5510-Projecxt

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Contents

0.1 How long did it take on average for the CFA brigade to respond to incidents in their own areas for hazard class 2 in Q4 2018/19 and Q4 2019/20? Also, this will be analyzed against the standard time (given in the data for each of the hazard classes). (CFA Emergency Response Time)

0.1.1 Introduction

There are three critical components of CFA delivery services: Response time: This is measured from when the brigade is alerted to an event to when the brigade arrives at the scene.

Brigade area: Each brigade has a defined brigade area, which specifies the operational footprint of the brigade.

Hazard classes: Hazard class defines the type of risk for a given area. Each brigade area may contain multiple hazard classes. However, each hazard class has a predefined service delivery standards.

In the data we have two variables that record the amount of time it CFA brigade to respond to incidents in specified areas:

- The time in which 90% of emergency incidents were responded to by any brigade; and,
- The time in which 90% of emergency incidents were responded to by the brigade within their own Brigade Area

The variable of interest for us is : The time in which 90% of emergency incidents were responded to by the brigade within their own Brigade Area. The reason is because we want to find out the mean time in which CFA brigade responded to incidents in their own brigade areas.

For this purpose, I did bit of data wrangling:

- renamed variables such that now we have a `TimeReponse` variable, and `TimeReponse_within`variable.
- mutate Number of incidents into a numeric vector.
- Changed the character variables to time using the contributed library chron.

For this specific question, we are going to analyze the data for ***Hazard Class 2*** that covers significant urban areas and is primarily residential including commercial centres, clusters of industrial and/or high density community services e.g. schools, correctional facilities, hospitals.

CFA has service delivery standards, which specify a response time target for a brigade to attend an emergency incident. The service delivery standard (response time) for Hazard Class 2 is **8 minutes**. Hence the analysis will be carried against this standard response time.

```
data_20 <- read.csv("data/dat_q4_2020.csv") %>%
  rename(CFA_district = CFA.District)%>%
  rename(CFA_Brigade_Area = CFA.Brigade.Area)%>%
  rename(Number_of_incidents = `Number.of.emergency.incidents.within.the.Brigade.Area.for.the.reporting
  rename(TimeResponse = `The.time.in.which.90..of.emergency.incidents.were.responded.to.by.any.brigade`)
  rename(TimeResponse_within = `The.time.in.which.90..of.emergency.incidents.were.responded.to.by.the.b
  mutate(`TimeResponse_within`= paste0("00:",`TimeResponse_within`))%>%
  mutate(TimeResponse = paste0("00:",TimeResponse))%>%
  mutate(Number_of_incidents = as.numeric(Number_of_incidents))

data_20
```

```
##     X CFA_district CFA_Brigade_Area Number_of_incidents TimeResponse
## 1   1            2          Bendigo                  71     00:06:51
## 2   2            2        Eaglehawk                  17     00:09:45
## 3   3            2    Golden Square                  21     00:07:45
## 4   4            2    Kangaroo Flat                  27     00:09:39
## 5   5            4         Portland                  12     00:06:30
## 6   6            5      Warrnambool                  86     00:07:28
## 7   7            7          Belmont                  61     00:06:49
## 8   8            7            Corio                 105     00:07:51
## 9   9            7     Geelong City                 117     00:06:40
## 10 10            7     Geelong West                  16     00:08:21
## 11 11            7             Lara                  36     00:11:00
## 12 12            7      Ocean Grove                  13     00:05:56
## 13 13            7          Torquay                  36     00:11:58
## 14 14            8          Berwick                  16     00:05:49
## 15 15            8     Carrum Downs                  27     00:10:30
## 16 16            8       Cranbourne                  91     00:08:26
## 17 17            8        Dandenong                 171     00:08:17
## 18 18            8       Edithvale                   13     00:07:18
## 19 19            8        Frankston                 143     00:07:19
## 20 20            8           Hallam                 106     00:08:10
## 21 21            8     Hampton Park                  32     00:08:12
## 22 22            8       Langwarrin                  17     00:10:05
## 23 23            8       Mornington                  24     00:07:20
## 24 24            8         Mt Eliza                  13     00:08:29
## 25 25            8      Noble Park                   31     00:06:47
## 26 26            8         Pakenham                  28     00:09:19
## 27 27            8  Patterson River                  46     00:06:47
```

```
## 28 28            8          Rosebud                  25     00:06:13
##    TimeResponse_within
## 1             00:06:53
## 2             00:13:24
## 3             00:10:14
## 4             00:09:02
## 5             00:06:30
## 6             00:07:28
## 7             00:07:00
## 8             00:07:39
## 9             00:06:40
## 10            00:09:15
## 11            00:10:44
## 12            00:05:56
## 13            00:11:58
## 14            00:05:49
## 15            00:10:44
## 16            00:08:26
## 17            00:08:18
## 18            00:07:20
## 19            00:07:19
## 20            00:08:10
## 21            00:13:12
## 22            00:10:05
## 23            00:07:20
## 24            00:08:29
## 25            00:10:14
## 26            00:09:19
## 27            00:07:35
## 28            00:06:13
```

```r
library(chron)

data_20$TimeResponse_within <- chron(times= data_20$TimeResponse_within)


data_20
```

```
##      X CFA_district CFA_Brigade_Area Number_of_incidents TimeResponse
## 1    1            2          Bendigo                  71     00:06:51
## 2    2            2        Eaglehawk                  17     00:09:45
## 3    3            2    Golden Square                  21     00:07:45
## 4    4            2    Kangaroo Flat                  27     00:09:39
## 5    5            4         Portland                  12     00:06:30
## 6    6            5      Warrnambool                  86     00:07:28
## 7    7            7          Belmont                  61     00:06:49
## 8    8            7            Corio                 105     00:07:51
## 9    9            7     Geelong City                 117     00:06:40
## 10  10            7     Geelong West                  16     00:08:21
## 11  11            7             Lara                  36     00:11:00
## 12  12            7      Ocean Grove                  13     00:05:56
## 13  13            7          Torquay                  36     00:11:58
## 14  14            8          Berwick                  16     00:05:49
## 15  15            8     Carrum Downs                  27     00:10:30
```

```
## 16 16             8       Cranbourne                   91      00:08:26
## 17 17             8        Dandenong                  171      00:08:17
## 18 18             8        Edithvale                   13      00:07:18
## 19 19             8        Frankston                  143      00:07:19
## 20 20             8           Hallam                  106      00:08:10
## 21 21             8     Hampton Park                   32      00:08:12
## 22 22             8       Langwarrin                   17      00:10:05
## 23 23             8       Mornington                   24      00:07:20
## 24 24             8         Mt Eliza                   13      00:08:29
## 25 25             8       Noble Park                   31      00:06:47
## 26 26             8         Pakenham                   28      00:09:19
## 27 27             8   Patterson River                  46      00:06:47
## 28 28             8          Rosebud                   25      00:06:13
##    TimeResponse_within
## 1             00:06:53
## 2             00:13:24
## 3             00:10:14
## 4             00:09:02
## 5             00:06:30
## 6             00:07:28
## 7             00:07:00
## 8             00:07:39
## 9             00:06:40
## 10            00:09:15
## 11            00:10:44
## 12            00:05:56
## 13            00:11:58
## 14            00:05:49
## 15            00:10:44
## 16            00:08:26
## 17            00:08:18
## 18            00:07:20
## 19            00:07:19
## 20            00:08:10
## 21            00:13:12
## 22            00:10:05
## 23            00:07:20
## 24            00:08:29
## 25            00:10:14
## 26            00:09:19
## 27            00:07:35
## 28            00:06:13
```

```r
data_20$TimeResponse <- chron(times=data_20$TimeResponse)

data_20
```

```
##     X CFA_district CFA_Brigade_Area Number_of_incidents TimeResponse
## 1   1            2          Bendigo                  71      00:06:51
## 2   2            2        Eaglehawk                  17      00:09:45
## 3   3            2    Golden Square                  21      00:07:45
## 4   4            2    Kangaroo Flat                  27      00:09:39
## 5   5            4         Portland                  12      00:06:30
## 6   6            5      Warrnambool                  86      00:07:28
```

```
## 7   7             7          Belmont                   61      00:06:49
## 8   8             7            Corio                  105      00:07:51
## 9   9             7     Geelong City                  117      00:06:40
## 10 10             7     Geelong West                   16      00:08:21
## 11 11             7             Lara                   36      00:11:00
## 12 12             7      Ocean Grove                   13      00:05:56
## 13 13             7          Torquay                   36      00:11:58
## 14 14             8          Berwick                   16      00:05:49
## 15 15             8     Carrum Downs                   27      00:10:30
## 16 16             8       Cranbourne                   91      00:08:26
## 17 17             8        Dandenong                  171      00:08:17
## 18 18             8        Edithvale                   13      00:07:18
## 19 19             8        Frankston                  143      00:07:19
## 20 20             8           Hallam                  106      00:08:10
## 21 21             8     Hampton Park                   32      00:08:12
## 22 22             8       Langwarrin                   17      00:10:05
## 23 23             8       Mornington                   24      00:07:20
## 24 24             8         Mt Eliza                   13      00:08:29
## 25 25             8       Noble Park                   31      00:06:47
## 26 26             8         Pakenham                   28      00:09:19
## 27 27             8  Patterson River                   46      00:06:47
## 28 28             8          Rosebud                   25      00:06:13
##    TimeResponse_within
## 1             00:06:53
## 2             00:13:24
## 3             00:10:14
## 4             00:09:02
## 5             00:06:30
## 6             00:07:28
## 7             00:07:00
## 8             00:07:39
## 9             00:06:40
## 10            00:09:15
## 11            00:10:44
## 12            00:05:56
## 13            00:11:58
## 14            00:05:49
## 15            00:10:44
## 16            00:08:26
## 17            00:08:18
## 18            00:07:20
## 19            00:07:19
## 20            00:08:10
## 21            00:13:12
## 22            00:10:05
## 23            00:07:20
## 24            00:08:29
## 25            00:10:14
## 26            00:09:19
## 27            00:07:35
## 28            00:06:13
```

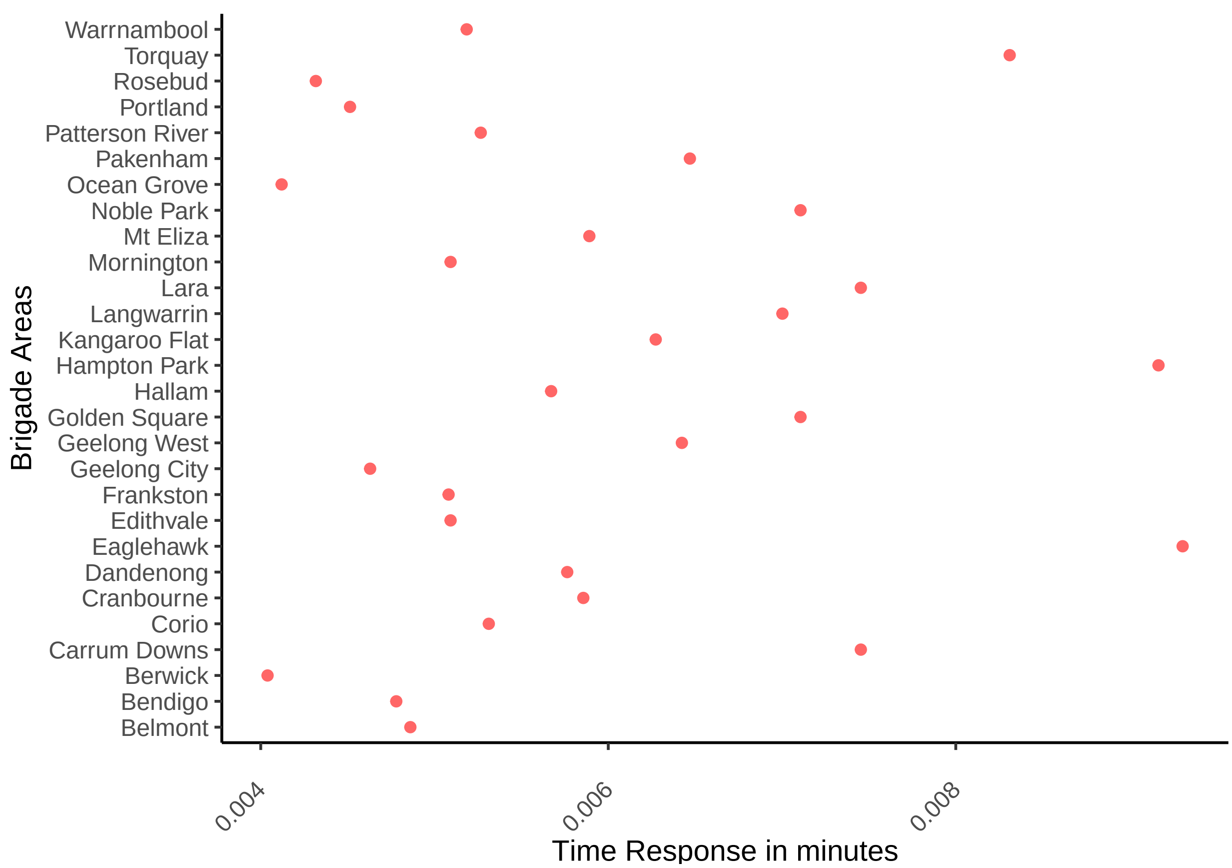
0.1.2 Context

The most recent data from April to June 2020 showed CFA brigades responded to 9,120 incidents, of which 4,893 required an emergency response.

In 87 per cent of incidents that required emergency response, the community received a fire service within the standard response time, which was broadly consistent with previous quarters.CFA News

Let's visualize the data first.

```
ggplot(data_20) +
  geom_point(data = data_20,
aes(x = TimeResponse_within,
y = CFA_Brigade_Area),
color = "red",
alpha = 0.6)+
  theme_classic()+
  theme(axis.text.x = element_text(angle = 45, vjust = 0.5, hjust=1), axis.title.x = element_text(vjust=
  labs(x = "Time Response in minutes",
y = "Brigade Areas")
```




```
data_20 %>%
  select(TimeResponse_within)%>%
  summary(data_20$TimeResponse_within)%>%
  kable() %>%
kable_styling(bootstrap_options = c("striped","hover"))
```

	TimeResponse_within
	Min. :00:05:49
	1st Qu.:00:07:14
	Median :00:08:14
	Mean :00:08:37
	3rd Qu.:00:10:07
	Max. :00:13:24

The mean time that it took CFA brigades to respond to incidents in their own CFA brigade areas is 0.0059838. This is very close to the target response time for brigades, which is eight minutes.

```
data20_avgRT <- function(TimeResponse_within){

  m = sum(TimeResponse_within)/length(TimeResponse_within)
  return(m)
}
data20_avgRT(data_20$TimeResponse_within)
```

```
## [1] 00:08:37
```

For the year 2018/19, we have used the data belonging to the year 2018/19, which was acquired from the CFA official site.

The most recent data set from July to September 2019 showed CFA brigades responding to 9,830 incidents, of which 5,013 required an emergency response.

In 87 per cent of emergencies, the community received a fire service within the standard response time, which was broadly consistent with previous quarters.CFA News

For this part of the question, I repeated the same data cleaning steps as mentioned above.

```
data_19 <- read.csv("data/dat_q4_2018_19.csv")%>%
  rename(CFA_district = CFA.District)%>%
  rename(CFA_Brigade_Area = CFA.Brigade.Area)%>%
  rename(Number_of_incidents = `Number.of.emergency.incidents.within.the.Brigade.Area.for.the.reporting
  rename(TimeResponse = `The.time.in.which.90..of.emergency.incidents.were.responded.to.by.any.brigade`)
  rename(TimeResponse_within = `The.time.in.which.90..of.emergency.incidents.were.responded.to.by.the.b
  filter(TimeResponse_within != "NULL")%>%
  mutate(`TimeResponse_within`= paste0("00:",`TimeResponse_within`))%>%
  mutate(TimeResponse = paste0("00:",TimeResponse))%>%
  mutate(Number_of_incidents = as.numeric(Number_of_incidents))


data_19
```

```
##     X CFA_district CFA_Brigade_Area Number_of_incidents TimeResponse
## 1   1            2          Bendigo                  58     00:07:32
## 2   2            2      Castlemaine                  10     00:09:36
## 3   3            2        Eaglehawk                  16     00:09:23
## 4   4            2    Kangaroo Flat                  12     00:07:48
## 5   5            4         Portland                  19     00:07:00
## 6   6            5      Warrnambool                  44     00:07:13
## 7   7            6            Colac                  10     00:07:46
```

```
## 8   8              7          Belmont                56       00:07:07
## 9   9              7            Corio               102       00:07:31
## 10 10              7     Geelong City              122       00:06:47
## 11 11              7             Lara               26       00:10:28
## 12 12              7      Ocean Grove               10       00:05:28
## 13 13              7          Torquay               15       00:11:55
## 14 14              8          Berwick               25       00:06:46
## 15 15              8     Carrum Downs               32       00:08:57
## 16 16              8       Cranbourne               78       00:09:51
## 17 17              8        Dandenong              126       00:09:13
## 18 18              8        Edithvale               13       00:06:52
## 19 19              8        Frankston              116       00:07:07
## 20 20              8           Hallam               71       00:07:23
## 21 21              8     Hampton Park               18       00:08:35
## 22 22              8       Mornington               38       00:07:07
## 23 24              8         Pakenham               27       00:08:13
## 24 25              8  Patterson River               29       00:07:33
## 25 26              8          Rosebud               17       00:07:27
## 26 27              8       Springvale               62       00:07:53
## 27 28             11       Bairnsdale               11       00:12:21
## 28 29             13        Bayswater               17       00:06:39
## 29 30             13          Boronia               46       00:06:17
## 30 31             13   Chirnside Park               14       00:08:57
## 31 32             13   Ferntree Gully               24       00:07:30
## 32 33             13         Lilydale               17       00:09:23
## 33 34             13         Montrose               16       00:06:49
## 34 35             13         Rowville               28       00:06:57
## 35 36             13         Scoresby               32       00:09:13
## 36 37             13       Warrandyte               14       00:07:27
## 37 38             14 Caroline Springs               67       00:08:57
## 38 39             14      Craigieburn               52       00:09:43
## 39 40             14           Eltham               25       00:06:48
## 40 41             14           Epping               28       00:09:09
## 41 42             14        Greenvale               17       00:08:51
## 42 43             14 Hoppers Crossing               61       00:08:18
## 43 44             14           Melton               79       00:08:04
## 44 45             14           Mernda               12       00:08:35
## 45 46             14       Point Cook               37       00:09:33
## 46 47             14     South Morang               22       00:07:24
## 47 48             14          Sunbury               44       00:08:20
## 48 49             14         Werribee               20       00:07:13
## 49 50             15    Bacchus Marsh               20       00:10:22
## 50 51             15         Ballarat               25       00:08:03
## 51 52             15    Ballarat City               58       00:05:28
## 52 53             15       Sebastopol               16       00:08:45
## 53 54             15        Wendouree               36       00:09:47
## 54 55             16          Stawell               14       00:09:29
## 55 56             18          Mildura               48       00:06:38
## 56 57             22       Shepparton               79       00:07:13
## 57 58             23          Benalla               13       00:08:34
## 58 59             23       Wangaratta               21       00:05:41
## 59 60             24          Wodonga               40       00:07:45
## 60 62             27          Morwell               39       00:06:28
## 61 63             27         Traralgon               34       00:06:34
```

```
##    TimeResponse_within
## 1             00:07:30
## 2             00:09:36
## 3             00:14:45
## 4             00:07:52
## 5             00:07:00
## 6             00:07:13
## 7             00:09:02
## 8             00:08:05
## 9             00:07:56
## 10            00:06:47
## 11            00:10:28
## 12            00:05:28
## 13            00:12:59
## 14            00:06:39
## 15            00:09:21
## 16            00:09:51
## 17            00:09:13
## 18            00:07:13
## 19            00:07:18
## 20            00:08:24
## 21            00:12:16
## 22            00:07:07
## 23            00:07:51
## 24            00:08:20
## 25            00:07:27
## 26            00:08:49
## 27            00:12:23
## 28            00:06:39
## 29            00:06:27
## 30            00:10:30
## 31            00:09:45
## 32            00:09:23
## 33            00:09:07
## 34            00:07:49
## 35            00:12:51
## 36            00:10:31
## 37            00:11:32
## 38            00:09:43
## 39            00:06:48
## 40            00:10:36
## 41            00:11:31
## 42            00:08:18
## 43            00:08:04
## 44            00:08:37
## 45            00:09:33
## 46            00:07:24
## 47            00:08:20
## 48            00:10:03
## 49            00:12:11
## 50            00:10:29
## 51            00:05:27
## 52            00:11:18
## 53            00:16:38
```

```
## 54            00:09:29
## 55            00:06:38
## 56            00:07:13
## 57            00:08:34
## 58            00:06:15
## 59            00:07:45
## 60            00:06:28
## 61            00:06:26
```

```r
library(chron)

data_19$TimeResponse_within <- chron(times= data_19$TimeResponse_within)



data_19
```

```
##      X CFA_district CFA_Brigade_Area Number_of_incidents TimeResponse
## 1    1            2          Bendigo                  58     00:07:32
## 2    2            2       Castlemaine                 10     00:09:36
## 3    3            2        Eaglehawk                  16     00:09:23
## 4    4            2    Kangaroo Flat                  12     00:07:48
## 5    5            4         Portland                  19     00:07:00
## 6    6            5      Warrnambool                  44     00:07:13
## 7    7            6            Colac                  10     00:07:46
## 8    8            7          Belmont                  56     00:07:07
## 9    9            7            Corio                 102     00:07:31
## 10  10            7     Geelong City                 122     00:06:47
## 11  11            7             Lara                  26     00:10:28
## 12  12            7      Ocean Grove                  10     00:05:28
## 13  13            7          Torquay                  15     00:11:55
## 14  14            8          Berwick                  25     00:06:46
## 15  15            8     Carrum Downs                  32     00:08:57
## 16  16            8       Cranbourne                  78     00:09:51
## 17  17            8        Dandenong                 126     00:09:13
## 18  18            8        Edithvale                  13     00:06:52
## 19  19            8        Frankston                 116     00:07:07
## 20  20            8           Hallam                  71     00:07:23
## 21  21            8     Hampton Park                  18     00:08:35
## 22  22            8       Mornington                  38     00:07:07
## 23  24            8         Pakenham                  27     00:08:13
## 24  25            8  Patterson River                  29     00:07:33
## 25  26            8          Rosebud                  17     00:07:27
## 26  27            8       Springvale                  62     00:07:53
## 27  28           11       Bairnsdale                  11     00:12:21
## 28  29           13        Bayswater                  17     00:06:39
## 29  30           13          Boronia                  46     00:06:17
## 30  31           13   Chirnside Park                  14     00:08:57
## 31  32           13   Ferntree Gully                  24     00:07:30
## 32  33           13         Lilydale                  17     00:09:23
## 33  34           13         Montrose                  16     00:06:49
## 34  35           13        Rowville                   28     00:06:57
## 35  36           13         Scoresby                  32     00:09:13
## 36  37           13       Warrandyte                  14     00:07:27
```

```
## 37 38           14 Caroline Springs                 67      00:08:57
## 38 39           14      Craigieburn                 52      00:09:43
## 39 40           14           Eltham                 25      00:06:48
## 40 41           14           Epping                 28      00:09:09
## 41 42           14        Greenvale                 17      00:08:51
## 42 43           14 Hoppers Crossing                 61      00:08:18
## 43 44           14           Melton                 79      00:08:04
## 44 45           14           Mernda                 12      00:08:35
## 45 46           14       Point Cook                 37      00:09:33
## 46 47           14     South Morang                 22      00:07:24
## 47 48           14          Sunbury                 44      00:08:20
## 48 49           14         Werribee                 20      00:07:13
## 49 50           15    Bacchus Marsh                 20      00:10:22
## 50 51           15         Ballarat                 25      00:08:03
## 51 52           15    Ballarat City                 58      00:05:28
## 52 53           15       Sebastopol                 16      00:08:45
## 53 54           15        Wendouree                 36      00:09:47
## 54 55           16          Stawell                 14      00:09:29
## 55 56           18          Mildura                 48      00:06:38
## 56 57           22       Shepparton                 79      00:07:13
## 57 58           23          Benalla                 13      00:08:34
## 58 59           23       Wangaratta                 21      00:05:41
## 59 60           24          Wodonga                 40      00:07:45
## 60 62           27          Morwell                 39      00:06:28
## 61 63           27        Traralgon                 34      00:06:34
##    TimeResponse_within
## 1             00:07:30
## 2             00:09:36
## 3             00:14:45
## 4             00:07:52
## 5             00:07:00
## 6             00:07:13
## 7             00:09:02
## 8             00:08:05
## 9             00:07:56
## 10            00:06:47
## 11            00:10:28
## 12            00:05:28
## 13            00:12:59
## 14            00:06:39
## 15            00:09:21
## 16            00:09:51
## 17            00:09:13
## 18            00:07:13
## 19            00:07:18
## 20            00:08:24
## 21            00:12:16
## 22            00:07:07
## 23            00:07:51
## 24            00:08:20
## 25            00:07:27
## 26            00:08:49
## 27            00:12:23
## 28            00:06:39
```

```
## 29             00:06:27
## 30             00:10:30
## 31             00:09:45
## 32             00:09:23
## 33             00:09:07
## 34             00:07:49
## 35             00:12:51
## 36             00:10:31
## 37             00:11:32
## 38             00:09:43
## 39             00:06:48
## 40             00:10:36
## 41             00:11:31
## 42             00:08:18
## 43             00:08:04
## 44             00:08:37
## 45             00:09:33
## 46             00:07:24
## 47             00:08:20
## 48             00:10:03
## 49             00:12:11
## 50             00:10:29
## 51             00:05:27
## 52             00:11:18
## 53             00:16:38
## 54             00:09:29
## 55             00:06:38
## 56             00:07:13
## 57             00:08:34
## 58             00:06:15
## 59             00:07:45
## 60             00:06:28
## 61             00:06:26
```

```
data_19$TimeResponse <- chron(times=data_19$TimeResponse)

data_19
```

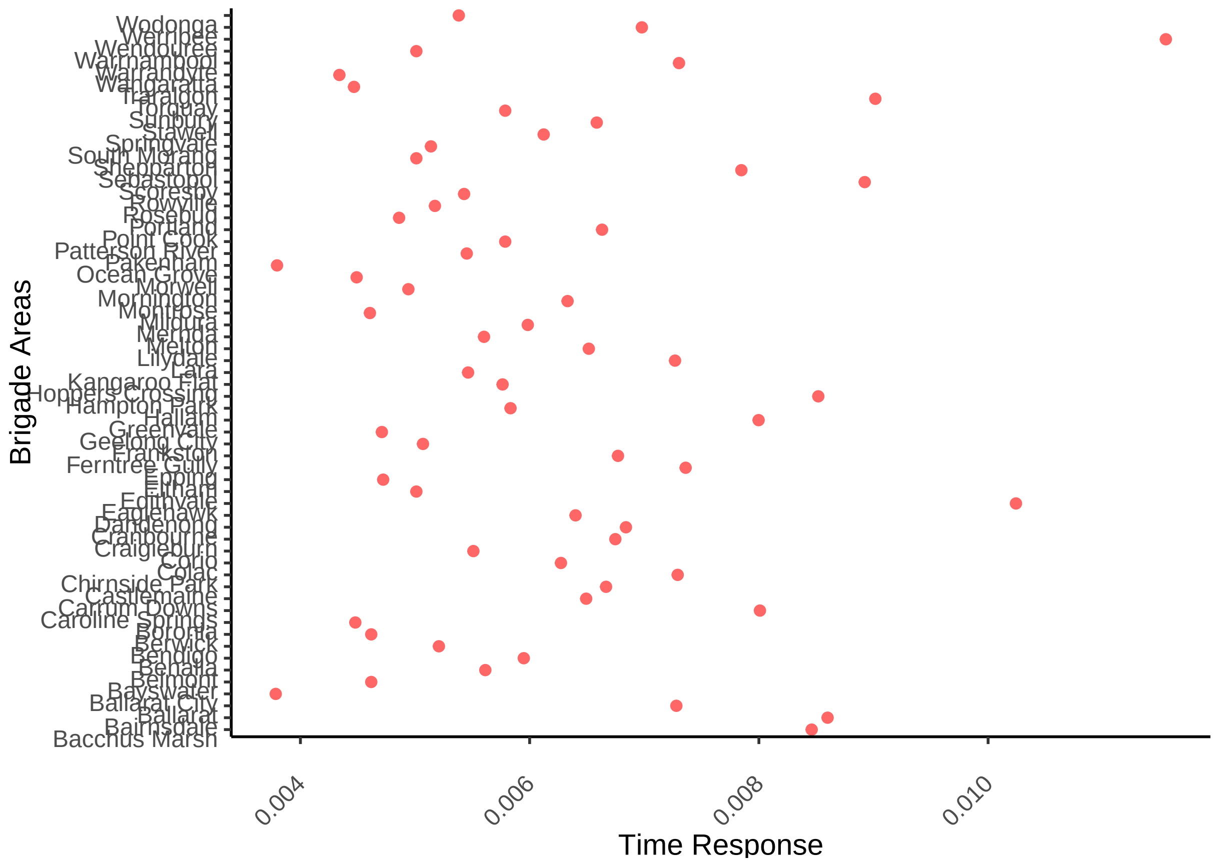
```
##       X CFA_district CFA_Brigade_Area Number_of_incidents TimeResponse
## 1     1            2          Bendigo                  58     00:07:32
## 2     2            2      Castlemaine                  10     00:09:36
## 3     3            2        Eaglehawk                  16     00:09:23
## 4     4            2    Kangaroo Flat                  12     00:07:48
## 5     5            4         Portland                  19     00:07:00
## 6     6            5      Warrnambool                  44     00:07:13
## 7     7            6            Colac                  10     00:07:46
## 8     8            7          Belmont                  56     00:07:07
## 9     9            7            Corio                 102     00:07:31
## 10   10            7     Geelong City                 122     00:06:47
## 11   11            7             Lara                  26     00:10:28
## 12   12            7      Ocean Grove                  10     00:05:28
## 13   13            7          Torquay                  15     00:11:55
## 14   14            8          Berwick                  25     00:06:46
## 15   15            8     Carrum Downs                  32     00:08:57
```

```
## 16 16              8         Cranbourne                    78      00:09:51
## 17 17              8          Dandenong                   126      00:09:13
## 18 18              8          Edithvale                    13      00:06:52
## 19 19              8          Frankston                   116      00:07:07
## 20 20              8             Hallam                    71      00:07:23
## 21 21              8       Hampton Park                    18      00:08:35
## 22 22              8         Mornington                    38      00:07:07
## 23 24              8           Pakenham                    27      00:08:13
## 24 25              8   Patterson River                    29      00:07:33
## 25 26              8            Rosebud                    17      00:07:27
## 26 27              8         Springvale                    62      00:07:53
## 27 28             11         Bairnsdale                    11      00:12:21
## 28 29             13          Bayswater                    17      00:06:39
## 29 30             13            Boronia                    46      00:06:17
## 30 31             13    Chirnside Park                    14      00:08:57
## 31 32             13    Ferntree Gully                    24      00:07:30
## 32 33             13           Lilydale                    17      00:09:23
## 33 34             13           Montrose                    16      00:06:49
## 34 35             13           Rowville                    28      00:06:57
## 35 36             13           Scoresby                    32      00:09:13
## 36 37             13         Warrandyte                    14      00:07:27
## 37 38             14 Caroline Springs                    67      00:08:57
## 38 39             14        Craigieburn                    52      00:09:43
## 39 40             14             Eltham                    25      00:06:48
## 40 41             14             Epping                    28      00:09:09
## 41 42             14          Greenvale                    17      00:08:51
## 42 43             14 Hoppers Crossing                    61      00:08:18
## 43 44             14             Melton                    79      00:08:04
## 44 45             14             Mernda                    12      00:08:35
## 45 46             14         Point Cook                    37      00:09:33
## 46 47             14       South Morang                    22      00:07:24
## 47 48             14            Sunbury                    44      00:08:20
## 48 49             14           Werribee                    20      00:07:13
## 49 50             15      Bacchus Marsh                    20      00:10:22
## 50 51             15           Ballarat                    25      00:08:03
## 51 52             15      Ballarat City                    58      00:05:28
## 52 53             15         Sebastopol                    16      00:08:45
## 53 54             15          Wendouree                    36      00:09:47
## 54 55             16            Stawell                    14      00:09:29
## 55 56             18            Mildura                    48      00:06:38
## 56 57             22         Shepparton                    79      00:07:13
## 57 58             23            Benalla                    13      00:08:34
## 58 59             23         Wangaratta                    21      00:05:41
## 59 60             24            Wodonga                    40      00:07:45
## 60 62             27            Morwell                    39      00:06:28
## 61 63             27          Traralgon                    34      00:06:34
##    TimeResponse_within
## 1             00:07:30
## 2             00:09:36
## 3             00:14:45
## 4             00:07:52
## 5             00:07:00
## 6             00:07:13
## 7             00:09:02
```

```
## 8                00:08:05
## 9                00:07:56
## 10               00:06:47
## 11               00:10:28
## 12               00:05:28
## 13               00:12:59
## 14               00:06:39
## 15               00:09:21
## 16               00:09:51
## 17               00:09:13
## 18               00:07:13
## 19               00:07:18
## 20               00:08:24
## 21               00:12:16
## 22               00:07:07
## 23               00:07:51
## 24               00:08:20
## 25               00:07:27
## 26               00:08:49
## 27               00:12:23
## 28               00:06:39
## 29               00:06:27
## 30               00:10:30
## 31               00:09:45
## 32               00:09:23
## 33               00:09:07
## 34               00:07:49
## 35               00:12:51
## 36               00:10:31
## 37               00:11:32
## 38               00:09:43
## 39               00:06:48
## 40               00:10:36
## 41               00:11:31
## 42               00:08:18
## 43               00:08:04
## 44               00:08:37
## 45               00:09:33
## 46               00:07:24
## 47               00:08:20
## 48               00:10:03
## 49               00:12:11
## 50               00:10:29
## 51               00:05:27
## 52               00:11:18
## 53               00:16:38
## 54               00:09:29
## 55               00:06:38
## 56               00:07:13
## 57               00:08:34
## 58               00:06:15
## 59               00:07:45
## 60               00:06:28
## 61               00:06:26
```

Let's visualize the data for the year 2018/19.

```
ggplot(data_19) +
  geom_point(data = data_19,
aes(x = TimeResponse_within,
y = CFA_Brigade_Area),
color = "red",
alpha = 0.6)+
  theme_classic()+
  theme(axis.text.x = element_text(angle = 45, vjust = 0.5, hjust=1), axis.title.x = element_text(vjust=
  theme(axis.text.y =  element_text(angle = , vjust = 1, hjust=1), axis.title.y =  element_text(vjust=-
labs(x = "Time Response",
y = "Brigade Areas")
```




```
data_19%>%
  select(TimeResponse_within)%>%
  summary(data_19$TimeResponse_within)%>%
  kable() %>%
kable_styling(bootstrap_options = c("striped","hover"))
```

Using the summary function, we can see that the mean time taken by the CFA brigades to respond to the incidents in their own areas was 0.0062073. This is agian very close to the target standard which was eight minutes.

	TimeResponse_within
	Min. :00:05:27
	1st Qu.:00:07:13
	Median :00:08:24
	Mean :00:08:56
	3rd Qu.:00:10:03
	Max. :00:16:38

```
data19_avgRT <- function(TimeResponse_within){

  m = sum(TimeResponse_within, na.rm = TRUE)/length(TimeResponse_within)
  return(m)
}
data19_avgRT(data_19$TimeResponse_within)
```

```
## [1] 00:08:56
```

0.1.3 Analysis

Keeping it brief, we can state that CFA brigades' performance against standard time of eight minutes for the hazard class 2 was achieved successfully, since we see a little variation in terms of amount of time taken by the CFA.

0.2 Which of the CFA brigade areas have had the highest number of incidents across Hazard classes for the reported period (2019/20) (four quarters). (CFA Emergency Response Time)

0.2.1 Introduction

In this question, we have one variable that records the number of incidents across all hazard classes for all the specified districts. There are three predefined hazard classes: 2, 3 and 4.

- Hazard class 2 (Medium Urban): This includes significant urban areas which are primarily residential including commercial centres, clusters of industrial and/or high density community services e.g. schools, correctional facilities, hospitals. (8 minutes SDS).
- Hazard Class 3 (Low Urban): This includes all urban areas that are not included in Hazard Class 2 and includes predominantly residential occupancies and small industries. (10 minutes SDS).
- Hazard Class 4 (Rural): This includes primarily the natural surroundings in terms of bush and grassland, but also involves isolated dwellings and structures within those areas.

The variable of interest for us is : Number_Incidents_total.

For this purpose, I did bit of data wrangling:

- renamed variables such that now we have a `CFA_Brigade_Area` variable, and `Number_Incidents_total`variable in each data set. (I had four datasets for Quarters 1, 2, 3,and 4)
- mutate Number of incidents into a numeric vector.
- Join data using bind_rows

0.2.2 Context

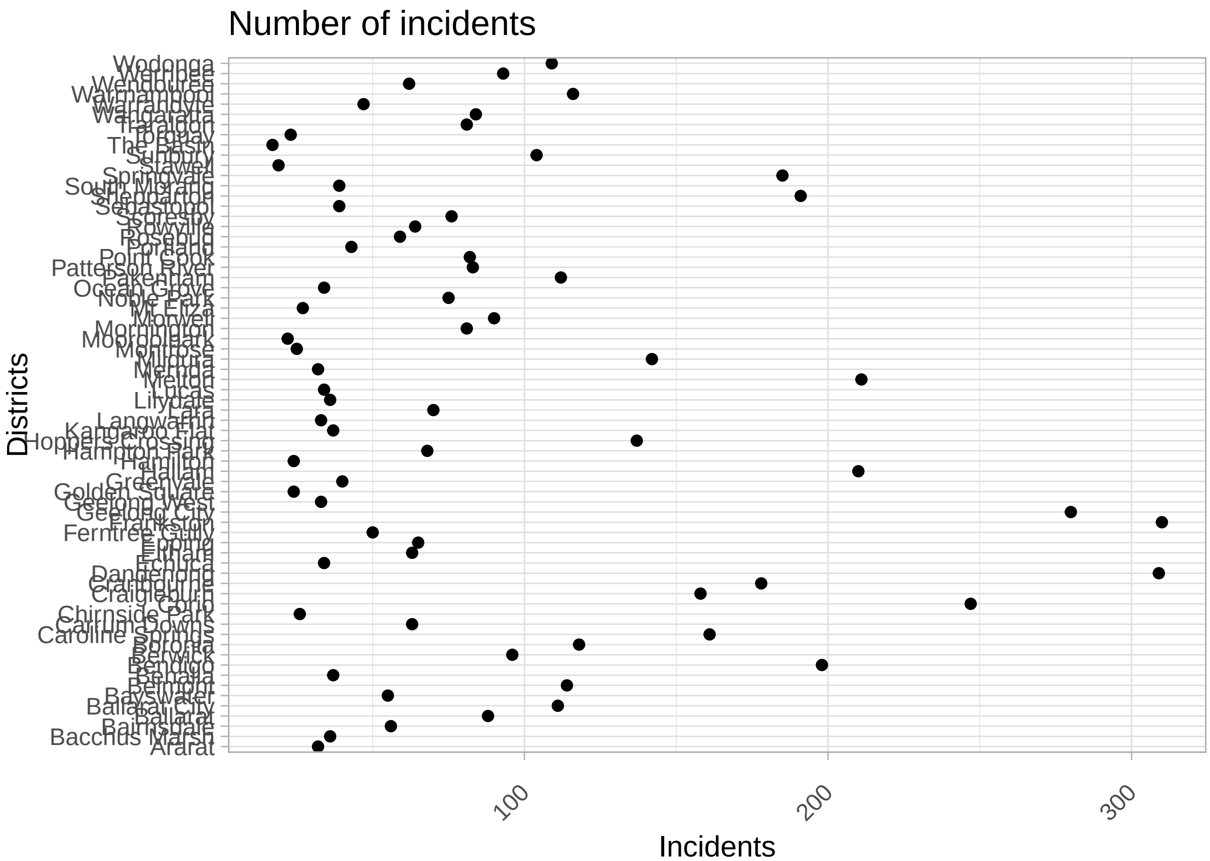
In this question we are concerned with district that has had the highest number of incidents across all hazard classes in the year 2019/20.

Let's first visualize data from each data set for the quarters 1, 2, 3 and 4 for the year 2019/20.

```
dat_Q1_2020 <- read_csv("data/dat_Q1_2020.csv") %>%
  rename(Number_Incidents_total =`Number of incidents within the Brigade Area for the reporting period a
  rename(CFA_Brigade_Area = `CFA Brigade Area`)

dat_Q1_2020
```

```
## # A tibble: 68 x 4
##       X1 `CFA District` CFA_Brigade_Area Number_Incidents_total
##    <dbl> <chr>          <chr>                             <dbl>
##  1     1 02             Bendigo                             198
##  2     2 02             Golden Square                        24
##  3     3 02             Kangaroo Flat                        37
##  4     4 04             Portland                             43
##  5     5 05             Hamilton                             24
##  6     6 05             Warrnambool                         116
##  7     7 07             Belmont                             114
##  8     8 07             Corio                               247
##  9     9 07             Geelong City                        280
## 10    10 07             Geelong West                         33
## # ... with 58 more rows
```

```
ggplot(dat_Q1_2020, aes( x = Number_Incidents_total,
                         y = CFA_Brigade_Area)) +
geom_point() +
  theme_light() +
  theme(axis.text.x = element_text(angle = 45, vjust = 0.5, hjust=1), axis.title.x = element_text(vjust=
  theme(axis.text.y =  element_text(angle = , vjust = 0.5, hjust=1), axis.title.y =  element_text(vjust=

  xlab("Incidents") +
 ylab("Districts") +
  ggtitle("Number of incidents")
```



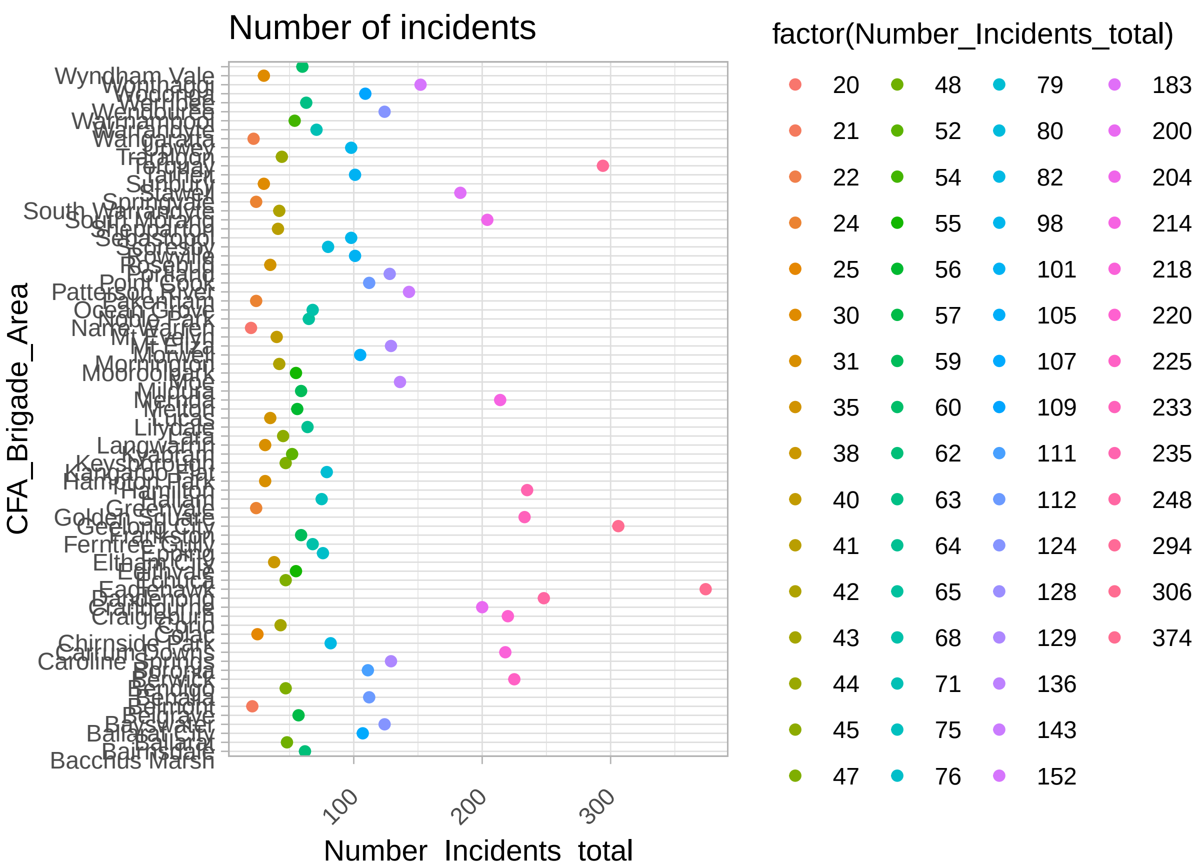
The above plot shows us the number of incidents for the first quarter 2019/20. On the x-axis we have number of incidents and the y-axis we can see the names of districts.

```
dat_Q2_2020 <- read_csv("data/dat_Q2_2020.csv")%>%
  rename(Number_Incidents_total = `Number of incidents within the Brigade Area for the reporting period
  rename(CFA_Brigade_Area = `CFA Brigade Area`)

dat_Q2_2020
```

```
## # A tibble: 77 x 4
##       X1 `CFA District` CFA_Brigade_Area Number_Incidents_total
##    <dbl> <chr>          <chr>                             <dbl>
##  1     1 02             Bendigo                             225
##  2     2 02             Eaglehawk                            47
##  3     3 02             Golden Square                        24
##  4     4 02             Kangaroo Flat                        47
##  5     5 04             Portland                             35
##  6     6 05             Hamilton                             31
##  7     7 05             Warrnambool                         124
##  8     8 06             Colac                                43
##  9     9 07             Belmont                             112
## 10    10 07             Corio                               220
## # ... with 67 more rows
```

```
ggplot(dat_Q2_2020, aes(x = Number_Incidents_total ,
                        y = CFA_Brigade_Area,
```

```
                                        colour = factor(Number_Incidents_total))+

  geom_point() +
  theme_light() +
  theme(axis.text.x = element_text(angle = 45, vjust = 0.5, hjust=1), axis.title.x = element_text(vjust=
  theme(axis.text.y =  element_text(angle = , vjust = 1, hjust=1), axis.title.y =  element_text(vjust=-
  ggtitle("Number of incidents")
```



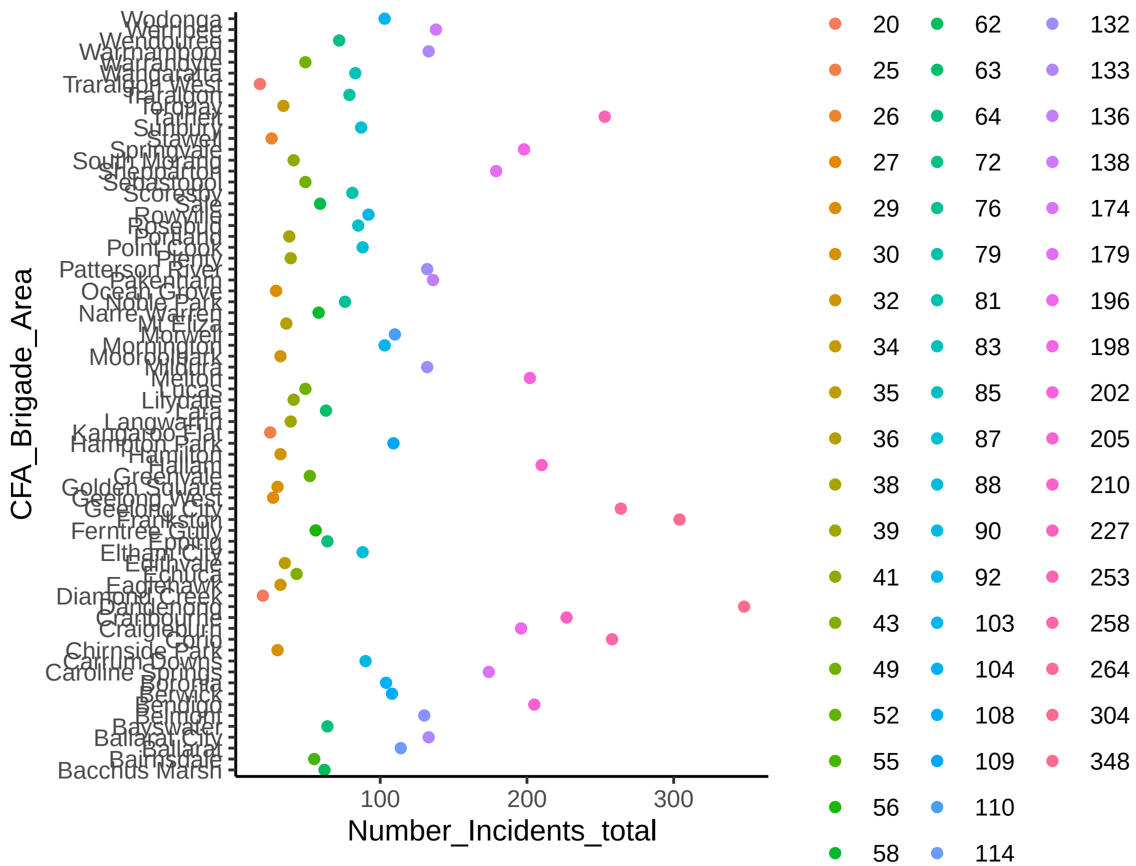
Similiar to the plot above, this plot shows us the number of incidents for the second quarter 2019/20. On the x-axis we have number of incidents and the y-axis we can see the names of districts.

```
dat_Q3_2020 <- read_csv("data/dat_Q3_2020.csv") %>%
  rename(Number_Incidents_total = `Number of incidents within the Brigade Area for the reporting period
  rename(CFA_Brigade_Area = `CFA Brigade Area`)


dat_Q3_2020
```

```
## # A tibble: 70 x 4
##       X1 ‘CFA District‘ CFA_Brigade_Area Number_Incidents_total
##    <dbl> <chr>          <chr>                             <dbl>
##  1     1 02             Bendigo                             205
##  2     2 02             Eaglehawk                            32
##  3     3 02             Golden Square                        30
##  4     4 02             Kangaroo Flat                        25
```

```
## 5      5 04             Portland                           38
## 6      6 05             Hamilton                           32
## 7      7 05             Warrnambool                       133
## 8      8 07             Belmont                           130
## 9      9 07             Corio                             258
## 10    10 07             Geelong City                      264
## # ... with 60 more rows
```

```
 ggplot(dat_Q3_2020) +
geom_point(aes(x = Number_Incidents_total,
y = CFA_Brigade_Area,
colour = factor(Number_Incidents_total)))  +
  theme_classic()
```



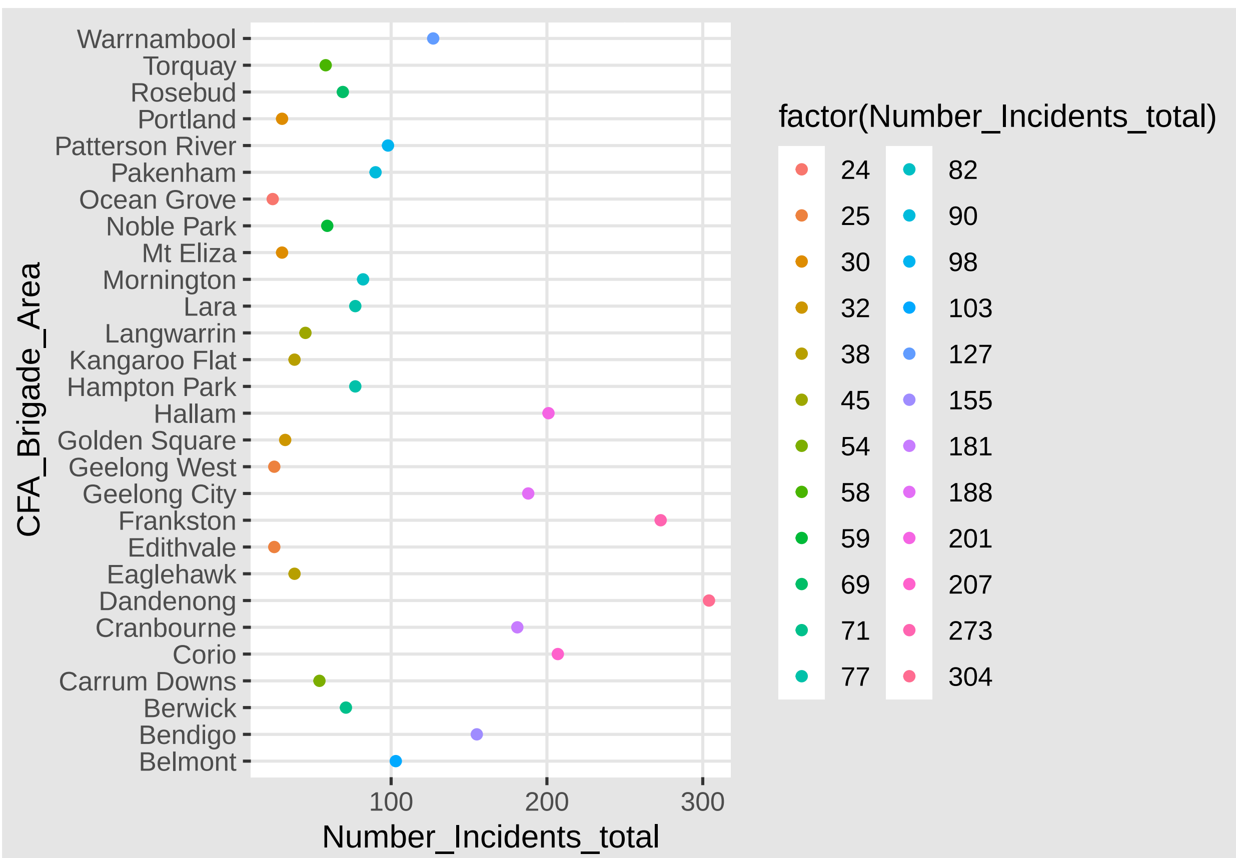
The above plot shows us the number of incidents for the third quarter 2019/20. On the x-axis we have number of incidents and the y-axis we can see the names of districts.

```
dat_Q4_2020 <- read_csv("data/dat_2020Q4.csv")%>%
  select(`CFA District`, `CFA Brigade Area`, `Number of incidents within the Brigade Area for the report
  rename(Number_Incidents_total = `Number of incidents within the Brigade Area for the reporting period
    rename(CFA_Brigade_Area = `CFA Brigade Area`)

dat_Q4_2020
```

```
## # A tibble: 28 x 3
```

```
##    `CFA District` CFA_Brigade_Area Number_Incidents_total
##    <chr>          <chr>                             <dbl>
##  1 02             Bendigo                             155
##  2 02             Eaglehawk                            38
##  3 02             Golden Square                        32
##  4 02             Kangaroo Flat                        38
##  5 04             Portland                             30
##  6 05             Warrnambool                         127
##  7 07             Belmont                             103
##  8 07             Corio                               207
##  9 07             Geelong City                        188
## 10 07             Geelong West                         25
## # ... with 18 more rows
```

```
ggplot(dat_Q4_2020) +
geom_point(aes(x = Number_Incidents_total,
y = CFA_Brigade_Area,
colour = factor(Number_Incidents_total))) +
  theme_igray()
```



The above plot shows us the number of incidents for the fourth quarter 2019/20. On the x-axis we have number of incidents and the y-axis we can see the names of districts.

```
binding_data <- bind_rows(dat_Q1_2020,dat_Q2_2020,dat_Q3_2020,dat_Q4_2020)

binding_data
```

Table 1: Summary of the incidents.

	Num_incdents1	Num_incdents2	Num_incdents3	Num_incdents4
	Min. : 23.0	Min. : 24.0	Min. : 25.0	Min. : 24.0
	1st Qu.: 63.0	1st Qu.: 52.0	1st Qu.: 76.0	1st Qu.: 54.0
	Median : 83.0	Median :101.0	Median :108.0	Median : 77.0
	Mean :125.5	Mean :126.8	Mean :134.2	Mean :110.1
	3rd Qu.:185.0	3rd Qu.:183.0	3rd Qu.:198.0	3rd Qu.:181.0
	Max. :310.0	Max. :374.0	Max. :348.0	Max. :304.0

```
## # A tibble: 243 x 4
##       X1 `CFA District` CFA_Brigade_Area Number_Incidents_total
##    <dbl> <chr>          <chr>                             <dbl>
##  1     1 02             Bendigo                             198
##  2     2 02             Golden Square                        24
##  3     3 02             Kangaroo Flat                        37
##  4     4 04             Portland                             43
##  5     5 05             Hamilton                             24
##  6     6 05             Warrnambool                         116
##  7     7 07             Belmont                             114
##  8     8 07             Corio                               247
##  9     9 07             Geelong City                        280
## 10    10 07             Geelong West                         33
## # ... with 233 more rows
```

0.2.3 Analysis

Using the summary function we can see the maximum number of incidents across all hazard classes for specified districts for the given time frame. Data used here is the merged data of the four data sets, using bind_rows function.

```
DataQ1_4 <-  read_csv("data/Question_3_dat_2.csv")%>%
  rename(Num_incdents1=`Number of incidents within the Brigade Area for the reporting period across all
  rename(Num_incdents2=`Number of incidents within the Brigade Area for the reporting period across all
  rename(Num_incdents3=`Number of incidents within the Brigade Area for the reporting period across all
  rename(Num_incdents4=`Number of incidents within the Brigade Area for the reporting period across all
```

```
DataQ1 <- DataQ1_4 %>%
  select(Num_incdents1,
         Num_incdents2,
         Num_incdents3,
         Num_incdents4)%>%
  summary()%>%
  kable(caption = "Summary of the incidents.") %>%
  kable_styling(bootstrap_options = c("striped", "hover"))

DataQ1
```

In the above table, we can see the summary for number of incidents in each quarter; we see that the highest number of incidents was recorded as 374 in the second quarter.

The data used here is the merged data that contains information on all four quarters. For the next steps, we will use the binding_data from above.

Table 2: This is the summary of number of incidents across all hazard classes

	Number_Incidents_total
	Min. : 17.00
	1st Qu.: 39.50
	Median : 71.00
	Mean : 95.96
	3rd Qu.:125.50
	Max. :374.00

Table 3: Dandenong district has the highest number of incidents across all hazard classes in all of the four quarters.

CFA_Brigade_Area	Number_Incidents_total
Dandenong	374

```
 Highest_NumberIncidents <- binding_data%>%
  select(Number_Incidents_total)%>%
summary()%>%
  kable(caption = "This is the summary of number of incidents across all hazard classes") %>%
  kable_styling(bootstrap_options = c("striped", "hover"))

Highest_NumberIncidents
```

We can see that highest number of incidents are 374, so now using the filter function. let's see which district has 374 incidents.

```
binding_data%>%
  select(-X1,
         -`CFA District`)%>%
  filter(Number_Incidents_total == "374" )%>%
  kable(caption = "Dandenong district has the highest number of incidents across all hazard classes in a
  kable_styling(bootstrap_options = c("striped", "hover"))
```

From the table we can see that Dandenong has had the highest number of incidents.

0.3 Conclusion

As per the analysis for question on the performance of the brigade, it is safe to say that CFA brigades performed well against the standard delivery service time of eight minutes for the hazard class two incidents. And as per the analysis for the question on the number of incidents, we can see that Dandenong appears to be the area that had highest number of incidents across all hazard classes.

0.4 Fire Detections and Land Type in Bushfire Season

According to the information provided by the department of agriculture of Australian, in the figure 4 below can be seen the number of the fire detections by year. The number of cases registered by the season 2019/2020 were 103.627. The extent of land affected by the bushfires will be detailed i the next part of the report. something interesting to remark it that even though the season 2019/2020 seemed very hard for the country,

Table 4: Total detections by year

Years	Total Counts
2006/2007	3327484
2002/2003	2974094
2013/2014	1016454
2008/2009	784110
2012/2013	736251
2010/2011	685265
2005/2006	557492
2018/2019	545723
2014/2015	523801
2009/2010	487338
2017/2018	469092
2004/2005	461358
2003/2004	446818
2011/2012	416408
2007/2008	381934
2016/2017	377902
2015/2016	315854
2019/2020	103627

in reality this number of cases is not compared with the number of observation for the same season in 2006/2007 and 2002/2003 that hold 3'327484 and 2'974.094 cases respectively in Victoria.

```
fire_total_detects %>%
  select(Years, n) %>%
  arrange(desc(n)) %>%
  rename("Total Counts" = n) %>%
  kable(caption = "Total detections by year") %>%
 kable_styling(c("hover",
                 "condensed",
                 position = "center",
                 fixed_thead = TRUE),
                 full_width = FALSE)
```

```
 ggplot(fire_total_detects,
                         aes(x = Years,
                             y = n)) +
  geom_col(fill= 'coral3') +
  coord_flip()+
  labs( y = "Counts") +
  geom_text(aes(label = n, size = 1, hjust= -0.5))+
  theme(legend.position = "none")+
  scale_y_continuous(limits = c(0,3500000))+
  theme_bw()
```

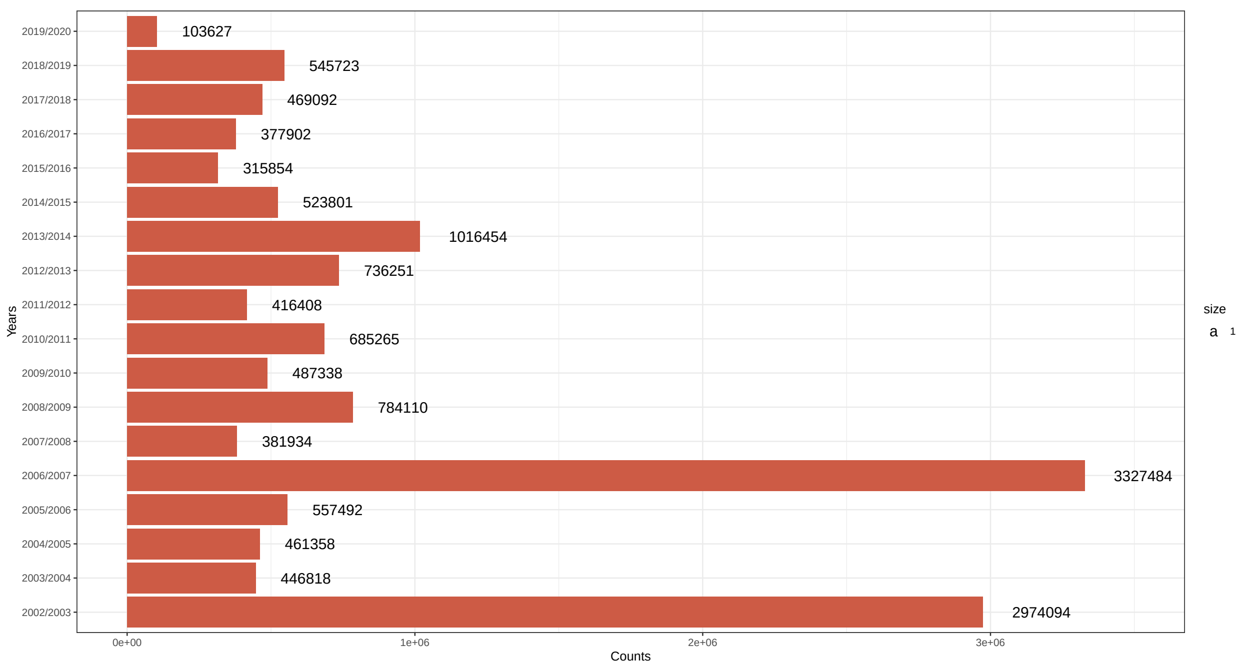


Figure 1: Number of Observations by Year

0.4.1 Percentage of Affected Land by State

Taking in detail the number of the observations by state in the season 2019/2020, we can see that the states with major affectation of the forested land were Australian Capital Territory, Victoria and New south Wales with 92.78%, 92.02% and 90.15% respectively. See Figure 2. The territory with the least affectation was Northern Territory (0%), followed by South Australia with 43.68%.

```
perc_affected_state <- perc_affected_state  %>%
  select(Jurisdiction,
         `Proportion of fire area that is forested (perc)`) %>%
  mutate("Proportion of fire" = 100-`Proportion of fire area that is forested (perc)`) %>%
  pivot_longer(names_to = "Burnt Area",
               values_to = "Percentage",
               cols = -Jurisdiction)
```

```
ggplot(data = perc_affected_state, aes(x = Jurisdiction,
                           y = Percentage,
                           fill= `Burnt Area`)) +
    geom_bar(position="stack",
             stat="identity")+
    geom_text(aes(label = paste0(round(Percentage,2),"%")),
              position = position_stack(vjust = 0.5),
              size = 3)+
    scale_y_continuous(labels = function(x) paste0(x, "%"),
                       breaks = seq(0, 100, 10))+
    coord_flip()+
    theme_bw()+
    theme(legend.position = "bottom")
```

0.4.2 Percentage of Forested Land Affected in Victoria by Type

According to the classification of the land in Victoria, Multiple-use Public Forest got affected by 29%, whereas the Nature Conservation Reserve had 15% of burnt land. similarly the Unresolved tenure land lost 13% of it's extent by the fires. In the case of private land, around 6% was consumed by fires. See Figure 3.

```
ft4perc <- ft4perc  %>%
  select(...1,Vic.) %>%
  rename("Type of Forest" = ...1, "Burnt Land" = Vic.) %>%
  filter(`Type of Forest` %in%
           c("Leasehold forest",
             "Multiple-use public forest",
             "Nature conservation reserve",
             "Other Crown land",
             "Private forest",
             "Unresolved tenure")) %>%
  mutate("Safe Land" = 100-`Burnt Land`) %>%
  pivot_longer(names_to = "Burnt Area Victoria", values_to = "Percentage", cols = -`Type of Forest`)

  ggplot(data = ft4perc, aes(x = `Type of Forest`,
                           y = Percentage, fill= `Burnt Area Victoria`)) +
    geom_bar(position= position_stack(reverse = T), stat="identity")+
    coord_flip()+
```

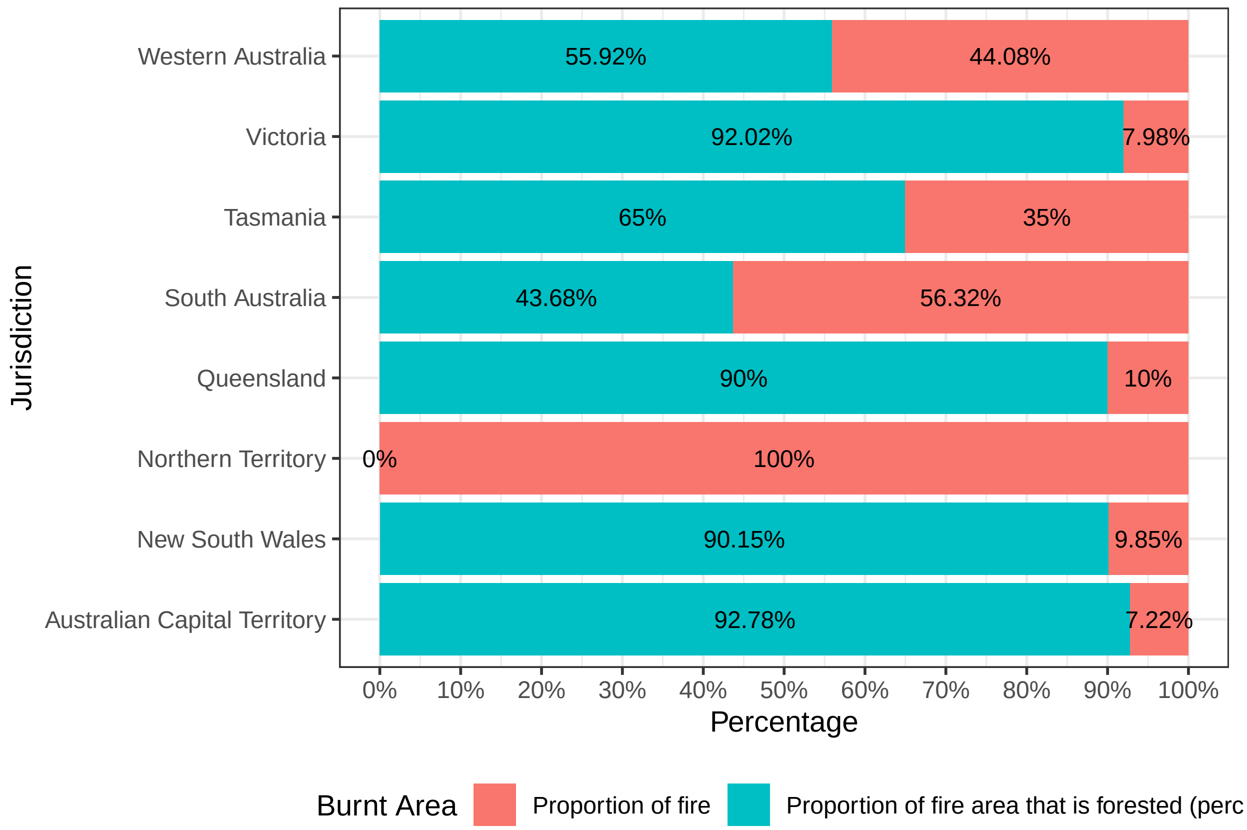


Figure 2: Affectation by State

```
    theme(legend.position = "bottom")+
    theme_bw() +
    geom_text(aes(label = paste0(round(Percentage,2),"%")), position = position_stack(vjust = 0.5, rever
```

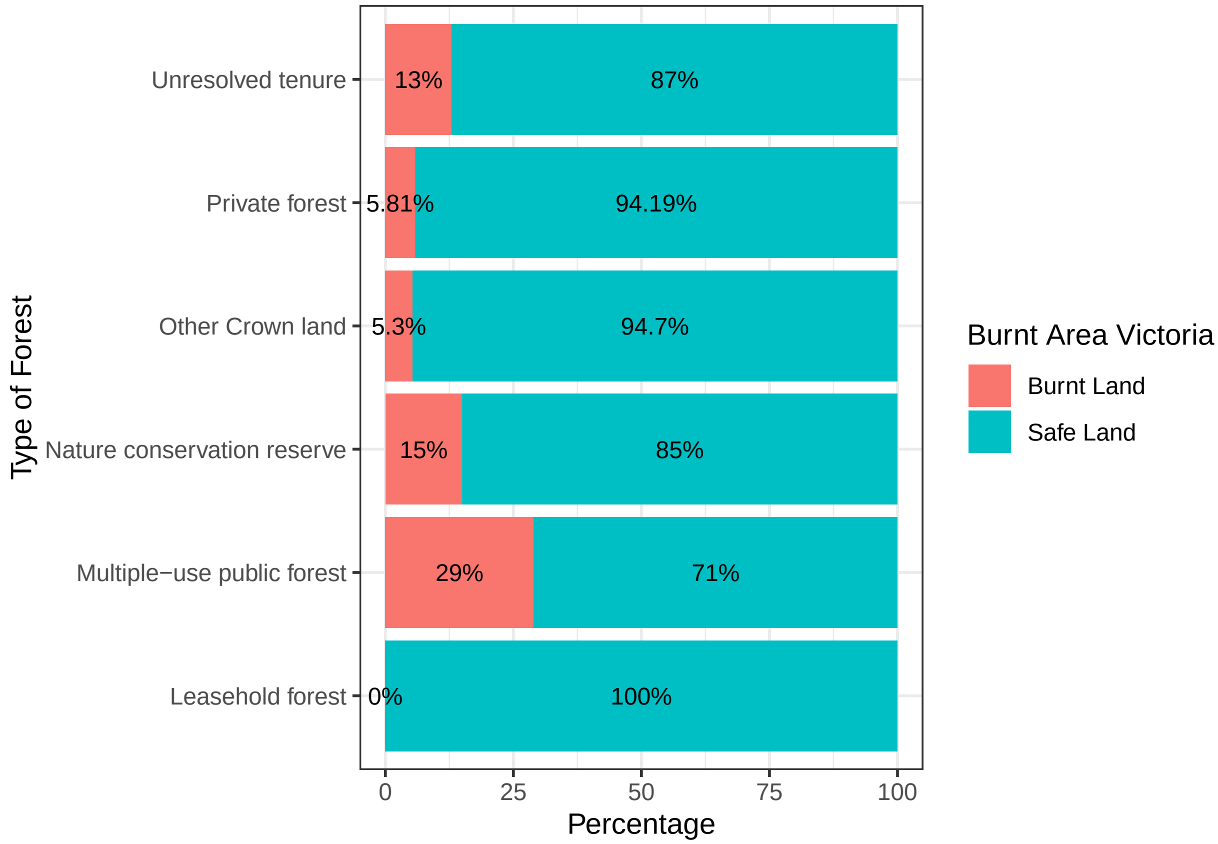


Figure 3: Land Type affected in Victoria

0.5 Melbourne Air Quality Index

The bushfires season had a huge negative impact in the air quality in Victoria, as an example we took data from the Environment Protection Authority in Australia which recorder the PM2.5 (Fine Particulate Matter 2.5) which is an air pollutant concern for the community's health, the higher the rate the worse impact for individuals. In the figure 4 below can be seen the levels for the previous four years, with clearly a huge peak in January 2020.

```
melb_air2 <- melb_air %>%  select(date,pm25) %>%
  mutate(date = as.Date(date, format = "%d/%m/%Y"))

melb_air2 %>%
  ggplot()+
  geom_line(aes(x = date,
              y = pm25),
            colour = "#FF6600")+
  theme_bw()+
  labs(x = "3 Year Historical Melbourne Air Index",
       y = "Air Index Score")+
  scale_y_continuous(limits = c(0,280),
                     breaks = seq(0,280,50))
```

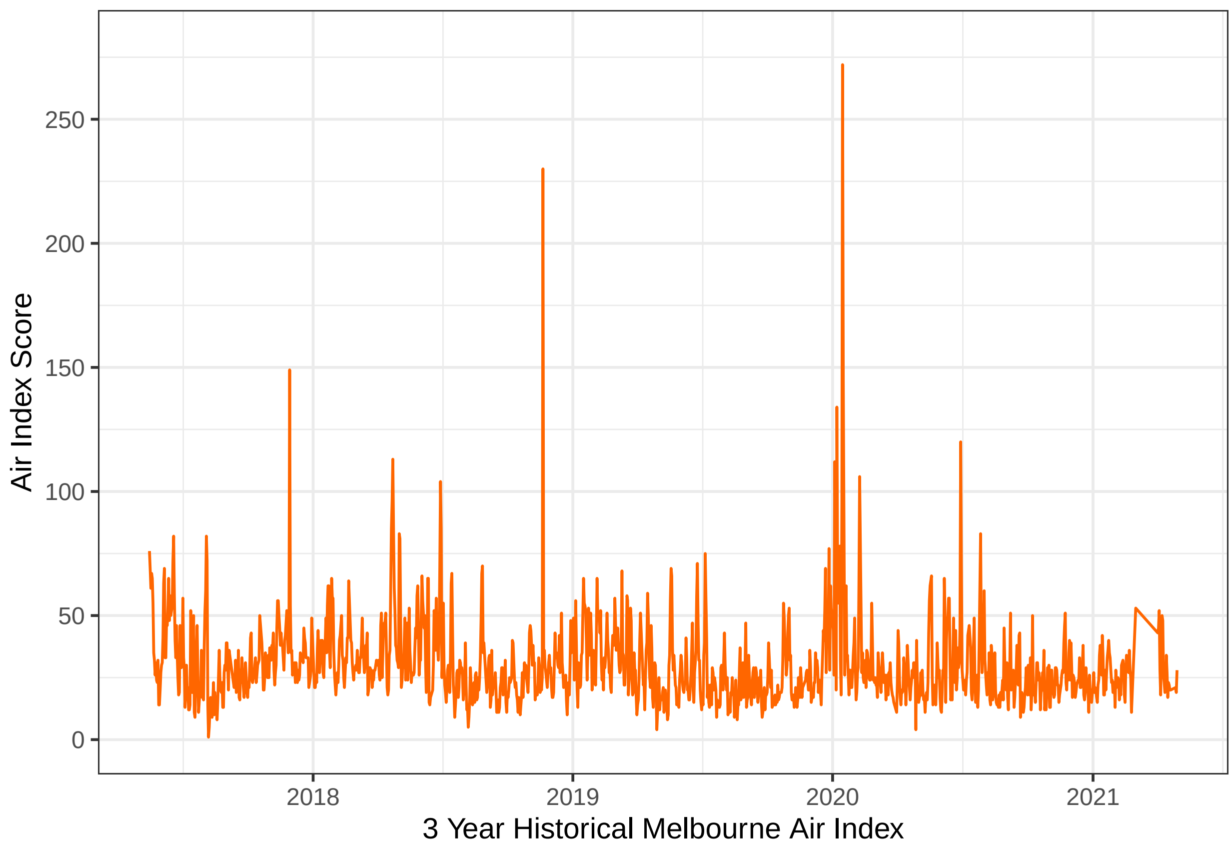


Figure 4: Melbourne Air Quality

The figure below shows the classification of the air quality index, this source will give a clearer idea of the readings of the bushfire season and for previous levels.

```r
knitr::include_graphics(here::here('images/polution_table.png'))
```

AQI	Air Pollution Level	Health Implications	Cautionary Statement (for PM2.5)
0 - 50	Good	Air quality is considered satisfactory, and air pollution poses little or no risk	None
51 -100	Moderate	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.	Active children and adults, and people with respiratory disease, such as asthma, should limit prolonged outdoor exertion.
101-150	Unhealthy for Sensitive Groups	Members of sensitive groups may experience health effects. The general public is not likely to be affected.	Active children and adults, and people with respiratory disease, such as asthma, should limit prolonged outdoor exertion.
151-200	Unhealthy	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects	Active children and adults, and people with respiratory disease, such as asthma, should avoid prolonged outdoor exertion; everyone else, especially children, should limit prolonged outdoor exertion
201-300	Very Unhealthy	Health warnings of emergency conditions. The entire population is more likely to be affected.	Active children and adults, and people with respiratory disease, such as asthma, should avoid all outdoor exertion; everyone else, especially children, should limit outdoor exertion.
300+	Hazardous	Health alert: everyone may experience more serious health effects	Everyone should avoid all outdoor exertion

Figure 5: Air Quality Levels

Finally, having a closer look to the most affected months from January to April, we cans see that on 15th January the levels recorded was 272, clearly very unhealthy, the population needed to be indoors even more for those with respiratory affections. Certainly the first two weeks were highly affected by the pollution and the fires, all this happened mainly in the first two weeks of the year, leaving highly affected the fauna and flora.

```r
melb_air2 %>%
  filter(date >= "2019-12-01" & date <= "2020-03-30" ) %>%


 ggplot()+
  geom_line(aes(x = date,
                y = pm25),
            colour = "#FF6600")+
  theme_bw()+
  labs(x = "Melbourne Air Index in 2020 (January to April)",
       y = "Air Index Score")+
  scale_y_continuous(limits = c(0,300),
                     breaks = seq(0,300,20))
```

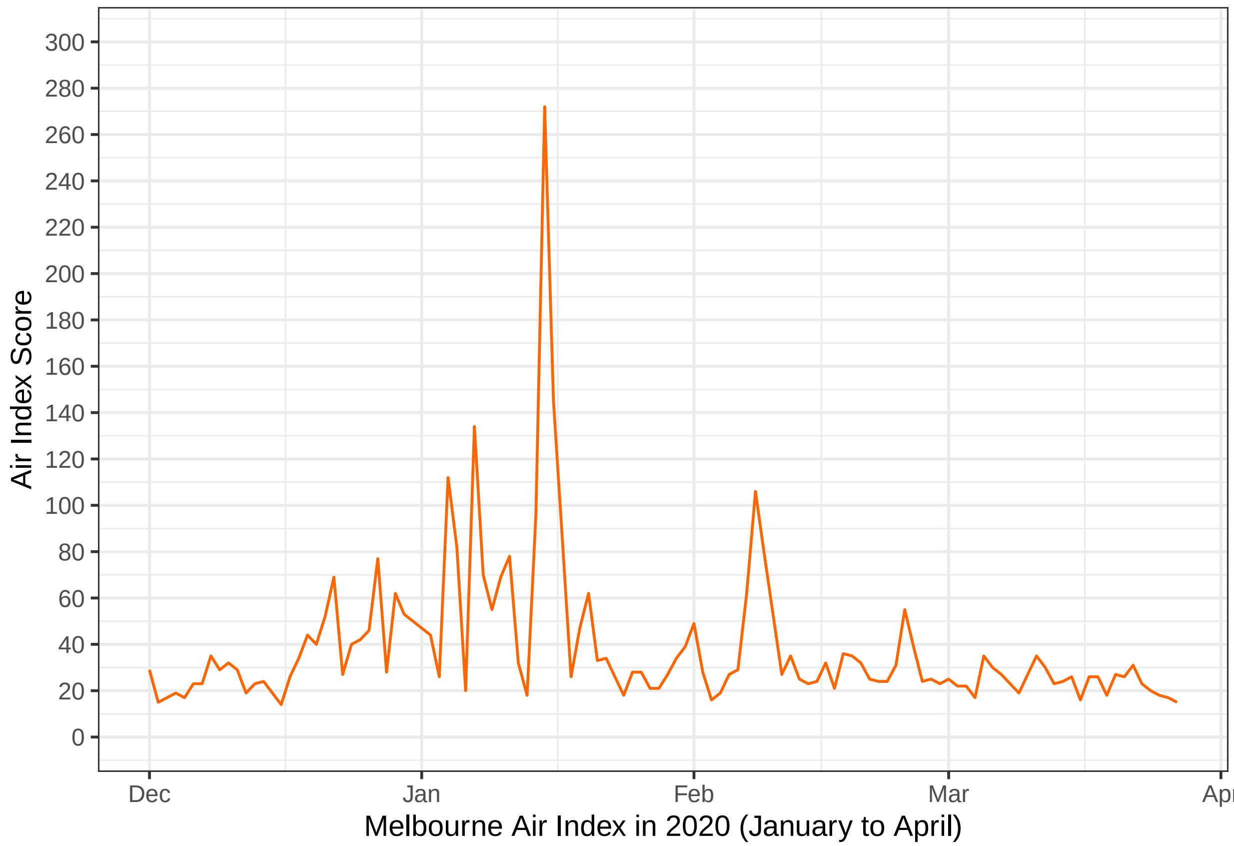


Figure 6: Bushfire Season 2019/2020 Air Quality in Melbourne