

Air Quality in Ukraine post Ukraine-Russia Dispute

Web address for GitHub repository

Curly Girlyes: Shirley Fontanié, Rachel Gordon, and Julia Weinberg

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1 Rationale and Research Questions

Research question: How does air quality in various Ukrainian cities differ before and after the Ukraine-Russia dispute?

***** Rationale: On February 24, 2022, Russia attacked Ukraine. The first city attacked was Lviv and Dnipro. Kyiv was hit February 24th.

2 Dataset Information

Describe sources of data here (input Julia paragraph)

Explain data wrangling process here (shirley do this)

Data File Name	Description
UkraineData	(Raw) Ukraine air quality data
Ukraine_Processed	(Processed) Ukraine air quality data, w/o na's
Dnipro_2021	Dnipro PM2.5 + PM10, Mar 2021
Dnipro_2022	Dnipro PM2.5+ PM10, Mar 2022
Lviv_2021	Lviv PM 2.5 + PM10, Mar 2021
Lviv_2022	Lviv PM 2.5 + PM10, Mar 2022
FULL_DNIPRO	Lviv_2021 + Lviv_2022 combined
FULL_LVIV	Dnipro_2021 + Dnipro_2022 combined

3 Exploratory Analysis

#I'm confused if we need to upload a shapefile of ukraine so that we can make a map bu
#https://simplemaps.com/data/ua-cities
#we can download a csv of all the cities with lat and long from this link and we could

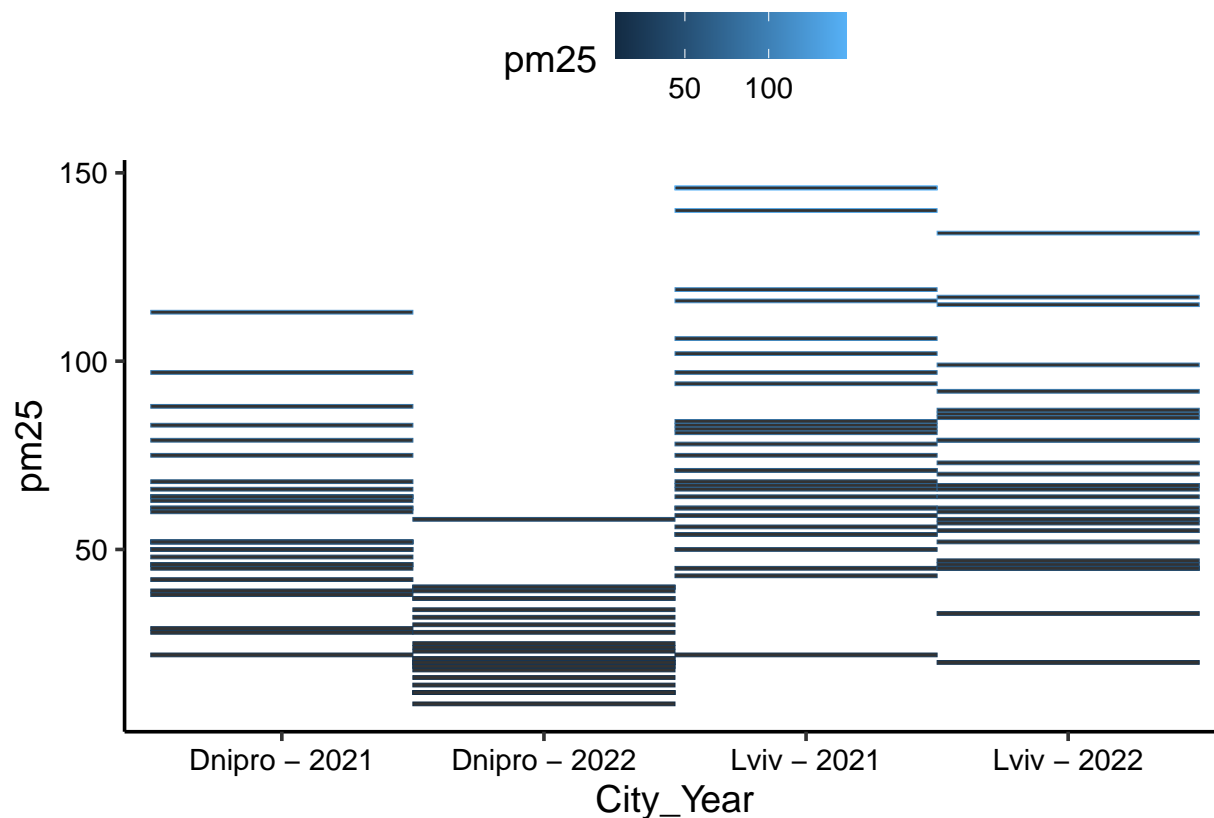


Figure 1: Air Pollution Heat Map

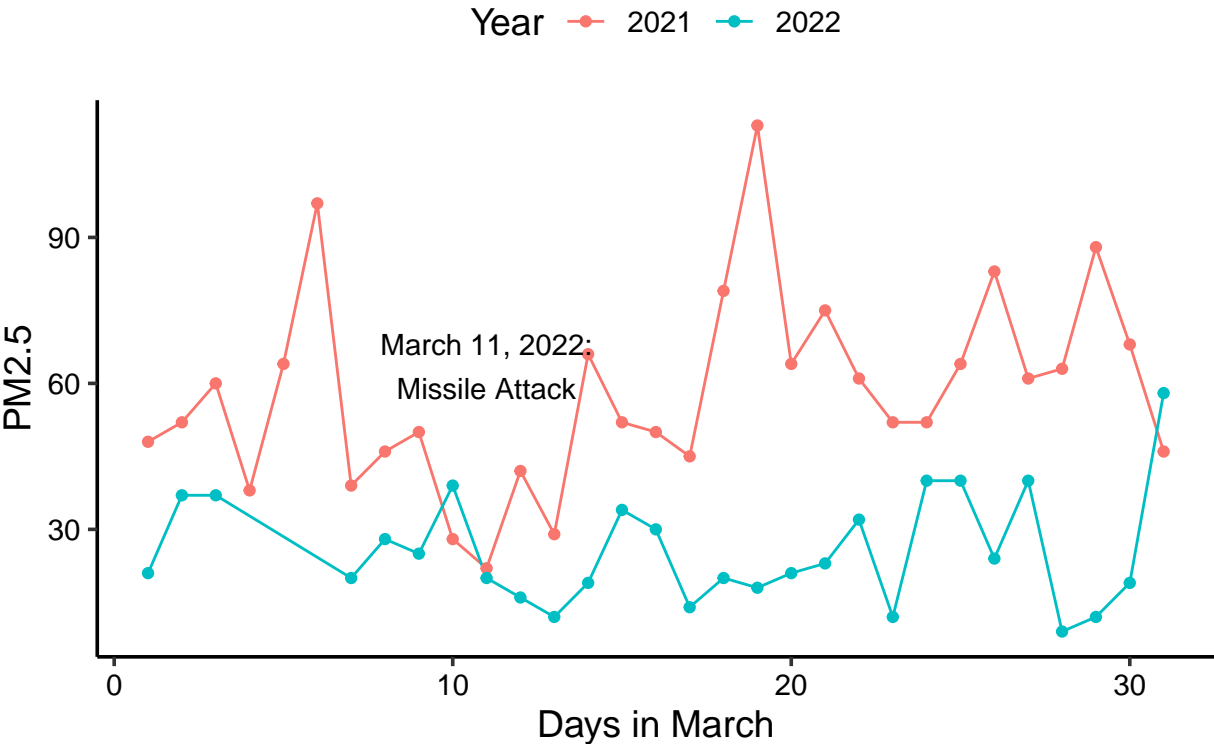
Table 2: PM2.5 Levels by City

City	Mean	Min	Max	Std Dev
Dnipro	49.41546	4	160	25.91608
Lviv	60.51086	8	518	34.79405

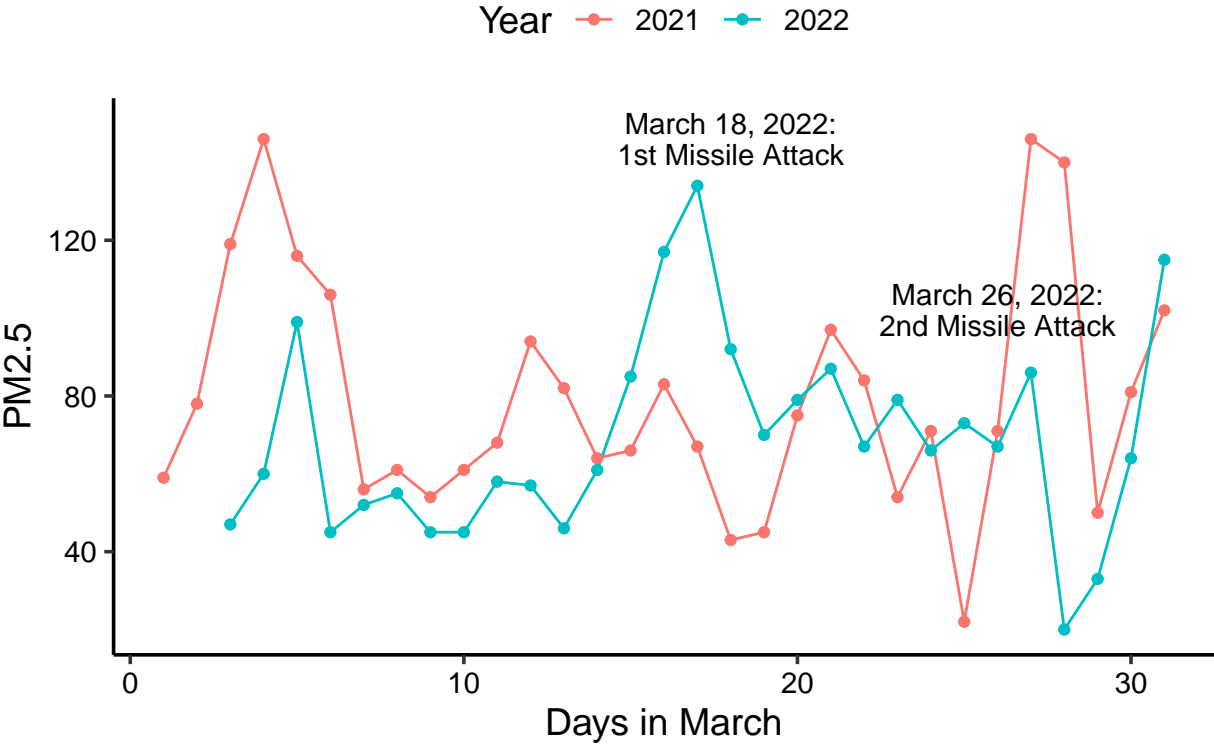
Table 3: PM10 Levels by City

City	Mean	Min	Max	Std Dev
Dnipro	24.73309	2	120	15.82186
Lviv	30.29246	4	606	26.78330

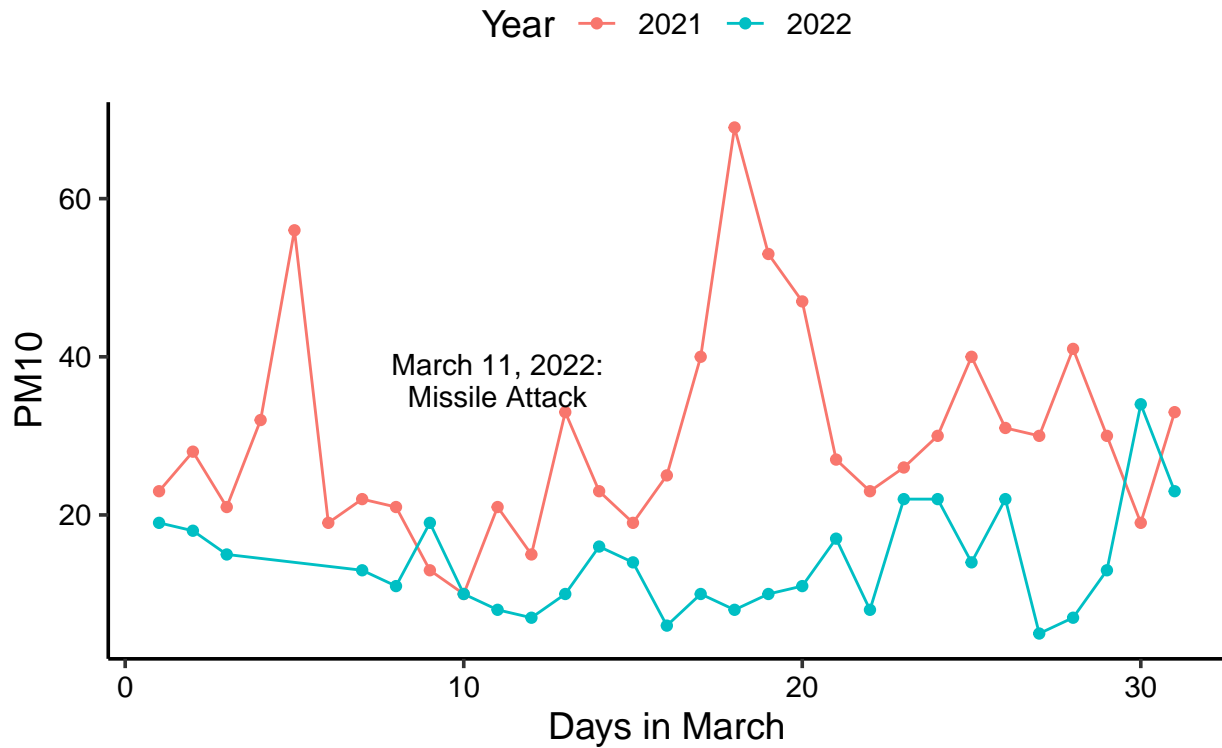
Observing PM2.5 Values in Dnipro, Ukraine



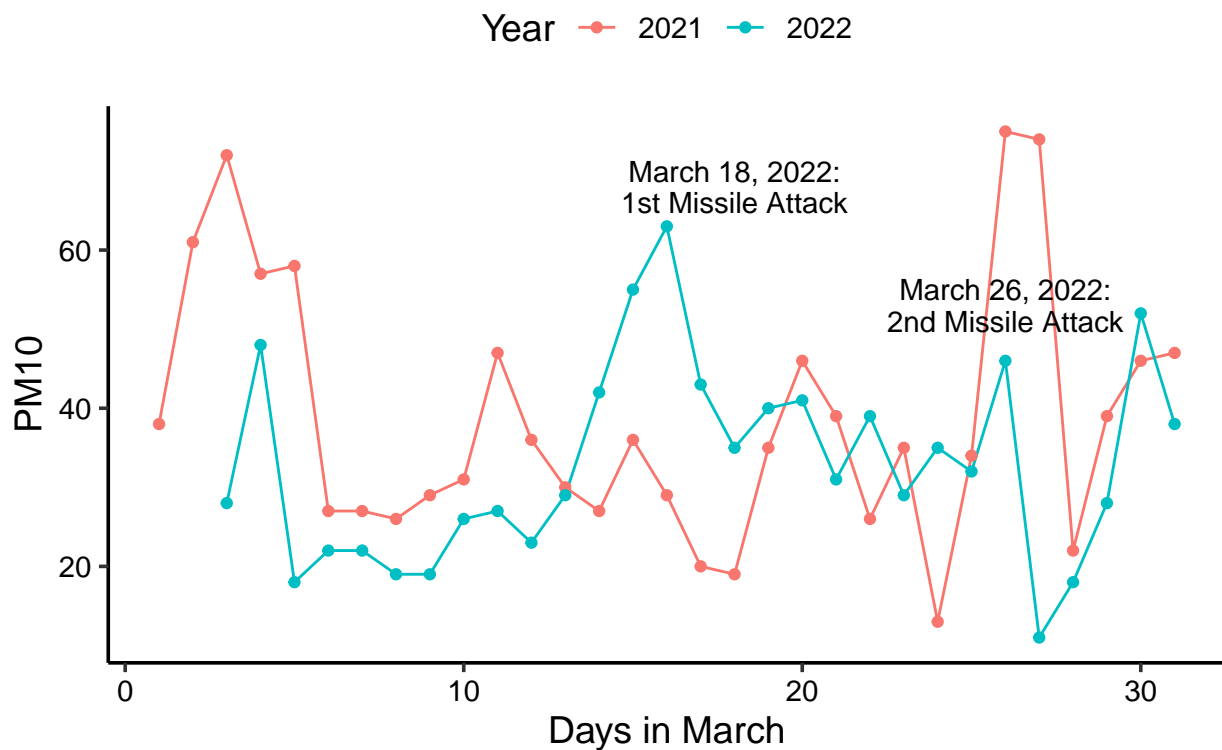
Observing PM2.5 Values in Lviv, Ukraine



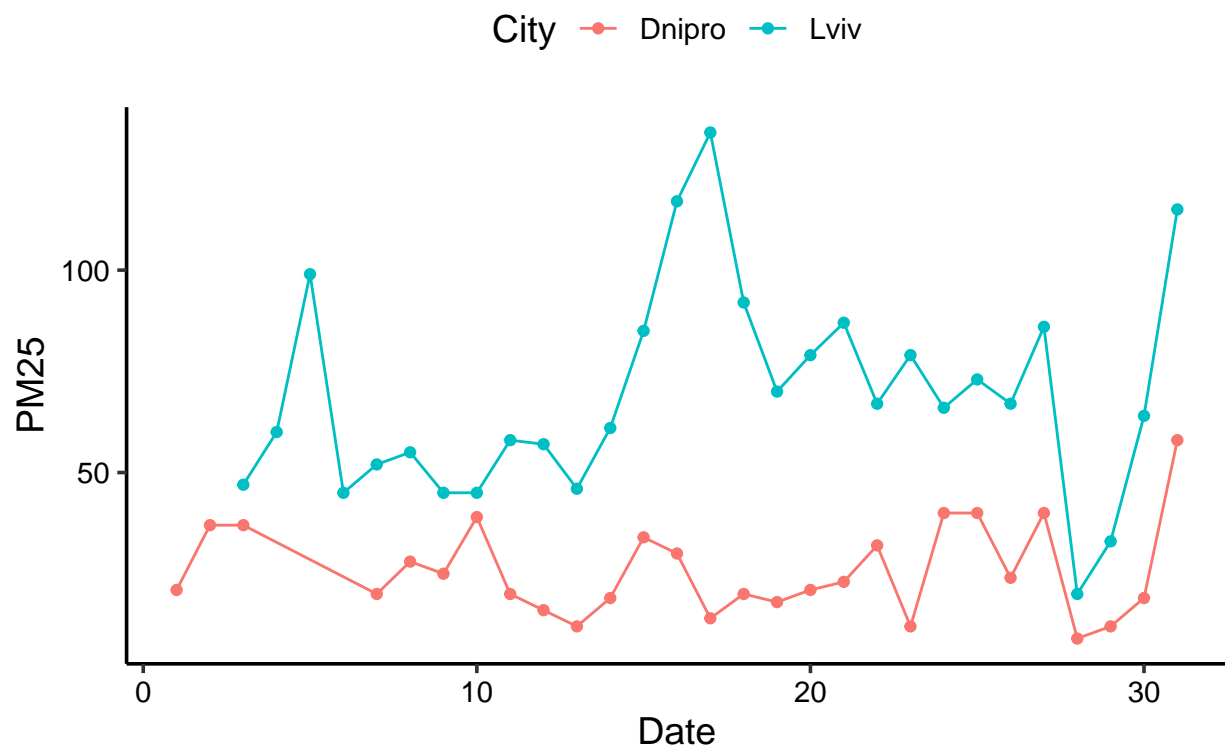
Observing PM10 Values in Dnipro, Ukraine



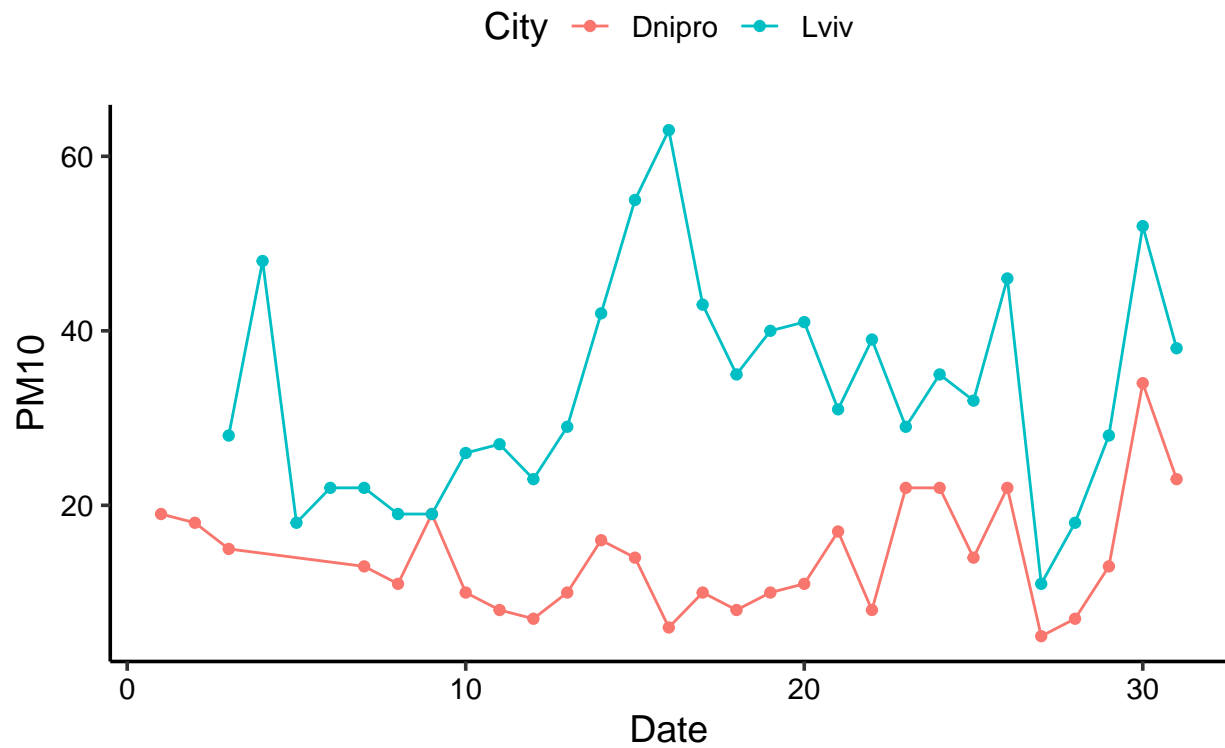
Observing PM10 Values in Lviv, Ukraine



Observing PM25 Values in 2022 Lviv and Dnipro Ukraine



Observing PM10 Values in 2022 Lviv and Dnipro Ukraine



4 Analysis

4.1 Question 1: Are there significant differences in air quality levels between affected Ukrainian cities during the Russian invasion?

[insert text about how we analyzed]

4.2 Question 2: Are there significant differences in air quality levels in affected Ukrainian cities before and during the Russian attacks?

[insert text about how we analyzed]

```
lviv.25.lm <- lm(data = FULL_LVIV, pm25 ~ Year)
summary(lviv.25.lm)
```

```
##
## Call:
## lm(formula = pm25 ~ Year, data = FULL_LVIV)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -57.387 -18.887  -4.745  16.147  66.613
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   79.387      5.071   15.66  <2e-16 ***
## Year2022     -10.284      7.294   -1.41   0.164
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 28.23 on 58 degrees of freedom
## Multiple R-squared:  0.03314,    Adjusted R-squared:  0.01647
## F-statistic: 1.988 on 1 and 58 DF,  p-value: 0.1639
```

```
lviv.10.lm <- lm(data = FULL_LVIV, pm10 ~ Year)
summary(lviv.10.lm)
```

```
##
## Call:
## lm(formula = pm10 ~ Year, data = FULL_LVIV)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -25.742 -11.069  -3.242   8.013  36.258
```

```
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   38.742      2.611   14.84  <2e-16 ***
## Year2022      -5.673      3.756   -1.51    0.136
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 14.54 on 58 degrees of freedom
## Multiple R-squared:  0.03784,    Adjusted R-squared:  0.02125
## F-statistic: 2.281 on 1 and 58 DF,  p-value: 0.1364
```

```
dnipro.25.lm <- lm(data = FULL_DNIPRO, pm25 ~ Year)
summary(dnipro.25.lm)
```

```
##
## Call:
## lm(formula = pm25 ~ Year, data = FULL_DNIPRO)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -35.968  -9.841  -4.714   8.159  55.032
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   57.968      2.971  19.510  < 2e-16 ***
## Year2022      -32.253      4.313  -7.478 5.07e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 16.54 on 57 degrees of freedom
## Multiple R-squared:  0.4952, Adjusted R-squared:  0.4864
## F-statistic: 55.93 on 1 and 57 DF,  p-value: 5.074e-10
```

```
dnipro.10.lm <- lm(data = FULL_DNIPRO, pm10 ~ Year)
summary(dnipro.10.lm)
```

```
##
## Call:
## lm(formula = pm10 ~ Year, data = FULL_DNIPRO)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -19.677  -6.677  -1.677   3.661  39.323
##
## Coefficients:
```

```
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)   29.677      1.893   15.681 < 2e-16 ***
## Year2022     -15.677      2.747   -5.707 4.33e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 10.54 on 57 degrees of freedom
## Multiple R-squared:  0.3636, Adjusted R-squared:  0.3524
## F-statistic: 32.57 on 1 and 57 DF,  p-value: 4.325e-07

dnipro.lviv.pm25.lm <- lm(data = FULL_Air_quality, pm25 ~ City)
summary(dnipro.lviv.pm25.lm)
```

```
##
## Call:
## lm(formula = pm25 ~ City, data = FULL_Air_quality)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -49.103 -11.714  -3.103   11.286   64.897
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)    25.714      3.791    6.783 8.54e-09 ***
## CityLviv       43.389      5.315    8.164 4.72e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 20.06 on 55 degrees of freedom
## Multiple R-squared:  0.5479, Adjusted R-squared:  0.5397
## F-statistic: 66.65 on 1 and 55 DF,  p-value: 4.715e-11

dnipro.lviv.pm10.lm <- lm(data = FULL_Air_quality, pm10 ~ City)
summary(dnipro.lviv.pm10.lm)
```

```
##
## Call:
## lm(formula = pm10 ~ City, data = FULL_Air_quality)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -22.069  -6.000  -1.069    5.931   29.931
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)    14.000      1.895    7.388 8.72e-10 ***
```

```

## CityLviv      19.069      2.657    7.178 1.93e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 10.03 on 55 degrees of freedom
## Multiple R-squared:  0.4837, Adjusted R-squared:  0.4743
## F-statistic: 51.52 on 1 and 55 DF,  p-value: 1.929e-09

```

5 Summary and Conclusions

5.1 Question 1: Are there significant differences in air quality levels between affected Ukrainian cities during the Russian invasion?

[insert text about summary]

5.2 Question 2: Are there significant differences in air quality levels in affected Ukrainian cities before and during the Russian attacks?

[insert text about summary]

6 References

<add references here if relevant, otherwise delete this section>