Principal Component Analysis (PCA)

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1. Primer paso: cargar las librerias que necesitas.

```
library(ggplot2)
library(dplyr)
library(missMDA) # Imputate
library(ggfortify) # autoplot()
library(cluster) #pam
library(factoextra) #get_pca_var()
library(data.table) # data.table()
library(devtools)

install_github("vqv/ggbiplot") #ggbiplot
library(ggbiplot)
```

2. Segundo paso: cargar los datos.

```
channel <- read.csv("data/channel_form.csv", header=TRUE)
head(channel)
```

```
##      Forma NAN_Am NADBO NAtemp  nit NASatO2 Elevacion Ancho Velocidad Rocas
## 1 Trapecio   0.03  2.38  27.33 0.35   92.04        23    16         5    20
## 2 Trapecio   0.03  2.95  27.81   NA  100.03        31    11         0    20
## 3 Trapecio   0.03  3.13  24.27   NA   96.82        35    14        10    30
## 4 Trapecio   1.15  4.73  27.06 7.54   64.35         9     5         2     0
## 5 Trapecio   0.50  8.16  26.60   NA  110.39        43    11         9    10
## 6 Trapecio   0.53  8.57  23.82   NA  106.09        23    11         5    20
##   Canto grava arena Limo
## 1    25    30    20    0
## 2    45    20    15    0
## 3    30    20    10    0
## 4     0     0    50   50
## 5    40    10    20   20
## 6    60    20     0    0
```

2.1 Vamos a examinar los datos

```
summary(channel)
```

```
##     Forma              NAN_Am         NADBO          NAtemp
##  Length:138         Min.   :0.0200   Min.   : 1.310   Min.   :14.67
##  Class :character   1st Qu.:0.0400   1st Qu.: 1.930   1st Qu.:24.30
##  Mode  :character   Median :0.2150   Median : 3.000   Median :26.05
##                     Mean   :0.3201   Mean   : 6.164   Mean   :25.84
##                     3rd Qu.:0.5000   3rd Qu.: 8.585   3rd Qu.:27.70
##                     Max.   :1.5000   Max.   :34.900   Max.   :32.18
##                                      NA's   :35
##       nit             NASatO2         Elevacion           Ancho
##  Min.   :  0.00   Min.   : 23.43   Min.   :   3.00   Min.   : 1.000
##  1st Qu.:  0.40   1st Qu.: 86.24   1st Qu.:  25.25   1st Qu.: 2.000
##  Median :  0.92   Median : 94.59   Median :  53.00   Median : 3.000
##  Mean   : 12.00   Mean   : 91.05   Mean   : 230.89   Mean   : 3.822
##  3rd Qu.:  1.62   3rd Qu.:100.52   3rd Qu.: 269.25   3rd Qu.: 3.000
##  Max.   :324.11   Max.   :122.73   Max.   :2370.00   Max.   :16.000
##  NA's   :57                                          NA's   :3
##    Velocidad          Rocas           Canto           grava
##  Min.   : 0.000   Min.   : 0.00   Min.   : 0.00   Min.   : 0.0
##  1st Qu.: 3.000   1st Qu.: 0.00   1st Qu.: 0.00   1st Qu.: 2.5
##  Median :11.000   Median :10.00   Median :25.00   Median :20.0
##  Mean   : 9.133   Mean   :16.25   Mean   :25.65   Mean   :17.8
##  3rd Qu.:14.000   3rd Qu.:30.00   3rd Qu.:40.00   3rd Qu.:25.0
##  Max.   :16.000   Max.   :90.00   Max.   :80.00   Max.   :80.0
##  NA's   :3        NA's   :3       NA's   :4       NA's   :3
##      arena             Limo
##  Min.   :  0.00   Min.   :  0.00
##  1st Qu.: 10.00   1st Qu.:  0.00
##  Median : 15.00   Median : 10.00
##  Mean   : 19.79   Mean   : 20.62
##  3rd Qu.: 25.00   3rd Qu.: 25.00
##  Max.   :100.00   Max.   :100.00
##  NA's   :3        NA's   :3
```

2.1 Remover la(s) variable(s) que tiene(n) mucho(s) NAs y las Etiquetas (a la funcion lo le gusta), luego las agregamos.

```r
channel_1 <- select(channel, -Forma)
summary(channel_1)
```

```
##      NAN_Am           NADBO            NAtemp            nit
##  Min.   :0.0200   Min.   : 1.310   Min.   :14.67   Min.   :  0.00
##  1st Qu.:0.0400   1st Qu.: 1.930   1st Qu.:24.30   1st Qu.:  0.40
##  Median :0.2150   Median : 3.000   Median :26.05   Median :  0.92
##  Mean   :0.3201   Mean   : 6.164   Mean   :25.84   Mean   : 12.00
##  3rd Qu.:0.5000   3rd Qu.: 8.585   3rd Qu.:27.70   3rd Qu.:  1.62
##  Max.   :1.5000   Max.   :34.900   Max.   :32.18   Max.   :324.11
##                   NA's   :35                       NA's   :57
##     NASatO2         Elevacion            Ancho          Velocidad
##  Min.   : 23.43   Min.   :   3.00   Min.   : 1.000   Min.   : 0.000
##  1st Qu.: 86.24   1st Qu.:  25.25   1st Qu.: 2.000   1st Qu.: 3.000
##  Median : 94.59   Median :  53.00   Median : 3.000   Median :11.000
##  Mean   : 91.05   Mean   : 230.89   Mean   : 3.822   Mean   : 9.133
##  3rd Qu.:100.52   3rd Qu.: 269.25   3rd Qu.: 3.000   3rd Qu.:14.000
```

```
##  Max.   :122.73   Max.   :2370.00   Max.   :16.000   Max.   :16.000
##                                     NA's   :3        NA's   :3
##      Rocas           Canto           grava          arena
##  Min.   : 0.00   Min.   : 0.00   Min.   : 0.0   Min.   :  0.00
##  1st Qu.: 0.00   1st Qu.: 0.00   1st Qu.: 2.5   1st Qu.: 10.00
##  Median :10.00   Median :25.00   Median :20.0   Median : 15.00
##  Mean   :16.25   Mean   :25.65   Mean   :17.8   Mean   : 19.79
##  3rd Qu.:30.00   3rd Qu.:40.00   3rd Qu.:25.0   3rd Qu.: 25.00
##  Max.   :90.00   Max.   :80.00   Max.   :80.0   Max.   :100.00
##  NA's   :3       NA's   :4       NA's   :3      NA's   :3
##       Limo
##  Min.   :  0.00
##  1st Qu.:  0.00
##  Median : 10.00
##  Mean   : 20.62
##  3rd Qu.: 25.00
##  Max.   :100.00
##  NA's   :3
```

2.2 Vamos a imputar datos. Esto es comun para set de datos de campo, los cuales tienden a tener ceros (por mal funcionamiento de los equipos, condiciones climticas adversas que no puedemos ir al campo). Se realiza como un paso preliminar para para realizar un PCA en un set de datos completos.

Mas informacion aca: https://www.rdocumentation.org/packages/missMDA/versions/1.18/topics/imputePCA

```
df1 <- select(channel_1, Elevacion, Ancho, Velocidad, Rocas, Canto, grava, arena, Limo)
df1
```

```
##    Elevacion Ancho Velocidad Rocas Canto grava arena  Limo
## 1         23    16         5  20.0  25.0  30.0  20.0   0.0
## 2         31    11         0  20.0  45.0  20.0  15.0   0.0
## 3         35    14        10  30.0  30.0  20.0  10.0   0.0
## 4          9     5         2   0.0   0.0   0.0  50.0  50.0
## 5         43    11         9  10.0  40.0  10.0  20.0  20.0
## 6         23    11         5  20.0  60.0  20.0   0.0   0.0
## 7         86    11        13   0.0  80.0  20.0  20.0   0.0
## 8         26     3        11   0.0  30.0  20.0  25.0  25.0
## 9         24     3        14   5.0  25.0  35.0  20.0  15.0
## 10        53    11         4   0.0  70.0   5.0  20.0   5.0
## 11        24    11         3   0.0  70.0  20.0  10.0   0.0
## 12       619     2        14  30.0  30.0  20.0  20.0   0.0
## 13       598     3        14  20.0  30.0  20.0  10.0  20.0
## 14       583     3        14  20.0  30.0  20.0  10.0  20.0
## 15       114     2        11   0.0  15.0  30.0  25.0  15.0
## 16        46     3        14   0.0   5.0  20.0  40.0  35.0
## 17        46     3        16   0.0   1.0  40.0  40.0  19.0
## 18       158    11         4  40.0  50.0   5.0   5.0   0.0
## 19        34    11         4   0.0  70.0  15.0  15.0   0.0
## 20      1818    NA        NA    NA    NA    NA    NA    NA
## 21       205    11         4   0.0  80.0  10.0  10.0   0.0
## 22        38     3        13   0.0  40.0  30.0  20.0  10.0
## 23        98     3        14  25.0  25.0  15.0  25.0  10.0
## 24        49     3        15  10.0  60.0  10.0  10.0  10.0
```

```
## 25         29     3        14   5.0  25.0  30.0  25.0  15.0
## 26         99     3        14  25.0  40.0   0.0  10.0  25.0
## 27         20     3        14  15.0  15.0   5.0  30.0  35.0
## 28         82     1        11  60.0   0.0  20.0  20.0   0.0
## 29         43     2        11   0.0  50.0  50.0   0.0   0.0
## 30         17     3         2   0.0  33.3  33.3  33.3   0.0
## 31        149     3         3  90.0  10.0   0.0   0.0   0.0
## 32         10     1        14  15.0  20.0  40.0  10.0  15.0
## 33         28     1        14  10.0  70.0  10.0   0.0  10.0
## 34         18     1        12  10.0  20.0  50.0  10.0  10.0
## 35         85     1        14  10.0  20.0  50.0  10.0  10.0
## 36        130     2         2   0.0  30.0   0.0  70.0   0.0
## 37         51     2        10  35.0  50.0   0.0  15.0   0.0
## 38        198     1         3  90.0   0.0   0.0  10.0   0.0
## 39         13     1         3  33.3  33.3   0.0   0.0  33.3
## 40         53     2         3   0.0   0.0  50.0  50.0   0.0
## 41        492     2        14  50.0  20.0  10.0  10.0  10.0
## 42        428     2        14  20.0  40.0  20.0  10.0  10.0
## 43         49     3        11   0.0  10.0  30.0  50.0  10.0
## 44         67     3        12  20.0  40.0  20.0  10.0  10.0
## 45         67     1        11  10.0  60.0  20.0   5.0   5.0
## 46        100     2         9  20.0  35.0  25.0  15.0   5.0
## 47         83     1        14  50.0  30.0  10.0   5.0   5.0
## 48         63     1        12  10.0  60.0  20.0   5.0   5.0
## 49         60     3        12  10.0   5.0   5.0  30.0  50.0
## 50         25     3        11   0.0  70.0  20.0   5.0   5.0
## 51         30     3        11   0.0  10.0  40.0  40.0  10.0
## 52         50     2         3   0.0   0.0   0.0  50.0  50.0
## 53         36     2         3   0.0   0.0  10.0  20.0  70.0
## 54         22     3        11   0.0  20.0  60.0  10.0  10.0
## 55         11     2        12   0.0   0.0  80.0  20.0   0.0
## 56         71     3        14   5.0  50.0  20.0  15.0  10.0
## 57         15     3        12   0.0  10.0  70.0  10.0  10.0
## 58         85     3         9   5.0  60.0  20.0  10.0   5.0
## 59         21     3        11   0.0  10.0  60.0  20.0  10.0
## 60        659     2        13  10.0  70.0  20.0   0.0   0.0
## 61        615     3        14  30.0  30.0  30.0  10.0   0.0
## 62        517     3        14  50.0  30.0  10.0  10.0   0.0
## 63        422     2        14  30.0  40.0  20.0  10.0   0.0
## 64        363     3        14  30.0  40.0  20.0   5.0   5.0
## 65        117     3        14  10.0  70.0  10.0  10.0   0.0
## 66        244     2         9  25.0  30.0  25.0  15.0   5.0
## 67         15     2        11   0.0   0.0  40.0  40.0  20.0
## 68         22     3        14  10.0  40.0  30.0  15.0   5.0
## 69       1114     1        10  75.0  15.0   0.0  10.0   0.0
## 70        353     1        14  40.0  20.0  20.0  20.0   0.0
## 71        314     1        14  50.0  10.0  20.0  20.0   0.0
## 72       1630     1        14  30.0  25.0  25.0   0.0  20.0
## 73        628     1        14  30.0  20.0  20.0  20.0  10.0
## 74        137     1        14  20.0  60.0  10.0  10.0   0.0
## 75         51     2        14  30.0  25.0  25.0   0.0  20.0
## 76         27     2         8  40.0  30.0  20.0  10.0   0.0
## 77         27    12         0   0.0   0.0  15.0  85.0   0.0
## 78         15    12         0   0.0   0.0  10.0  90.0   0.0
```

```
## 79          16    12         0   0.0   0.0  20.0  80.0   0.0
## 80          15     5         2   0.0   0.0   0.0  50.0  50.0
## 81           6    11         2   0.0   0.0   0.0  50.0  50.0
## 82           3    11         2   0.0   0.0   0.0  50.0  50.0
## 83          10    11         2   0.0   0.0   0.0  50.0  50.0
## 84           8    11         2   0.0   0.0   0.0   0.0 100.0
## 85          86    11         4   0.0  65.0  20.0  10.0   5.0
## 86          26    11         2   0.0   0.0   0.0  50.0  50.0
## 87           9     2        11   0.0   0.0   0.0   0.0 100.0
## 88          28     5         2   0.0    NA  80.0  10.0  10.0
## 89          27     5         1   0.0   0.0  60.0  20.0  20.0
## 90          21     3        11   0.0   0.0   0.0  40.0  60.0
## 91          13     3         2   0.0   0.0   0.0  20.0  80.0
## 92          23     3         2   0.0   0.0   0.0  50.0  50.0
## 93          23     3         2   0.0   0.0   0.0   0.0 100.0
## 94          11     3         2   0.0   0.0   0.0   0.0 100.0
## 95          27     2         3   0.0   0.0   0.0   0.0 100.0
## 96          19     2         2   0.0   0.0   0.0   0.0 100.0
## 97          43     1         2   0.0   0.0   0.0   0.0 100.0
## 98          46     2         3   0.0   0.0  10.0   0.0  90.0
## 99          44     3        12   0.0   0.0   0.0   0.0 100.0
## 100         53     2        14   0.0  15.0   5.0  15.0  65.0
## 101         42     3         2   0.0   0.0   0.0   0.0 100.0
## 102         50     3         2   0.0   0.0   0.0  15.0  85.0
## 103         42     2         2   0.0   0.0   0.0   5.0  95.0
## 104         58     3        12   0.0   0.0   0.0  50.0  50.0
## 105         43     2         3   0.0   0.0   0.0 100.0   0.0
## 106         51     2        11   0.0   0.0  50.0  50.0   0.0
## 107         15     3         2   0.0   0.0   0.0  50.0  50.0
## 108         22     2        11   0.0   0.0   0.0  50.0  50.0
## 109         13     2        11   0.0   5.0  35.0  30.0  30.0
## 110        115     5         9   0.0  80.0  10.0  10.0   0.0
## 111        491     2        14  35.0  20.0   0.0  35.0  10.0
## 112        524     3        14  40.0  30.0  20.0  10.0   0.0
## 113         98     2        14  25.0  30.0  25.0  15.0   5.0
## 114        275    NA        NA    NA    NA    NA    NA    NA
## 115       1488     2        14  20.0  40.0  20.0  10.0  10.0
## 116        196     2        15  35.0  40.0  10.0  10.0   5.0
## 117        291     2        11  30.0  30.0  20.0  15.0   5.0
## 118        223    11         5  40.0  50.0   5.0   5.0   0.0
## 119       1346    NA        NA    NA    NA    NA    NA    NA
## 120       2370     2        15  25.0  25.0  35.0  10.0   5.0
## 121         17    11         4  30.0  40.0  10.0  10.0  10.0
## 122       1412     2        15  35.0  40.0  15.0  10.0   0.0
## 123        490     2        15  20.0  30.0  35.0  15.0   0.0
## 124        252     3        15  25.0  30.0  30.0  15.0   0.0
## 125        162     2        14  15.0  20.0  15.0  25.0  25.0
## 126        494     2        15  45.0  25.0  10.0  15.0   5.0
## 127        428     2        15  55.0  30.0   5.0   5.0   5.0
## 128        358     1         4  30.0  60.0   0.0  10.0   0.0
## 129        363     1         3  10.0  40.0  25.0  25.0   0.0
## 130        371     2         6  25.0  25.0  20.0  20.0  10.0
## 131       1420     1         5  40.0  40.0  10.0  10.0   0.0
## 132        828     1         4  40.0  40.0  10.0  10.0   0.0
```

```
## 133       952     1        14  50.0  20.0  20.0  10.0   0.0
## 134       422     2        13  30.0  40.0  20.0  10.0   0.0
## 135       144     3        15  50.0  30.0  10.0   5.0   5.0
## 136       200     3        14  15.0  30.0  30.0  20.0   5.0
## 137       327     2        13  40.0  30.0  20.0   8.0   2.0
## 138        60     3        15  30.0  25.0  10.0  30.0   5.0
```

```
df1a <- imputePCA(df1,ncp=2, scale = TRUE, method = c("Regularized","EM"),
                      row.w = NULL, ind.sup=NULL,quanti.sup=NULL,quali.sup=NULL,
                      coeff.ridge = 1, threshold = 1e-06, seed = NULL, nb.init = 1,
                      maxiter = 1000)


df2 <- select(channel_1, Elevacion, NAN_Am, NAtemp, NASatO2, nit, NADBO)
df2a <- imputePCA(df2, ncp=2, scale = TRUE, method = c("Regularized","EM"),
                      row.w = NULL, ind.sup=NULL,quanti.sup=NULL,quali.sup=NULL,
                      coeff.ridge = 1, threshold = 1e-06, seed = NULL, nb.init = 1,
                      maxiter = 1000)

df1b <- as.data.frame(df1a) # Sustrata
df2b <- as.data.frame(df2a) # Physicochemical


new_channel <- do.call("merge", c(lapply(list(df1b, df2b), data.frame, row.names=NULL),
  by = 0, all = TRUE, sort = FALSE))[-1]

new_channel2 <- select(new_channel,
                       completeObs.Elevacion.x, completeObs.Ancho, completeObs.Velocidad,
                       completeObs.Rocas, completeObs.Canto, completeObs.grava, completeObs.arena,
                       completeObs.Limo, completeObs.NAN_Am, completeObs.NAtemp, completeObs.NASatO2,
                       )
```

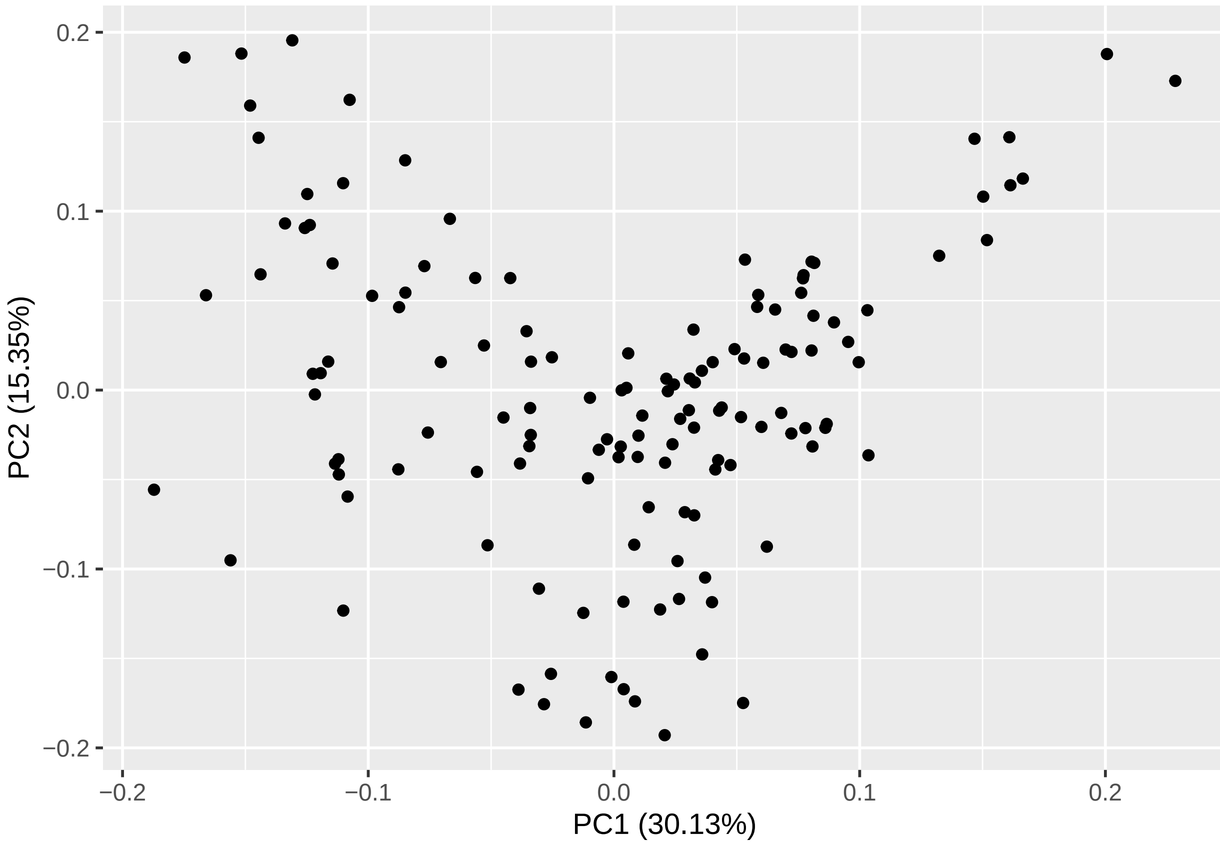
3. Vamos a correr el PCA

```
channel.pca <- prcomp(new_channel2, center = TRUE, scale = TRUE)
summary(channel.pca)
```

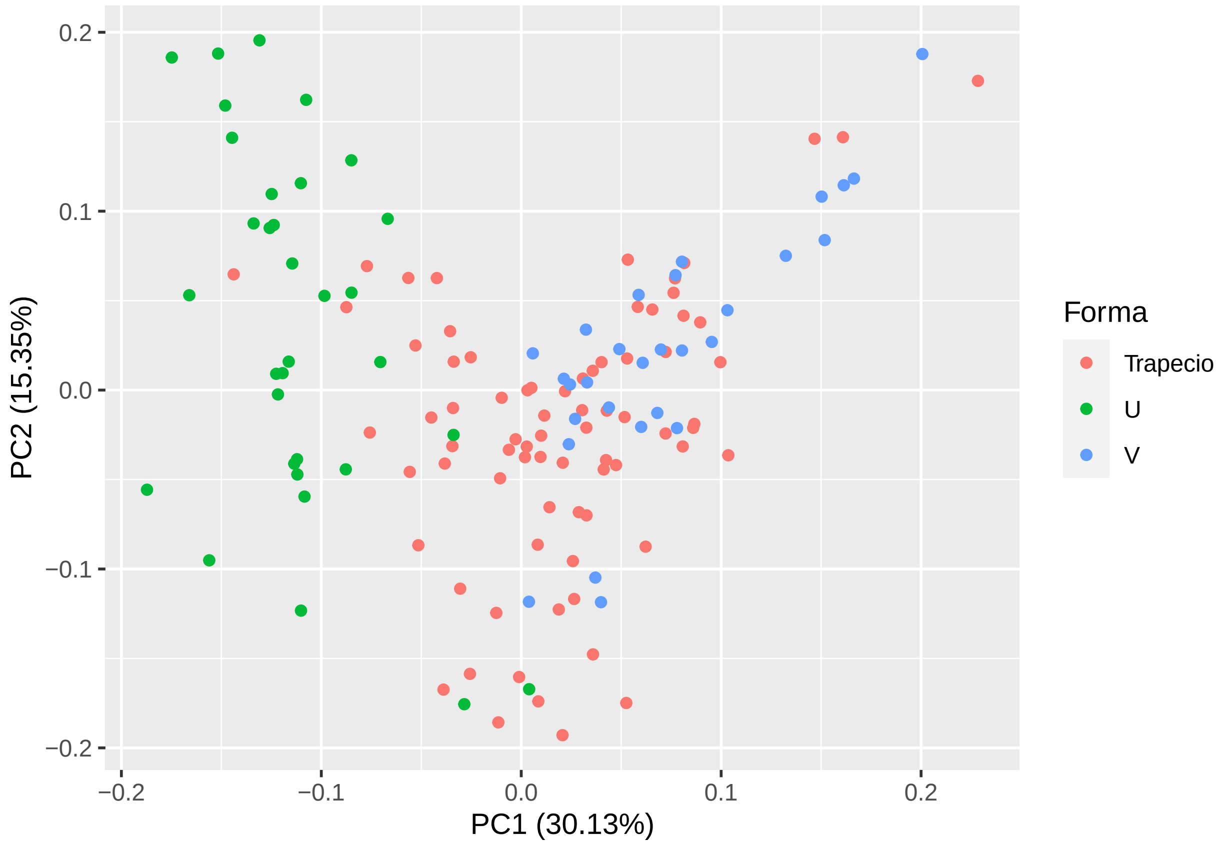
```
## Importance of components:
##                           PC1    PC2    PC3    PC4     PC5     PC6     PC7
## Standard deviation     1.8204 1.2996 1.1989 1.1224 1.00580 0.88356 0.75458
## Proportion of Variance 0.3013 0.1535 0.1307 0.1145 0.09197 0.07097 0.05176
## Cumulative Proportion  0.3013 0.4548 0.5855 0.7000 0.79195 0.86292 0.91468
##                            PC8     PC9    PC10    PC11
## Standard deviation     0.66732 0.59198 0.37028 0.07501
## Proportion of Variance 0.04048 0.03186 0.01246 0.00051
## Cumulative Proportion  0.95517 0.98702 0.99949 1.00000
```

3.1 Vamos a ver el grafico.

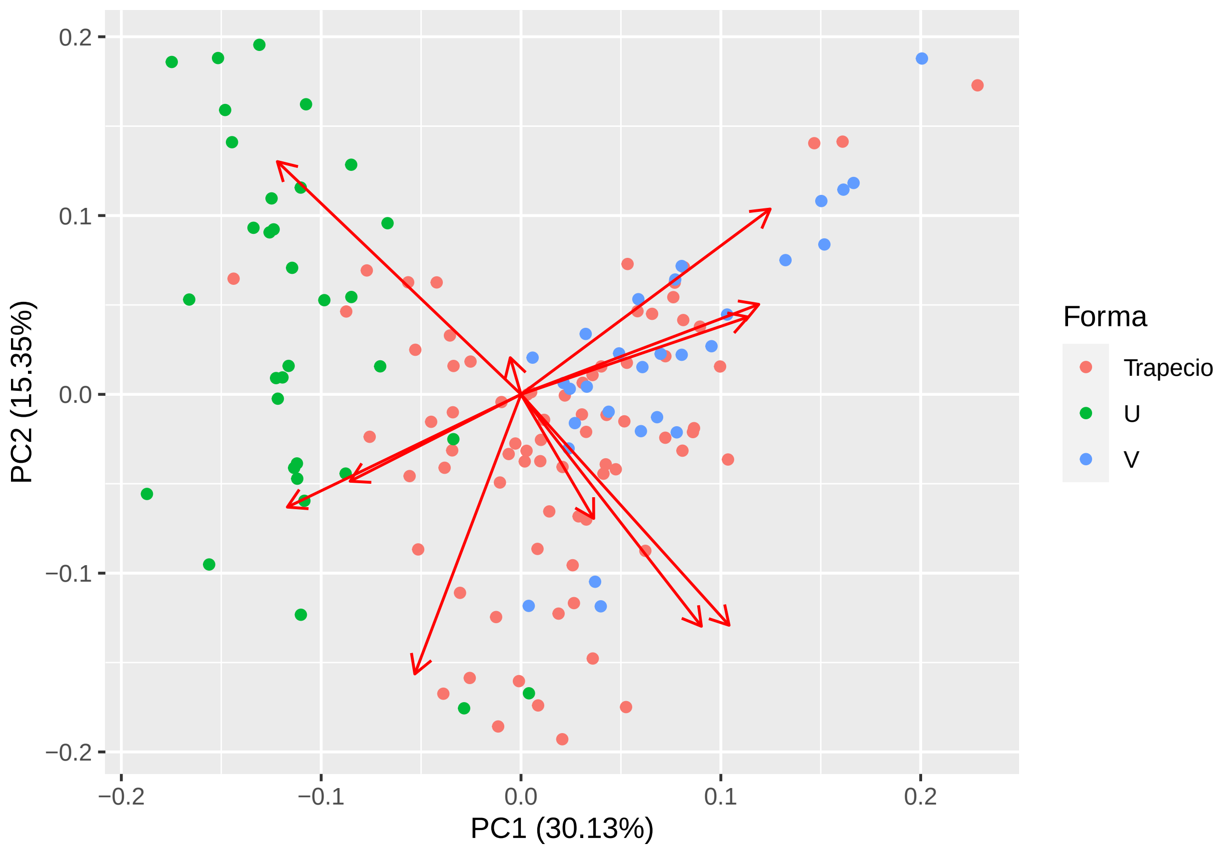
```
autoplot(channel.pca)
```



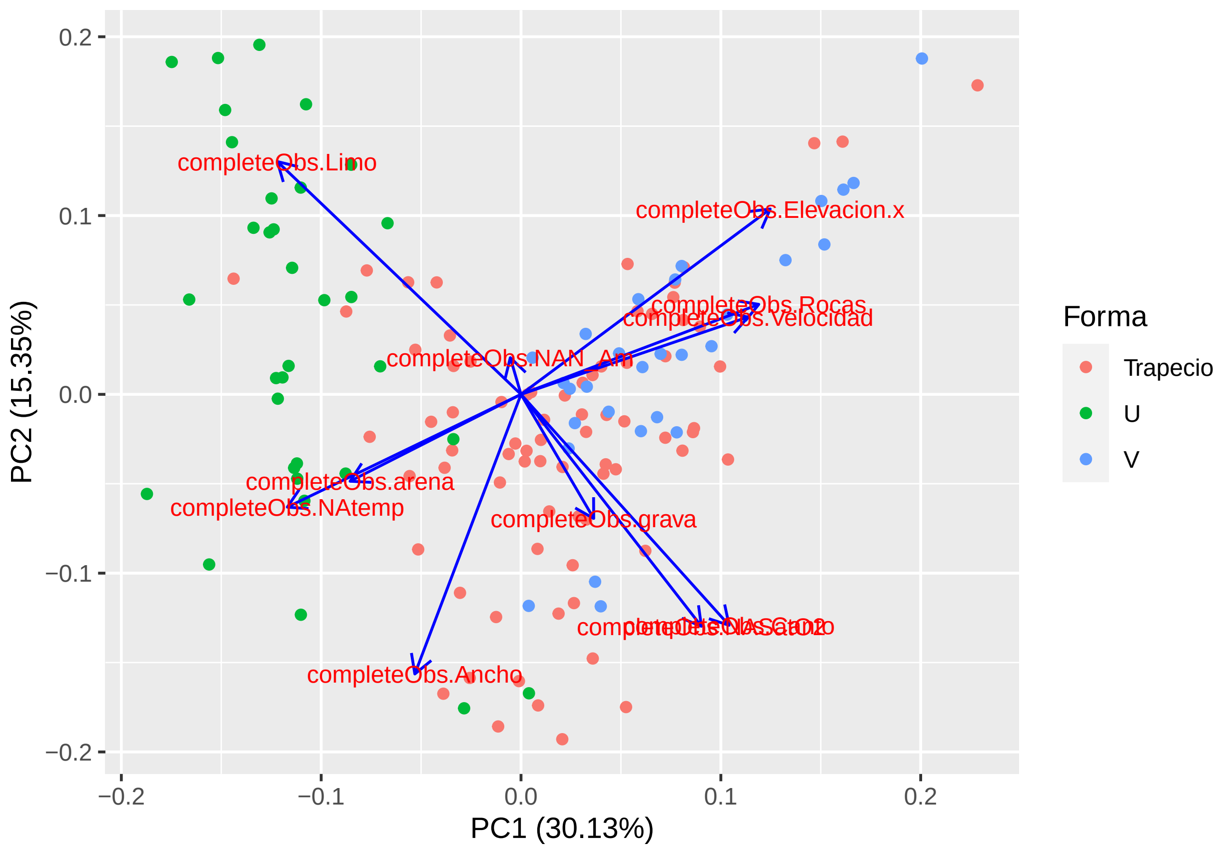

```
autoplot(channel.pca, data = channel, colour = 'Forma')
```




```
autoplot(channel.pca, data = channel, colour = 'Forma', loadings = TRUE)
```

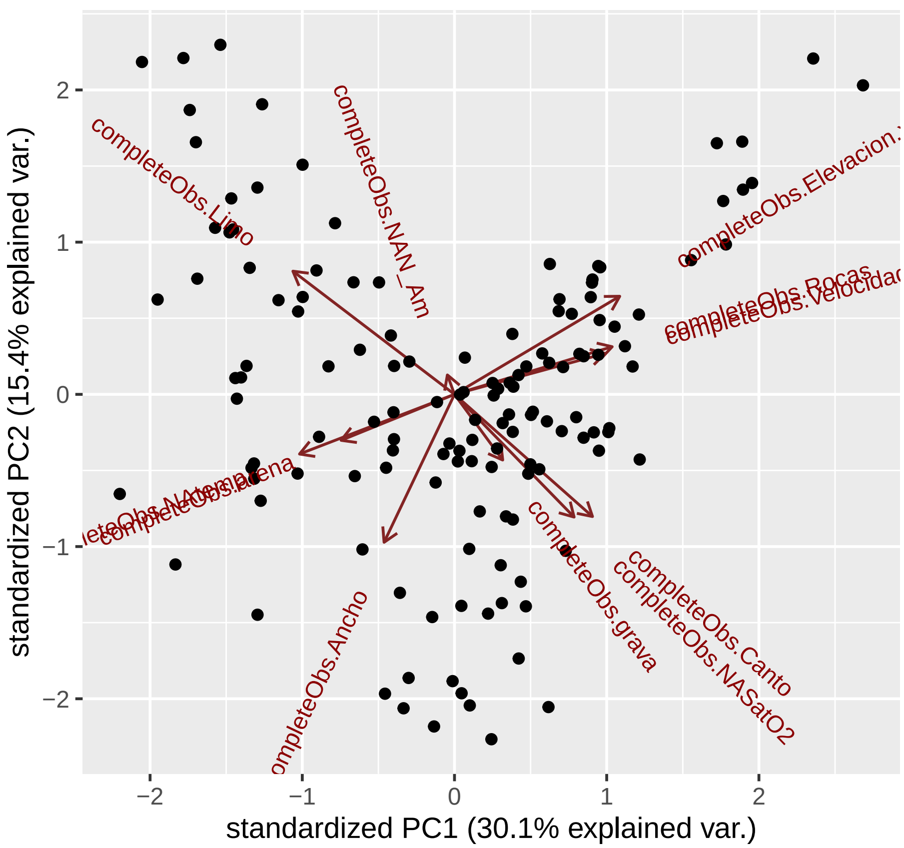



```r
autoplot(channel.pca, data = channel, colour = 'Forma', loadings = TRUE,
         loadings.colour = 'blue',
         loadings.label = TRUE, loadings.label.size = 3)
```



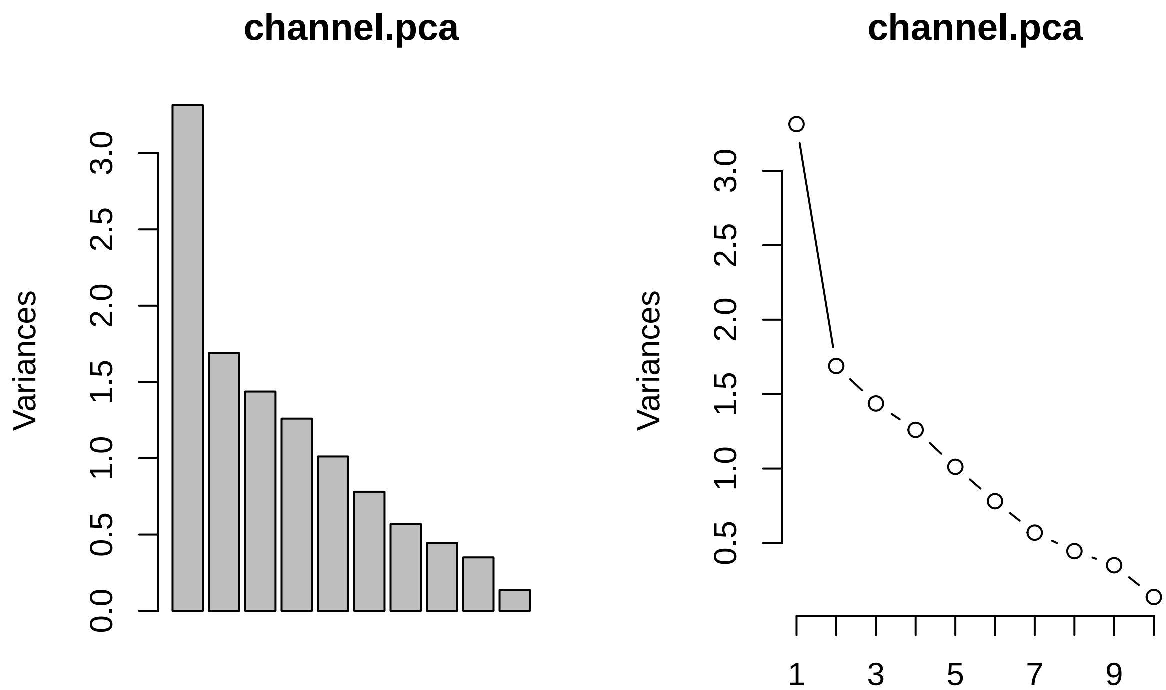
Otra manera de ver el grafico

```
ggbiplot(channel.pca, labels=rownames(channel$Forma))
```



3.2 Ver graficamente lo que explica cada axis.

```
layout(matrix(1:2, ncol=2))
screeplot(channel.pca)
screeplot(channel.pca, type="lines")
```



3.3 Vamos a ver la contribucion de cada una de las variables. Usamos otra libreria. factoextra

```
get_eigenvalue(channel.pca)
```

```
##          eigenvalue variance.percent cumulative.variance.percent
## Dim.1  3.313755251      30.12504773                    30.12505
## Dim.2  1.689049493      15.35499539                    45.48004
## Dim.3  1.437244748      13.06586135                    58.54590
## Dim.4  1.259763350      11.45239409                    69.99830
## Dim.5  1.011629652       9.19663320                    79.19493
## Dim.6  0.780673684       7.09703349                    86.29197
## Dim.7  0.569391016       5.17628197                    91.46825
## Dim.8  0.445319958       4.04836326                    95.51661
## Dim.9  0.350437019       3.18579108                    98.70240
## Dim.10 0.137109816       1.24645287                    99.94885
## Dim.11 0.005626012       0.05114556                   100.00000
```

```
res.var <- get_pca_var(channel.pca)
res.var$contrib        # Contributions to the PCs
```

```
##                                Dim.1      Dim.2      Dim.3      Dim.4      Dim.5
## completeObs.Elevacion.x 15.29621110 10.5676990  6.6474128  4.3496592  0.8767749
## completeObs.Ancho        2.77771564 24.0608974 20.3460480  0.3823721  1.2441681
## completeObs.Velocidad   12.70587345  1.8406123 13.6779648  2.8497532  1.4993696
## completeObs.Rocas       13.93190883  2.4914189  2.6855542  3.9529342  1.9580543
```

```
## completeObs.Canto       10.66628290 16.4122996  0.1153770  4.4867880 12.5906780
## completeObs.grava        1.30143186  4.7421878 30.9010043 17.2113363  0.3104132
## completeObs.arena        7.19595359  2.3235895  2.3293132 17.3249555 35.1004115
## completeObs.Limo        14.62778901 16.6759938  0.4949031  4.8118433  6.2978302
## completeObs.NAN_Am       0.02842016  0.4138249  5.9566920 31.2616088 32.6711964
## completeObs.NAtemp      13.45278080  3.9142178 16.6886573  3.7314123  2.0509508
## completeObs.NASatO2      8.01563266 16.5572589  0.1570733  9.6373371  5.4001531
##                             Dim.6        Dim.7       Dim.8        Dim.9
## completeObs.Elevacion.x  9.185024  0.238732001  1.00279477 3.220621e+00
## completeObs.Ancho        2.520523  5.676961709  0.01584748 3.784466e+01
## completeObs.Velocidad    4.450552 21.845733874  0.14825648 3.950071e+01
## completeObs.Rocas       29.924538 23.017661922  4.01893997 1.260225e+00
## completeObs.Canto        5.170944 10.866802835 12.98206646 6.416521e+00
## completeObs.grava        9.535450 21.805367681  2.87461644 2.075289e-05
## completeObs.arena        3.612484 13.791520805  1.08894421 6.335258e-01
## completeObs.Limo         2.372910  0.562086854 16.23212704 1.715186e+00
## completeObs.NAN_Am      17.207962  0.004598295  5.72331166 6.114050e+00
## completeObs.NAtemp      13.707101  0.765766615  0.65948897 2.106257e+00
## completeObs.NASatO2      2.312512  1.424767409 55.25360652 1.188222e+00
##                              Dim.10       Dim.11
## completeObs.Elevacion.x 48.57727559 3.779553e-02
## completeObs.Ancho        5.12981047 9.952647e-04
## completeObs.Velocidad    1.45642015 2.475280e-02
## completeObs.Rocas        0.08799712 1.667077e+01
## completeObs.Canto        0.07559349 2.021665e+01
## completeObs.grava        0.49725283 1.082092e+01
## completeObs.arena        0.56807769 1.603122e+01
## completeObs.Limo         0.08040327 3.612893e+01
## completeObs.NAN_Am       0.61644440 1.890604e-03
## completeObs.NAtemp      42.88140533 4.196242e-02
## completeObs.NASatO2      0.02931968 2.411734e-02
```

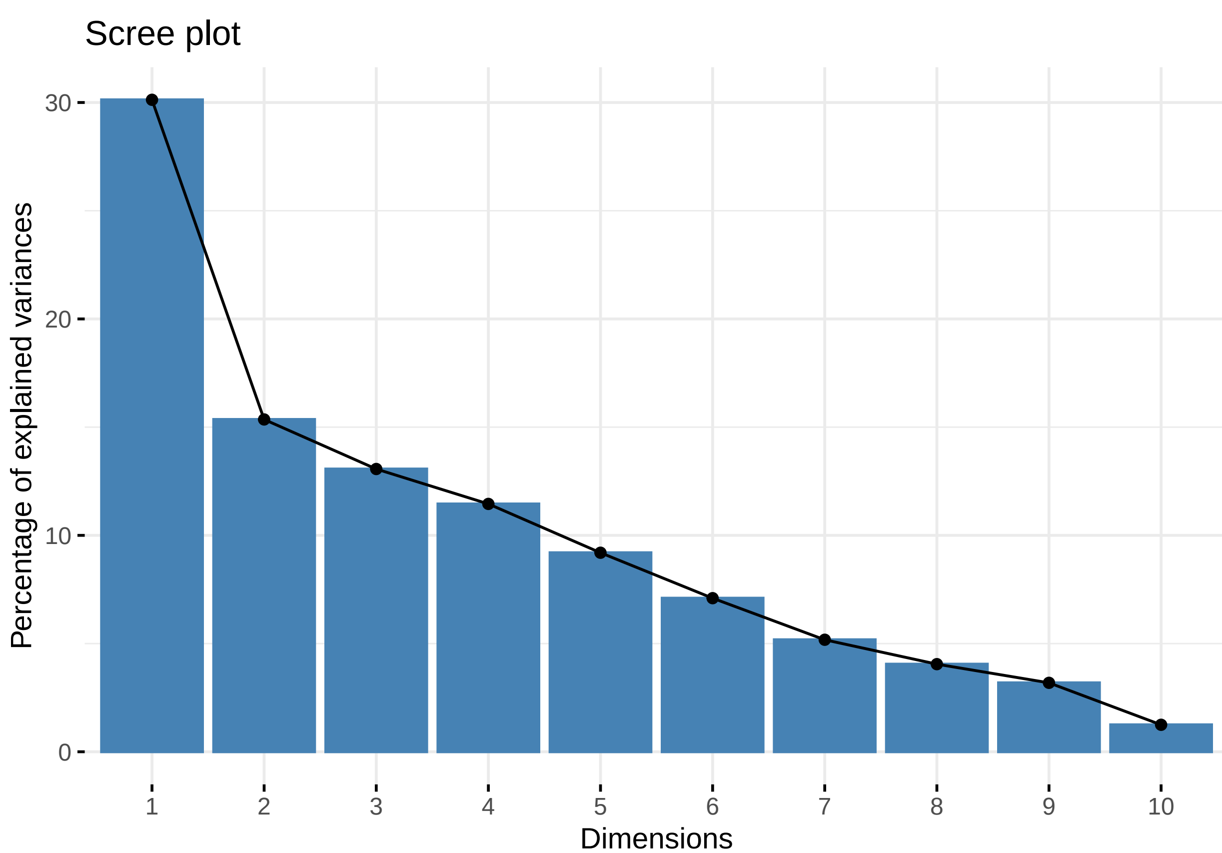
```
res.var$coord          # Coordinates
```

```
##                              Dim.1       Dim.2       Dim.3      Dim.4
## completeObs.Elevacion.x  0.71195435  0.42248511 -0.30909479  0.2340842
## completeObs.Ancho       -0.30339199 -0.63749546 -0.54076104  0.0694045
## completeObs.Velocidad    0.64887714  0.17632031  0.44338001  0.1894733
## completeObs.Rocas        0.67946255  0.20513727 -0.19646371 -0.2231538
## completeObs.Canto        0.59452040 -0.52650913 -0.04072162 -0.2377455
## completeObs.grava        0.20766865 -0.28301572  0.66642559  0.4656416
## completeObs.arena       -0.48831986 -0.19810749 -0.18296976  0.4671760
## completeObs.Limo        -0.69622491  0.53072195 -0.08433842 -0.2462069
## completeObs.NAN_Am      -0.03068835  0.08360447  0.29259570 -0.6275526
## completeObs.NAtemp      -0.66767674 -0.25712463  0.48975183 -0.2168109
## completeObs.NASatO2      0.51538185 -0.52882918 -0.04751345 -0.3484360
##                              Dim.5      Dim.6        Dim.7        Dim.8
## completeObs.Elevacion.x -0.09417916  0.2677780 -0.036868938  0.066825484
## completeObs.Ancho        0.11218901  0.1402749 -0.179789071 -0.008400714
## completeObs.Velocidad    0.12315871 -0.1863982  0.352686328  0.025694663
## completeObs.Rocas       -0.14074181 -0.4833353 -0.362022788 -0.133780199
## completeObs.Canto        0.35689078  0.2009184  0.248746053 -0.240440706
## completeObs.grava       -0.05603777  0.2728383 -0.352360334  0.113142568
## completeObs.arena       -0.59589107 -0.1679336  0.280227908 -0.069636814
```

```
## completeObs.Limo         0.25240982  0.1361054  0.056572715  0.268858515
## completeObs.NAN_Am      -0.57490131  0.3665215  0.005116862 -0.159646638
## completeObs.NAtemp       0.14404175 -0.3271204 -0.066031858 -0.054192583
## completeObs.NASatO2     -0.23372965 -0.1343621  0.090069405  0.496039653
##                                 Dim.9      Dim.10        Dim.11
## completeObs.Elevacion.x -0.1062367582  0.25807792  0.0014582116
## completeObs.Ancho        0.3641726255  0.08386581 -0.0002366299
## completeObs.Velocidad    0.3720552567  0.04468663 -0.0011800828
## completeObs.Rocas        0.0664552221 -0.01098420 -0.0306251429
## completeObs.Canto       -0.1499528738  0.01018067 -0.0337252275
## completeObs.grava        0.0002696773 -0.02611096 -0.0246735933
## completeObs.arena       -0.0471180304  0.02790861 -0.0300319602
## completeObs.Limo         0.0775283498  0.01049956 -0.0450845632
## completeObs.NAN_Am       0.1463758711  0.02907242 -0.0003261374
## completeObs.NAtemp      -0.0859133478  0.24247601  0.0015364930
## completeObs.NASatO2     -0.0645288183  0.00634036  0.0011648368
```

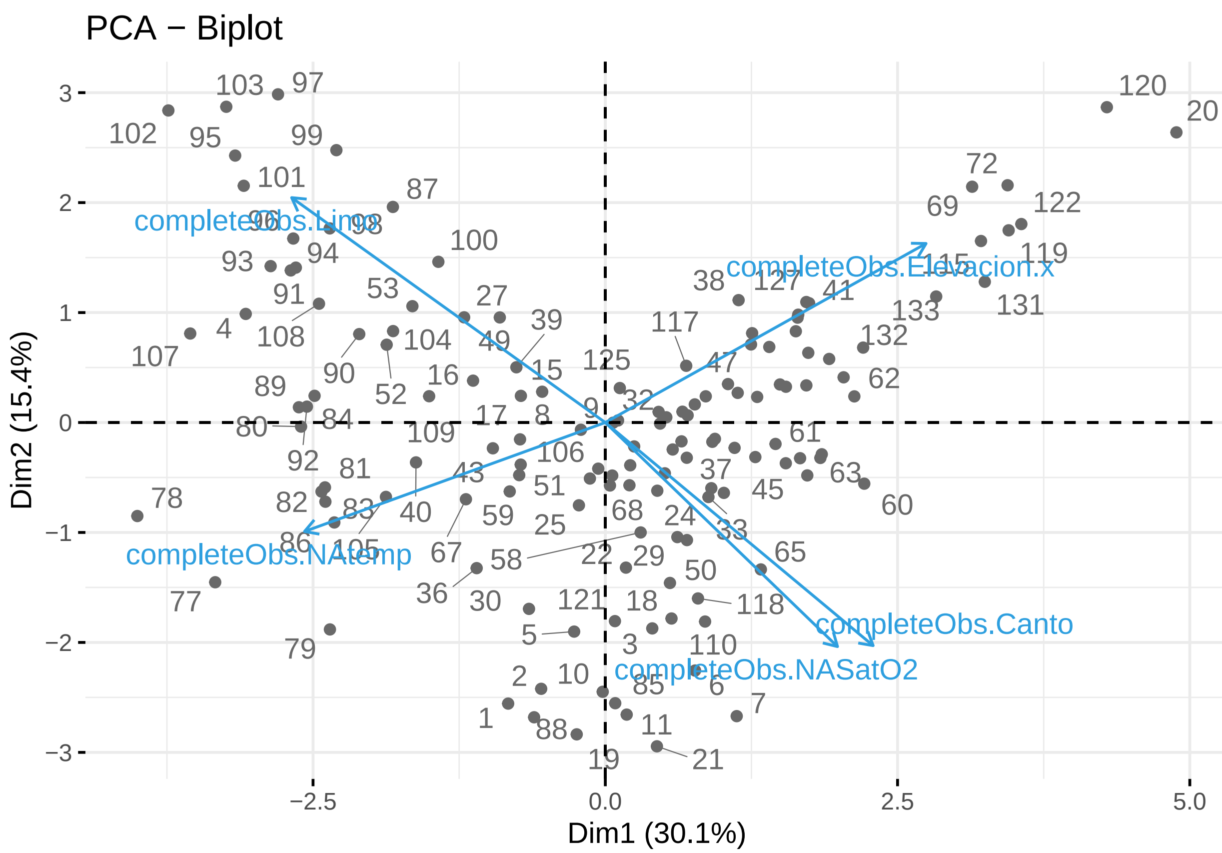
4 Otras formas de visualizar los datos.

```
fviz_eig(channel.pca)
```



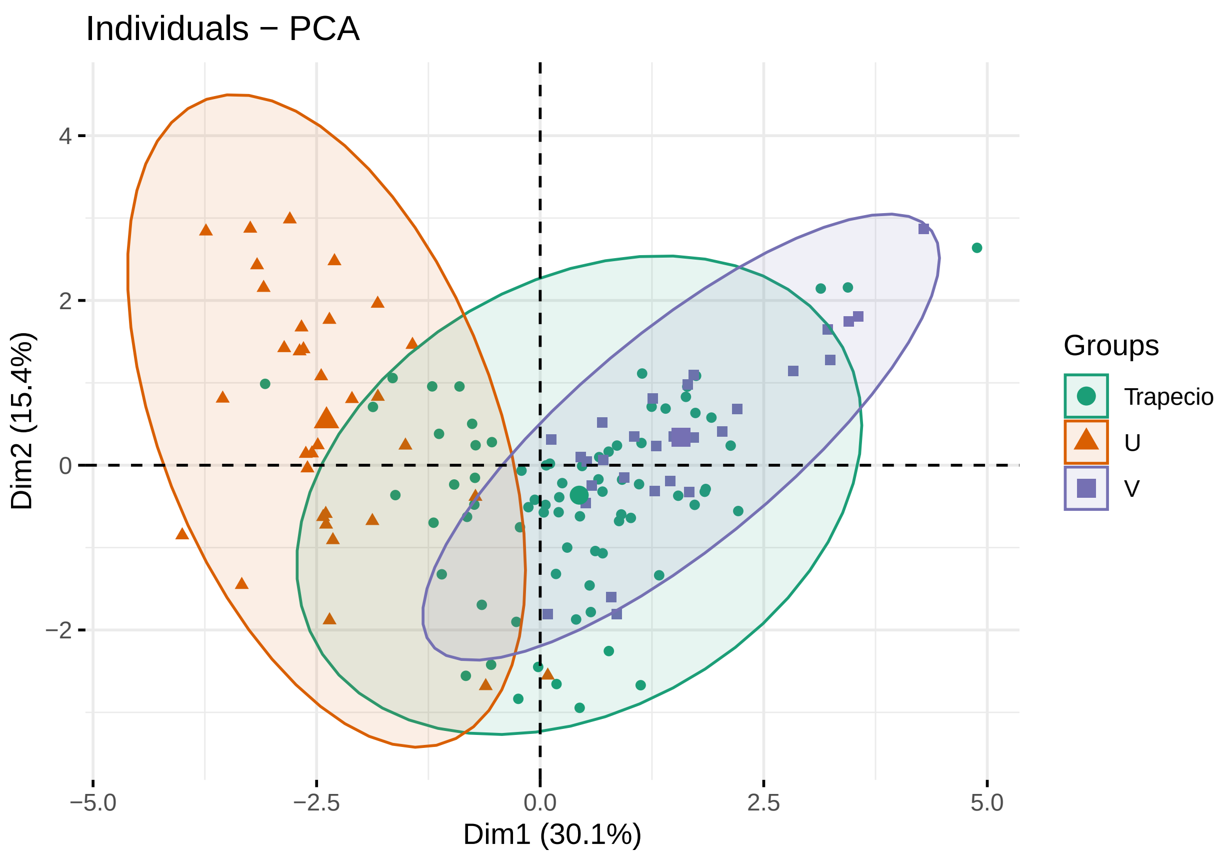

```
fviz_pca_biplot(channel.pca, repel = TRUE,
                col.var = "#2E9FDF", # Variables color
                col.ind = "#696969",  # Individuals color
                select.var = list(contrib = 5))
```

```
## Warning: ggrepel: 41 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps
```



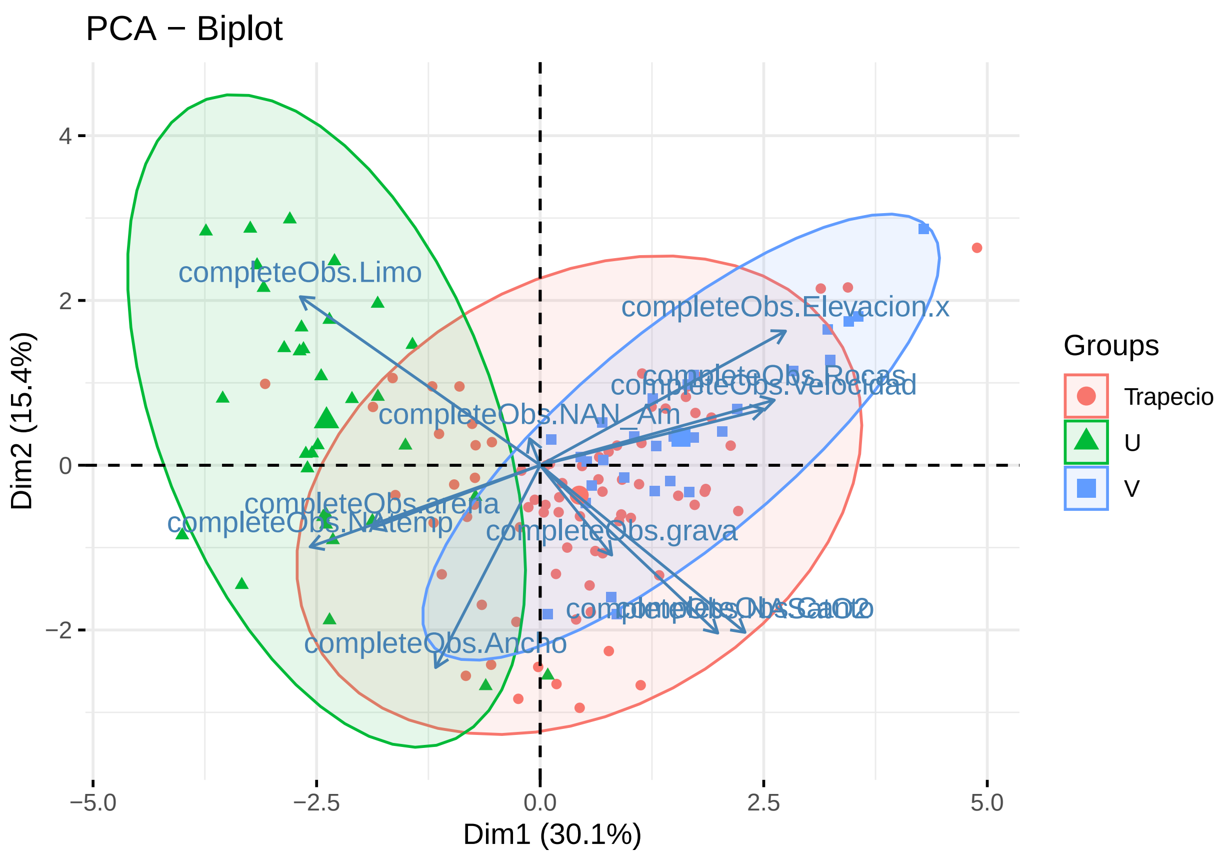
4.1 Con las elipses.

```
fviz_pca_ind(channel.pca, label="none", habillage=channel$Forma,
     addEllipses=TRUE, ellipse.level=0.95, palette = "Dark2")
```



4.1

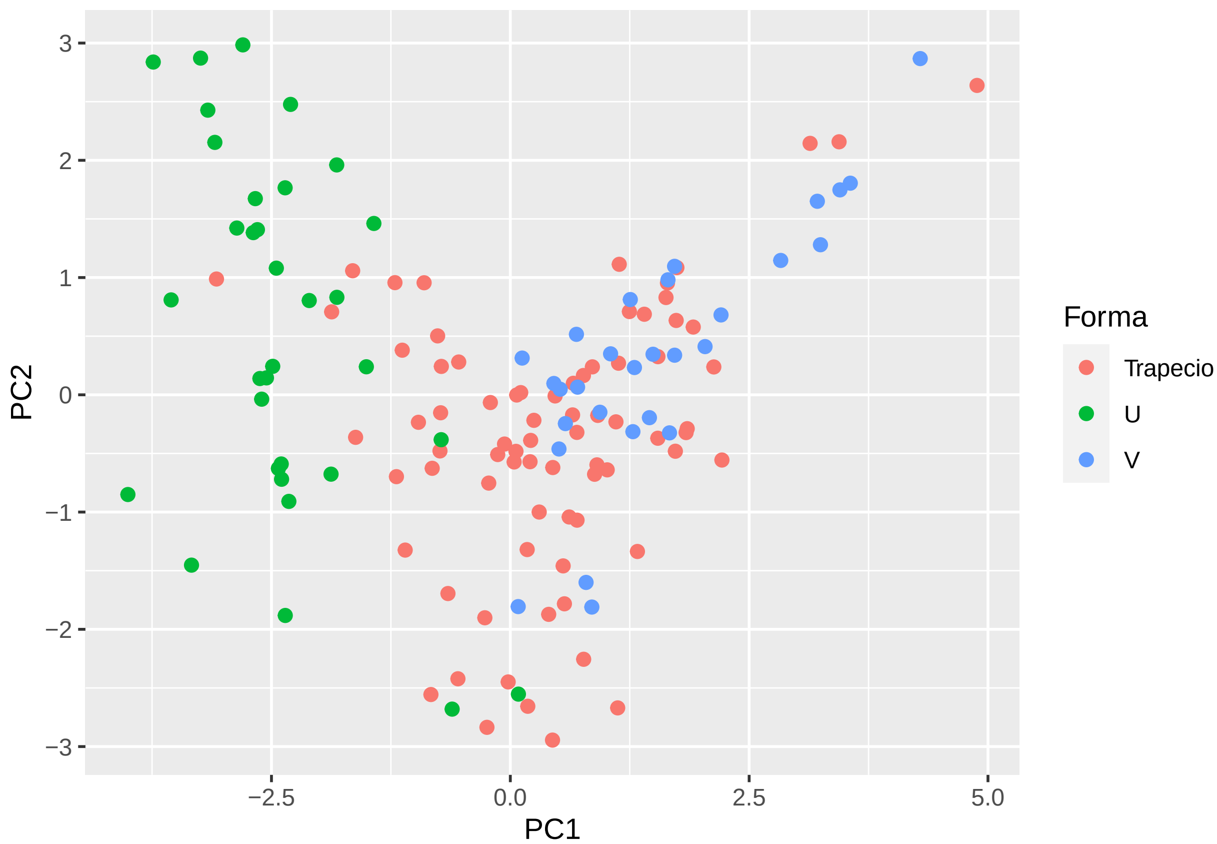
```
fviz_pca_biplot(channel.pca, label = "var", habillage=channel$Forma,
                addEllipses=TRUE, ellipse.level=0.95,
                ggtheme = theme_minimal())
```



5. Convertirlo en una data.frame para trabajarlo en ggplot2

```
data <- data.table(PC1=channel.pca$x[,1], PC2=channel.pca$x[,2], Forma=  channel[,1])
data <- data[order(channel$Forma),]

ggplot(data, aes(x=PC1,y=PC2)) +
  geom_point(size = 2, aes(color=Forma))
```



3
2
1
0
−1
−2
−3
PC2
−2.5
0.0
2.5
5.0
PC1
Forma
Trapecio
U
V