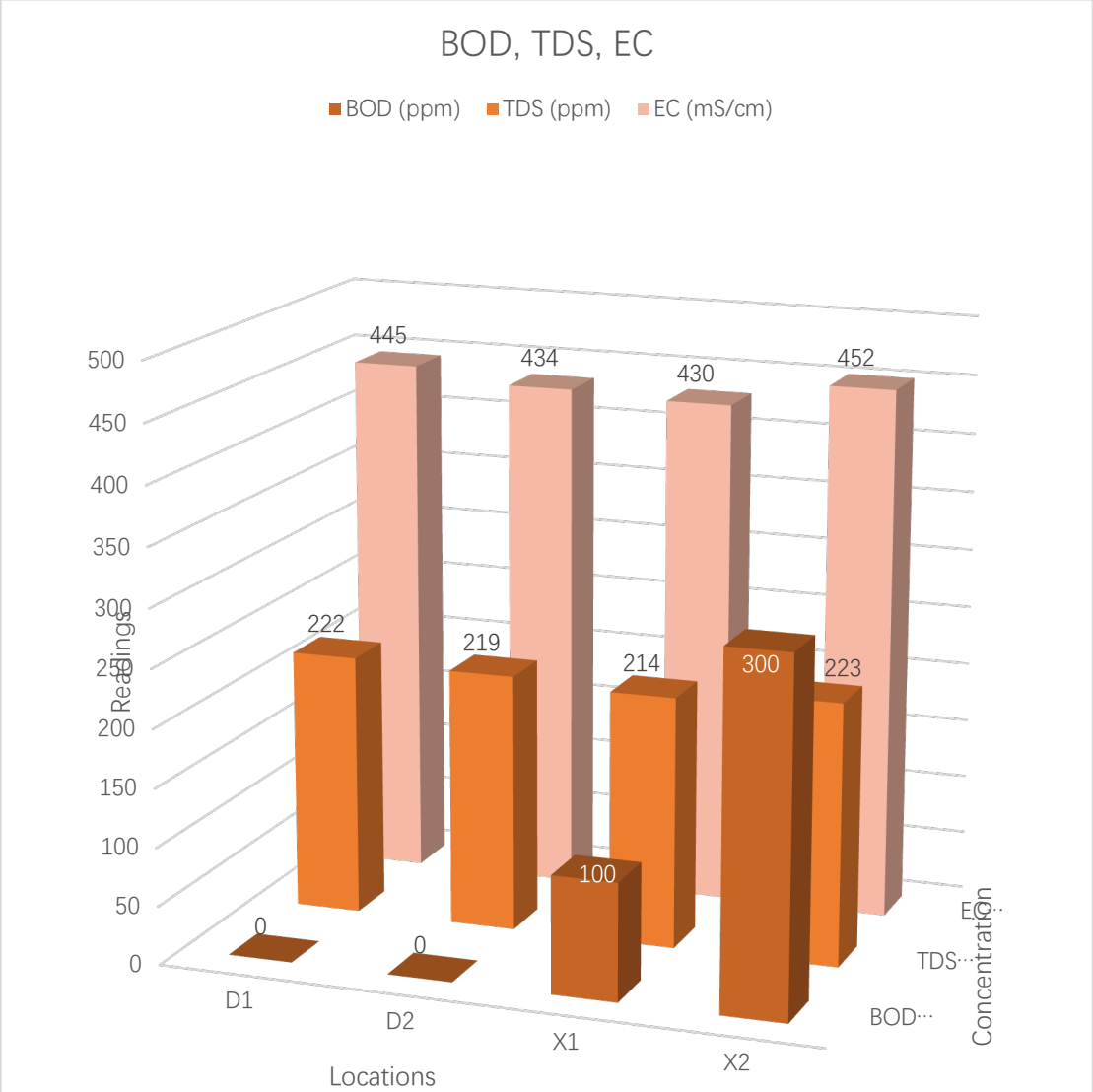


Fig. 3.13, Nitrogen Contents where nitrogen is involved as compounds

For water quality, first the Total Amount of Nitrogen Contents graph is analyzed. As we can see from the graph, X2 has significantly higher amount of nitrogen contents, and if we look at the details, X2 has the highest concentration of all three types of compounds of nitrogen. This can be because of two reasons. First, the Wanghuge Harbor is more frequently used as a harbor compared to the Moon Harbor at D2. Second, the nitrogen compounds in air dissolved more at X2 due to higher day temperatures as shown in the Air Quality Aspects graph.[23]

[23] Lizhi Zheng, M. Cardenas, and Lichun Wang, "Temperature Effects on Nitrogen Cycling and Nitrate Removal-



	D1	D2	X1	X2
BOD (ppm)	0	0	100	300
TDS (ppm)	222	219	214	223
EC (mS/cm)	445	434	430	452

Fig. 3.14, BOD, TDS, EC values

In the BOD, TDS, EC graph, we can see that the TDS and EC values for all four locations are similar, while the BOD value for X2 is significantly higher than all others, the BOD value for X1 is the second highest, while the BOD values for D1 and D2 are 0. This suggested that the water quality at X2 is worst. As a subjective addition information, during the water collection at X2 and X1, the water is very odorous and is covered by green algae.

Production Efficiency in Bedform-Induced Hyporheic Zones," *Journal of Geophysical Research: Biogeosciences* 121 (March 1, 2016): n/a-n/a, https://doi.org/10.1002/2015JG003162.

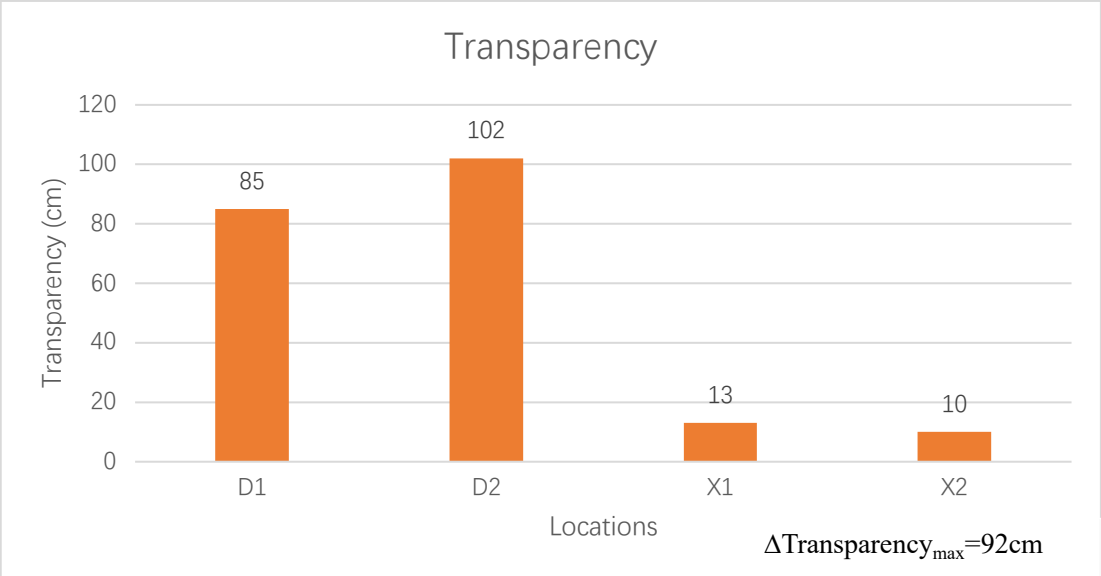


Fig. 3.15, Transparency readings

As I said in the last paragraph, green algae covered X1 and X2, therefore the transparency is poor. The source of green algae may not be known, but it can have several drawbacks, including the decreasing in the beauty of the city, and headache and other issues to humans[24]. The SIP government is said to be improving the water quality environment specifically on resolving problems brought by algae since Nov. 2022, months after my fieldwork[25]。

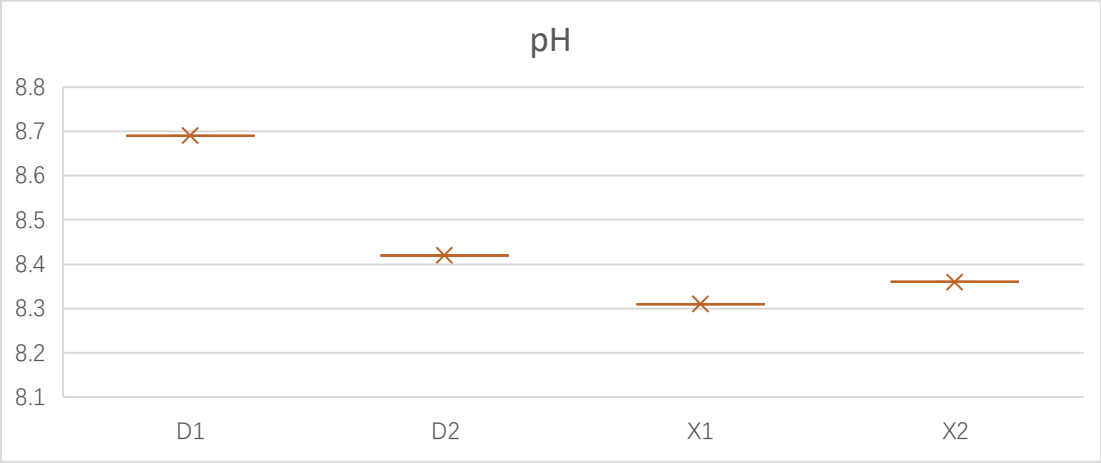


Fig. 3.16, pH values

All the water samples are basic, but in the range of pH 6-9, suiting the range of healthy water as indicated by Surface Water Environment Quality Standards. Despite all the pH values are in the save range, we can see that the pH level of the lake is not average.

[24] Alberta, "Blue-Green Algae," accessed February 22, 2023, https://myhealth.alberta.ca/alberta/pages/blue-green-algae.aspx#:~:text=Blue%2Dgreen%20algae%20(also%20called,on%20the%20surface%20of%20water.
[25] Suzhou Industrial Park Administrative Committee, "Suzhou Industrial Park Takes Various Measures to Help Steadily Improve Water Environment Quality.," accessed February 22, 2023, https://www.suzhou.gov.cn/szsrmzf/wsyljcl/202111/57cad1242b9e4530aa4dc04436b18205.shtml.

Therefore, from the spatial perspective, we can see that the **water quality** is **the worst at X2**, where there are lots of major constructions.

Temporal Comparison

Temporally, we can also see the improvements in the water quality of Jinji Lake since 2005 from governmental statistics.

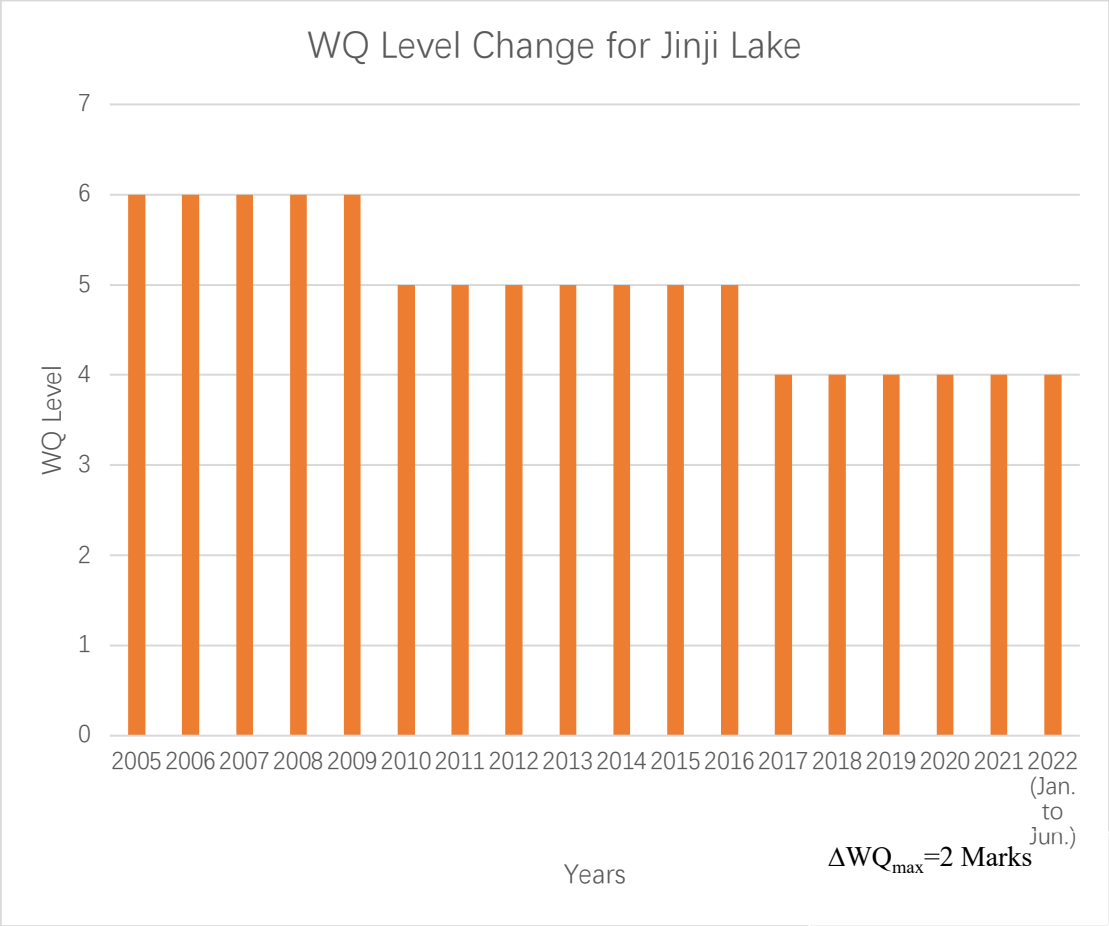


Fig. 3.17, WQ in Jinji Lake[26]

In this graph, "6" represents Level V-, "5" represents Level V, while "4" represents Level IV. The lower the mark, the better the water quality. We can see that there is an improving trend in WQ. This is thanks to SIP's effort in preserving water resources. Additionally, because the Jinji Lake CBD functions as a travel interest point as well, the government sponsored extra investment in treating the water quality.

In conclusion, the change in water quality in Jinji Lake over time can be described as **improved** over time.

[26] Suzhou Open Resources Platform, "Report of the Water Quality of Jinji Lake 2005-2022," accessed February 22, 2023, https://data.suzhou.gov.cn/.

3.3 Change in Biodiversity and Forest Coverage Rate

In SIP, biodiversity and Forest Coverage Rate are measured by the Ecological Environment Index (EI)[27], in which is calculated by

$$EI = 0.35 \times Biodiversity\ Index + 0.25 \times Forest\ Coverage\ Index + 0.15 \times Waternet\ Density + 0.15 \times (100 - Land\ Stress\ Index) + 0.10 \times (100 - Pollution\ Stress\ Index) + Environmental\ Constrained\ Index$$

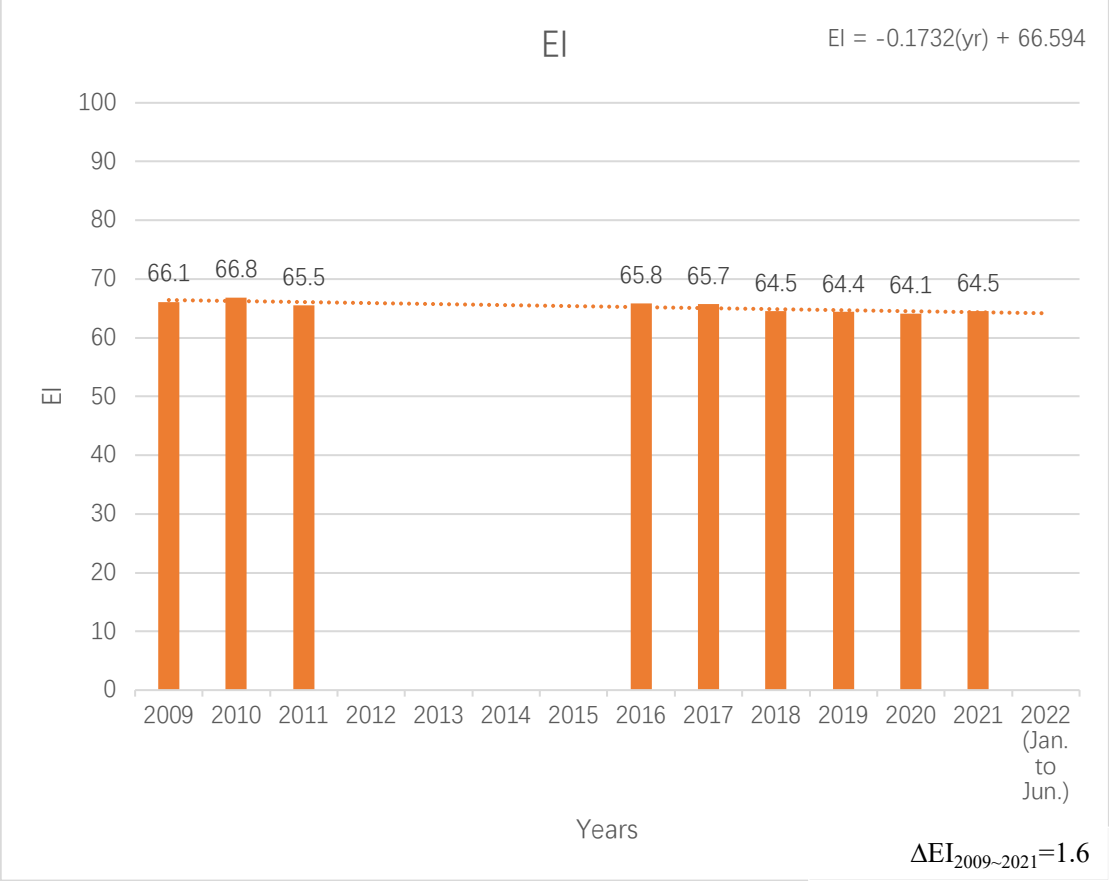


Fig. 3.18, EI ratings[28]

We can see that there is a decreasing trend in biodiversity and forest coverage rate as indicated by EI. This indicates that the environment is deteriorating in SIP.However, the efforts of the SIP government are also seen with the foundation of the Suzhou Industrial Park Jinji Lake Wetland Protection Community in 2012, which indicated the forbidding of opening or enclosing the wetlands, digging sand, borrowing soil, mining, digging ponds, burning wasteland, introducing alien species, releasing animals (unfortunately, this was what I had done in 2009, I released a local crucian in this lake, hopefully it did not impact the environment), and destroying habitats and migration routes.

[27] Meng Xiangliang et al., "Ecological Management Utility Assessment of the Revised Technical Criterion for Ecosystem Status Evaluation in Shandong Province," *Environmental Monitoring and Forewarning* 12, no. 2 (20200331): 56–62.

[28] Figures from the SIPAC official site

Fig. 3.19, Protection of Migratory Birds[29]

Fig. 3.20, Wetland protection board[30]

Furthermore, the changing in Forest Coverage (or the plant coverage overall) can be seen from the changes in the satellite map over the years.

2003

Fig. 3.21, the reuse of Fig. 1.5[31]

2023

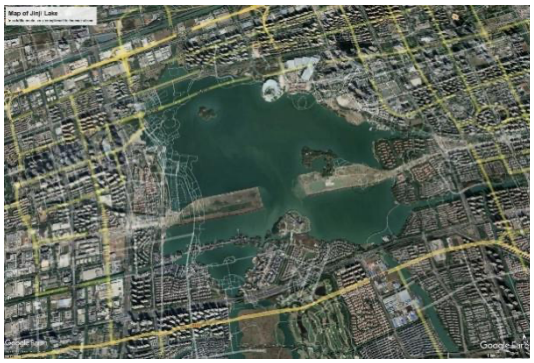


Fig. 3.22, satellite image of Jinji Lake 2023[32]

From the two maps, we can see there are two land reclamation projects in the lake of Jinji, which can potentially harm the biodiversity of the lake of Jinji. In addition, it is obvious that lots of grass land are replaced by apartment buildings and business areas. All the changes are reflected by the decreasing trend in EI as shown in Fig. 3.18.

In conclusion, the change in forest coverage and biodiversity can be described as tried to preserve, but due to development needs, **dropped** initially, but later **recovered**.

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[29] Author, *Photo of the Protection of Migratory Birds*, 2023, 2023.
[30] Author, *Photo of Wetland Protection Board*, 2023, 2023.
[31] Google Earth, "The Satellite Image of Jinji Lake in Its Early Stage of Development in 2003."
[32] Google Earth

4 Conclusions

From this investigation, it can be concluded that:

1. The environment of SIP **had not** degraded much ever since the development of all three CBDs around the Jinji Lake in 2005.
    - The development of the Jinji Lake CBD demonstrates high quality of environmental protection as well as the great effort made by SIP government to regulate air and water pollution in SIP. Nevertheless, in the fieldwork part and the document review part of the investigation, in the year of 2022, there is a decrease in air quality in most measures and have seen a trend of worsening air quality.
2. **Improvements** in AQ and WQ is seen from 2005 to 2021.
    - However, as said in 1, there is a negative trend in AQ and WQ in the year of 2022. This can be a result of global warming and economic recovery after the pandemics as the traffic flow in Suzhou increased.
3. By comparing between the Huxi and Hudong CBDs which have a difference in year of development by three years, we can see that both AQ and WQ at Hudong is **better** than Huxi. Also, Huxi has larger buildings than Hudong.
    - This indicates that the SIP and Singaporean government learned from past experiences to improve their air ventilation design in the urban area and better regulated both air and water pollution in Hudong. In Huxi, as an earlier densely populated area, there is a precipitation of water pollution near both the CBD and the residential around the CBD.

Generally speaking, as a planned urbanization development, Suzhou Industrial Park performs a well-preserved environment in terms of air quality, water quality and biodiversity and forest coverage rate. Inevitably, there are still destructive actions taken on all the measures. Nevertheless, as we can see from the annual data collections, the environment has not degraded much since the development of the Jinji Lake CBD.

It can be firmly concluded that despite certain deterioration in the environment, the overall impact brought by the CBD development around Jinji lake **DID NOT** impact itself and SIP much. Nevertheless, there are even **IMPROVEMENTS** in the environment as shown by certain aspects.

Additionally, a **new** development model can be concluded.

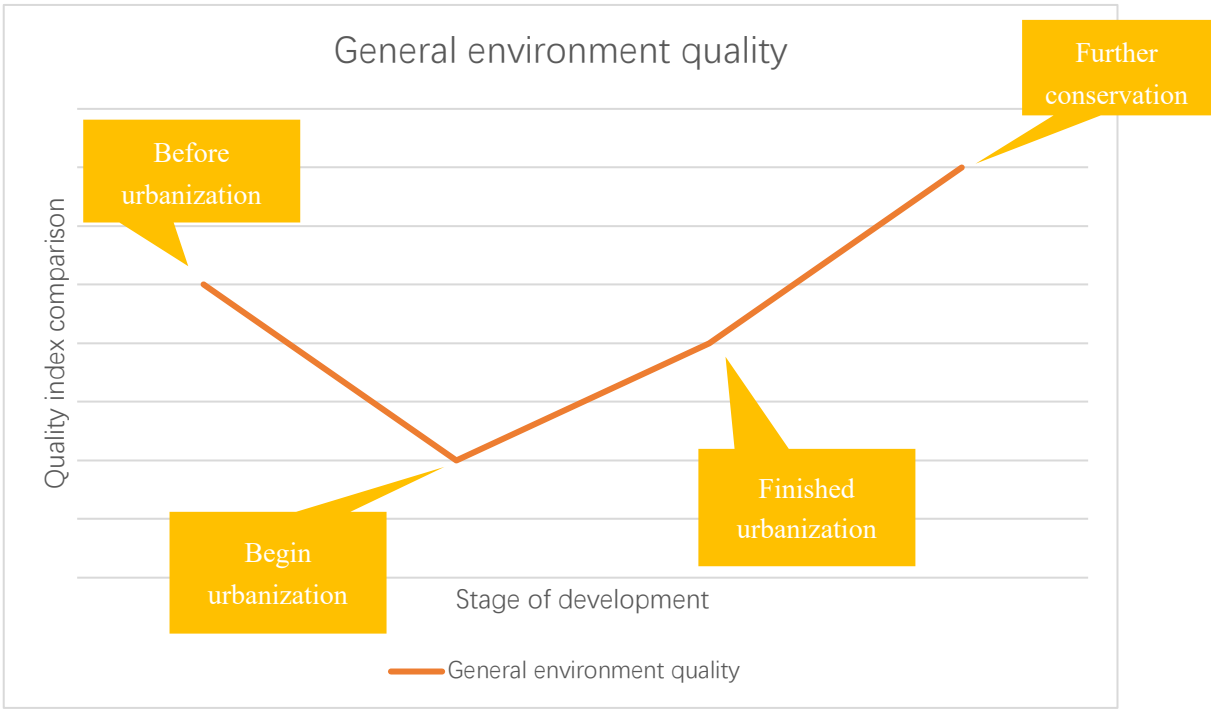

Fig. 4.1, SIP model

This model is based on the data collected in SIP dividing into different stages of development. This model presents that despite there can be deterioration in the development of an urban area, if we tried to conserve the environment, the quality of environment can still improve.

In general, this investigation is a success as it answered the hypotheses at the beginning of the project.

In the future, there should be also investigation on the development of eastern SIP where only the Chinese Government is leading the development project. It is also worthy to compare the improvements of the model from Singapore to SIP. It is my pleasure to live in this planned development urban area and my proud to contribute in investigating hometown.

5 Evaluations

Strengths of this essay:

1. Thorough insight into the major environmental consequences of CBD development around Jinji Lake. All the first-hand data are collected according to relevant standards and all the second-hand data come directly from governmental websites, ensuring their quality and accuracy. The analysis toward the data is directly reflected by the raw data and all the conclusions drawn are compared to literature reviews to ensure their accuracy.
2. Easy to understand diagrams are drawn and pictures to help understanding are used. Diagrams can partially present the trend of my data, and the pictures are both proves of SIP's responsibility in protecting the environment at the same time as the city prospers with all of its magnificent buildings.
3. Air qualities and water qualities have multiple indices to support the overall correlation. A wide variety of indices are collected and analyzed in this essay.

Weaknesses and rooms of improvements of this essay:

1. Do not have access to detailed figures of governmental statistics of water quality and EI as mentioned in *section 3.2* and *3.3*. To improve, and for future studies, should I and future investigators try to access paper-based documentations of the previous data collectors and environmental impact analyzers stored at SIPAC building.
2. Comparison to other models should be included. To improve, I first have to make my model more sophisticated and precise. The current model is still rough one, and to improve, I will have to figure out a new index system that can combine all the aspects of environment together with the level of development of the Jinji Lake CBD or even the SIP as an urban area all together. In addition, my model can only represent the change for urbanization, but not suburbanization, counter-urbanization, and re-urbanization.
3. Possible **improvements** in **choice** of **sampling points**.
    a) This investigation only includes sampling points around the lake shore but did not include the water near the artificial islands, which can be heavily polluted due to its reclamation constructions. Unfortunately, only a limited number of tourists are allowed to go to the two artificial islands due to pandemics. In future investigations, such sampling points should be included and can tell how reclamation might change the water quality locally.
    b) In addition, all the samples are taken near the lake. For air quality, it is better if the air quality has more sample from the more densely populated area, for example, in the Suzhou Center Shopping Mall's Plaza or Time Plaza as introduced in *section 2 Methodologies*.

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