Temporal and spatial variations of PM2 and PM10 concentrations in Mongolia

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Abstract

PM2.5 and PM10 data for the 4 distinct sites of Mongolia from 2008 to 2020 is found …. …

Plain Language Summary

PM2.5 and PM10 data for the 4 distinct sites of Mongolia from 2008 to 2020 is found …

0.1 Data & Methods

1 01_datawork

Munkhtsetseg

Library

1.1 Import the dataset and remove the duplicates

Import the dataset from the directory of: ~/Data Input/Preprocessing data/Preprocessing data.csv, assign the dataset as object of df:

Remove the duplicates with the function of distinct(), assign the dataset as df_01:

1.2 Produce a table with missing data

1.2.0.1 For date options as year, month, etc:

```
# A tibble: 35 × 9
# Groups:   Station.name [4]
   Station.name  Year NA_date NA_PM2 NA_PM10 NA_Vis NA_WD NA_WS NA_OPC
   <chr>        <int>   <int>  <int>   <int>  <int> <int> <int>  <int>
 1 Dalanzadgad   2009    8760    715     929    659   748   748   8760
 2 Dalanzadgad   2010    8784    921    1086    756   787   787   8784
 3 Dalanzadgad   2011    8760   2652    3309   1759  2394  2394   8760
 4 Dalanzadgad   2012    5088   1074    3016    693  1412  1412   5088
 5 Dalanzadgad   2013    6096   1766    1809   2479  1240  1240   6096
 6 Dalanzadgad   2014    7800    843     921   6068  1482  1482   7800
 7 Dalanzadgad   2015    8760   1539    1587   8115  2635  2635   8760
 8 Dalanzadgad   2016    6288   1654    1613   5995  3306  3306   6288
 9 Sainshand     2009    8688    376     424    423   587   587   8688
10 Sainshand     2010    8784   2557    2577   1113  1210  1210   8784
#  25 more rows
```

1.2.0.2 For station

```
# A tibble: 4 × 8
  Station.name NA_date NA_PM2 NA_PM10 NA_Vis NA_WD NA_WS NA_OPC
  <chr>          <int>  <int>   <int>  <int> <int> <int>  <int>
1 Dalanzadgad    60336  11164   14270  26524 14004 14004  60336
2 Sainshand      59040  11727   11929   9320  8527  8527  59040
3 UB             76656   7879    8716   3770  4053  4053  43415
4 Zamynuud       67392   8880   10075   3444  4960  4960  67392
```

1.2.1 By percentages

```
# A tibble: 4 × 6
# Groups:   Station.name [4]
  Station.name missing_PM2 missing_PM10 missing_Vis missing_WS missing_WD
  <chr>              <dbl>        <dbl>       <dbl>      <dbl>      <dbl>
1 Dalanzadgad         25.7         19.2        44.5       24.3       24.3
2 Sainshand           20.0         19.7        15.7       14.6       14.6
3 UB                  11.9         11.0         4.53       4.85       4.85
4 Zamynuud            14.4         12.7         5.49       7.44       7.44
```

1.3 Note that:

We use the data in the period of 2009-2018, which has been regarded as a monitoring work stabilized since 2008 when is the beginning of the monitoring. According to NIES, site maintenance was consistent up to 2018.

+Sainshand site, data 2009-2015 get used; + Dalanzad site: 2009-2016. + UB: 2009-2018 + Zamyn uud: 2009-2018

2 Remove the spikes, and produce an extended table

Remove the spikes in the datasets, and produce the table with NA, with removed spikes; express it in a percentages. ### Remove the spikes Method 1. Mean value +- (3-5)SD - Find Monthly mean

```
# A tibble: 1,798 × 12
    Year Month   Day  Hour PM2   PM10  Visibility    WD    WS   OPC Station.name
   <int> <int> <int> <int> <chr> <chr>      <int> <int> <dbl> <int> <chr>
 1  2009     1     2    17 Outl… 0.29        3622   141 0.524    NA UB
 2  2009     1     3    12 Outl… 0.446       2399   109 0.117    NA UB
 3  2009     1     3    13 Outl… 0.288       1347    17 0.492    NA UB
 4  2009     1     3    14 Outl… 0.504       1241    12 0.829    NA UB
 5  2009     1     3    15 Outl… 0.478       1341    11 0.39     NA UB
 6  2009     1     3    16 Outl… 0.449       2945   136 0.123    NA UB
 7  2009     1     3    18 Outl… 0.341       1436    13 0.742    NA UB
 8  2009     1     3    19 Outl… 0.397       1847    13 0.453    NA UB
 9  2009     1     3    20 Outl… 0.297       3359    22 0.462    NA UB
10  2009     1     4     2 Outl… 0.311       3167    96 0.759    NA UB
#   1,788 more rows
#   1 more variable: Date <chr>
```

```
# A tibble: 4,014 × 12
    Year Month   Day  Hour PM2   PM10  Visibility    WD    WS   OPC Station.name
   <int> <int> <int> <int> <chr> <chr>      <int> <int> <dbl> <int> <chr>
 1  2009     1     3    15 Outl… 0.292       3444   119 0.856    NA Dalanzadgad
 2  2009     1     5    13 Outl… 0.419       1383   260 1.7      NA Dalanzadgad
 3  2009     1     5    14 Outl… 0.415       1072   266 1.84     NA Dalanzadgad
 4  2009     1     5    15 Outl… 0.466       1099   261 0.83     NA Dalanzadgad
 5  2009     1     5    16 Outl… 0.509       1814   260 0.788    NA Dalanzadgad
 6  2009     1     6     0 Outl… 0.547        744   248 1.23     NA Dalanzadgad
 7  2009     1     6     1 Outl… 0.728       1093   277 0.738    NA Dalanzadgad
 8  2009     1     6     2 Outl… 0.597       1723     0 1.62     NA Dalanzadgad
 9  2009     1     6     3 Outl… 0.33        8186    95 1.1      NA Dalanzadgad
10  2009     1     6    11 Outl… 0.39        1150   258 1.48     NA Dalanzadgad
#   4,004 more rows
#   1 more variable: Date <chr>
```

2.1 Save dataset in folder: 01_data_raw

3 Tidy data

3.1 Fill the missing data

Method 1. Fill the gap Method 2. Relationship equation Method 3. Look-up table

3.2 Save dataset in folder: 02_data_tidy

Source: 01_datawork

3.3 Introduction

Source: Article Notebook

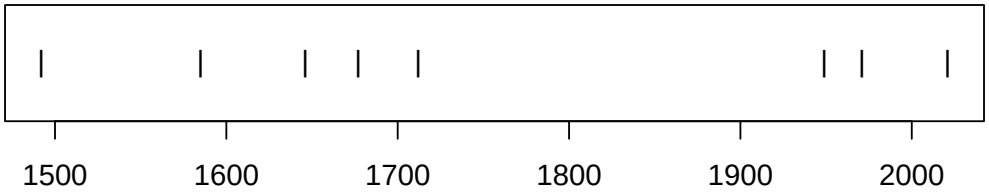

Figure 1: Timeline of recent earthquakes on La Palma

Source: Article Notebook

Source: Article Notebook

Based on data up to and including 1971, eruptions on La Palma happen every 79.8 years on average.

Studies of the magma systems feeding the volcano, such as Marrero et al. (2019), have proposed that there are two main magma reservoirs feeding the Cumbre Vieja volcano; one in the mantle (30-40km depth) which charges and in turn feeds a shallower crustal reservoir (10-20km depth).

Eight eruptions have been recorded since the late 1400s (Figure 1).

Data and methods are discussed in Section 0.1.

Let x denote the number of eruptions in a year. Then, x can be modeled by a Poisson distribution

$$p(x) = \frac{e^{-\lambda}\lambda^x}{x!} \tag{1}$$

where λ is the rate of eruptions per year. Using Equation 1, the probability of an eruption in the next t years can be calculated.

Table 1: Recent historic eruptions on La Palma

Name	Year
Current	2021
Teneguía	1971
Nambroque	1949
El Charco	1712
Volcán San Antonio	1677
Volcán San Martin	1646
Tajuya near El Paso	1585
Montaña Quemada	1492

Table 1 summarises the eruptions recorded since the colonization of the islands by Europeans in the late 1400s.

La Palma is one of the west most islands in the Volcanic Archipelago of the Canary Islands (Figure 2).

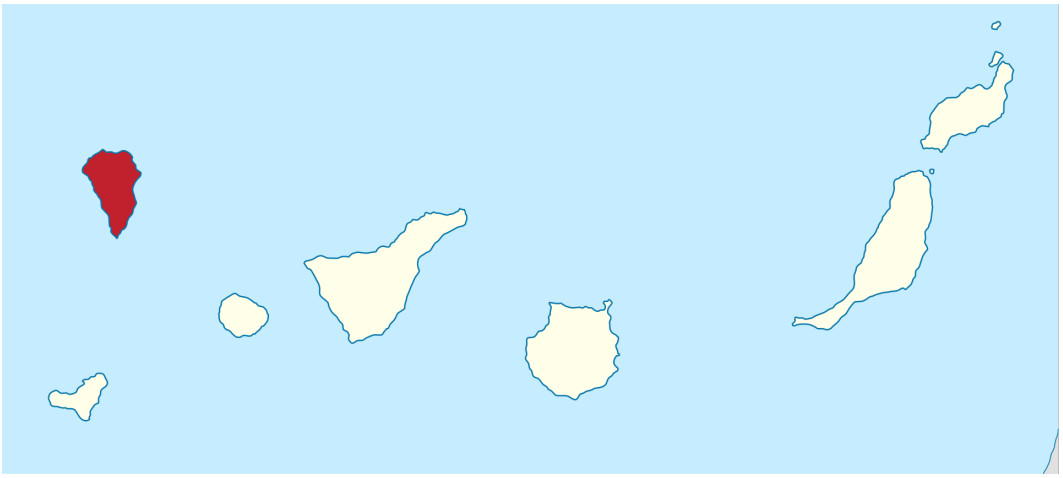

Figure 2: Map of La Palma

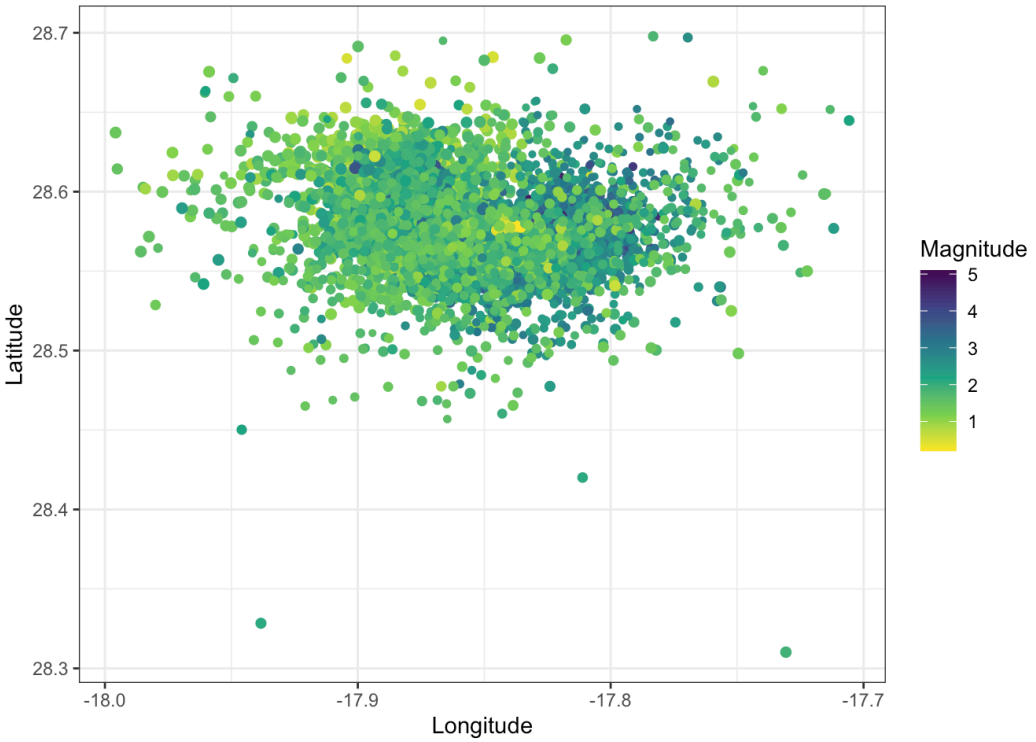

Figure 3: Locations of earthquakes on La Palma since 2017

Source: Explore Earthquakes

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4 Explore Earthquakes

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Library

5 Import the dataset and remove the duplicates

Import the dataset from the directory of: ~/Data Input/Preprocessing data/Preprocessing data.csv, assign the dataset as object of df:

Remove the duplicates with the function of distinct(), assign the dataset as df_01:

5.1 Produce a table with missing data

For date options as year, month, etc:

```
# A tibble: 52 × 9
# Groups:   Station.name [4]
   Station.name  Year NA_date NA_PM2 NA_PM10 NA_Vis NA_WD NA_WS NA_OPC
   <chr>        <int>   <int>  <int>   <int>  <int> <int> <int>  <int>
 1 Dalanzadgad   2008    4630   1543    1672   1463  1566  1566   4630
 2 Dalanzadgad   2009    8760    715     929    659   748   748   8760
 3 Dalanzadgad   2010    8784    921    1086    756   787   787   8784
 4 Dalanzadgad   2011    8760   2652    3309   1759  2394  2394   8760
 5 Dalanzadgad   2012    5088   1074    3016    693  1412  1412   5088
 6 Dalanzadgad   2013    6096   1766    1809   2479  1240  1240   6096
 7 Dalanzadgad   2014    7800    843     921   6068  1482  1482   7800
 8 Dalanzadgad   2015    8760   1539    1587   8115  2635  2635   8760
 9 Dalanzadgad   2016    6288   1654    1613   5995  3306  3306   6288
10 Dalanzadgad   2017    3264     36      45   3264  3264  3264   3264
#  42 more rows
```

For station

```
# A tibble: 4 × 8
  Station.name NA_date NA_PM2 NA_PM10 NA_Vis NA_WD NA_WS NA_OPC
  <chr>          <int>  <int>   <int>  <int> <int> <int>  <int>
1 Dalanzadgad    69454  13081   16327  32475 20058 20058  69454
2 Sainshand     101230  27588   36117  28986 13768 13768 101230
3 UB             95662   7895    8785   3775  4121  4121  62421
4 Zamynuud       99742  32281   33597  22525  5373  5373  99742
```

By percentages

```
# A tibble: 4 × 2
# Groups:   Station.name [4]
  Station.name   sdq
  <chr>        <dbl>
1 Dalanzadgad   10.7
2 Sainshand     25.9
3 UB            17.9
4 Zamynuud      39.6
```

Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.

6 Remove the spikes, and produce an extended table

Remove the spikes in the datasets, and produce the table with NA, with removed spikes; express it in a percentages.

6.0.1 Remove the spikes Method 1. Mean value +- (3-5)SD

Method 2. Seasonal variations, and trend-mean

6.1 Save dataset in folder: 01_data_raw

7 Tidy data

7.1 Fill the missing data

Method 1. Fill the gap Method 2. Relationship equation Method 3. Look-up table

7.2 Save dataset in folder: 02_data_tidy

Read a clean version of data:

Create spatial plot:

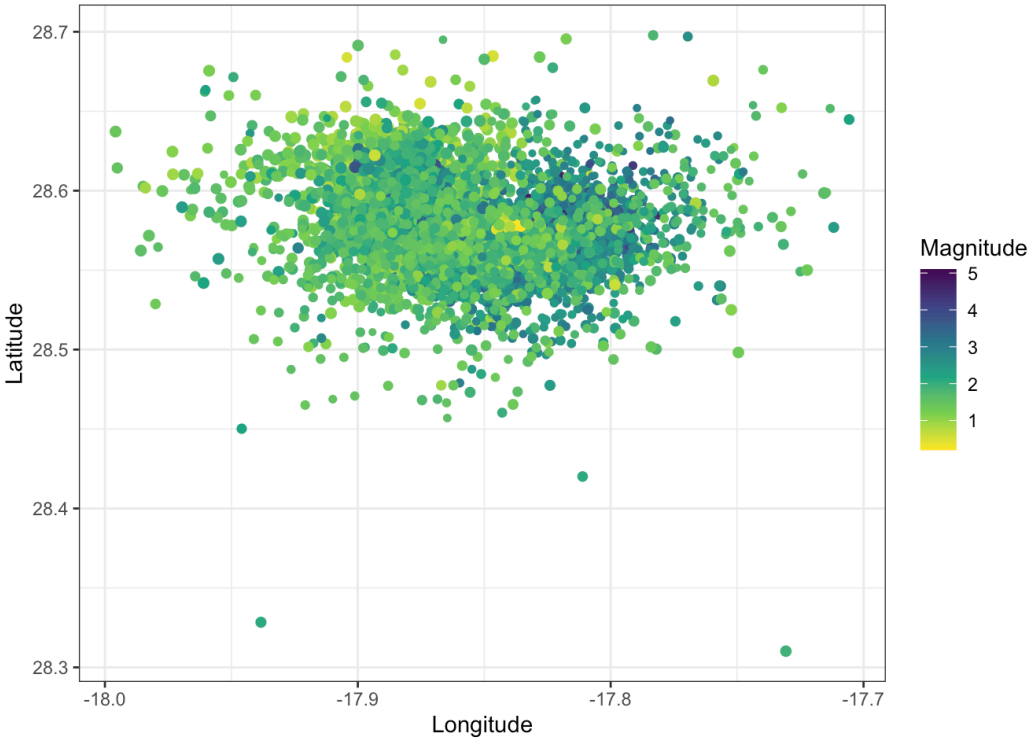

Figure 4: Locations of earthquakes on La Palma since 2017

Source: Explore Earthquakes

Figure 4 shows the location of recent Earthquakes on La Palma.

7.3 Results

7.4 Discussion

7.5 Conclusions

References

Marrero, J., García, A., Berrocoso, M., Llinares, Á., Rodríguez-Losada, A., & Ortiz, R. (2019). Strategies for the development of volcanic hazard maps in monogenetic volcanic fields: The example of La Palma (Canary Islands). *Journal of Applied Volcanology*, *8*. https://doi.org/10.1186/s13617-019-0085-5