Supplementary Material

Contents

Hypothesis 1

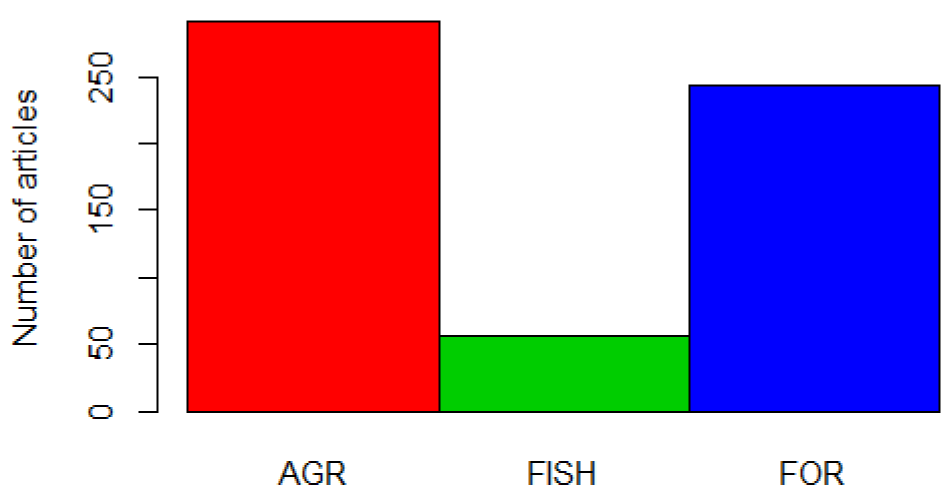
1. The application of the Multi-Criteria Decision-Making (MCDM) techniques does not significantly differ in the three fields (Agriculture, Forestry and Fishery), given that we have not seen comparative studies that support the opposite.

==> We reject the Hypothesis

==> With DEA: We reject the null hypothesis that they are independent. They significantly differ when the field is changed.

==> Without DEA: We cannot reject the null hypothesis that they are independent. They do not significantly differ when the field is changed.

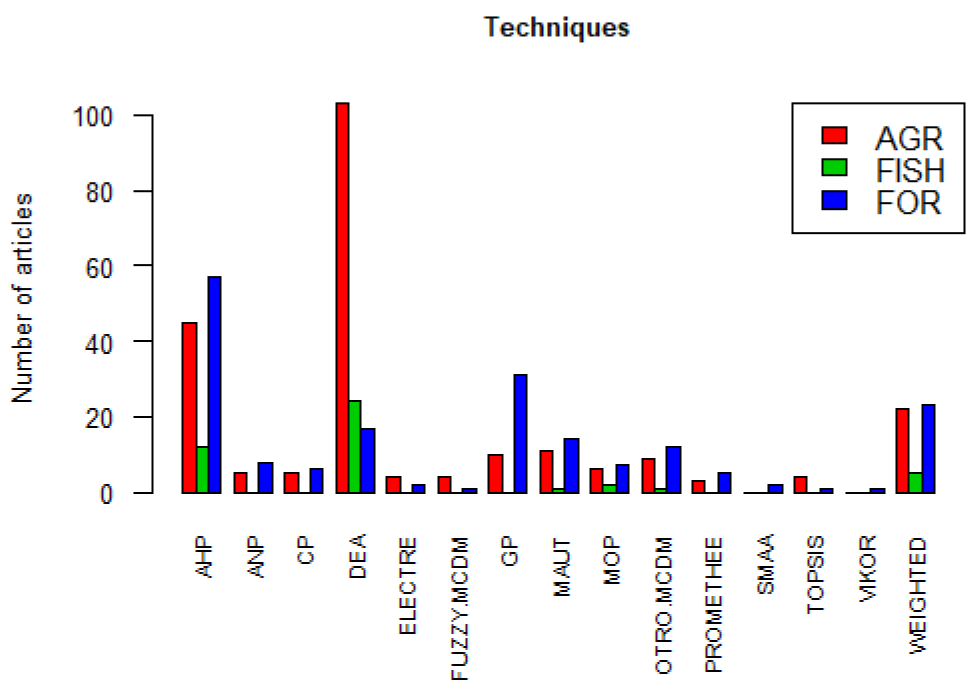
```
db$Campo <- NA; db$Campo[db$FOR > 0 ] <- "FOR"; db$Campo[db$AGR > 0 ] <- "AGR"; db$Campo[db$FISH > 0 ] <- "FISH"
db$Campo[(db$FOR > 0 & db$AGR > 0) | (db$FISH > 0 & db$AGR > 0) | (db$FISH > 0 & db$FOR > 0)] <- NA
tbl <- table(db$Campo)
barplot(as.matrix(tbl), beside = TRUE, col=c(2:4), ylab="Número de artículos",names.arg = rownames(tbl))
```




```
chisq.test(tbl) # The number of items differs significantly when we change the field.

##
##  Chi-squared test for given probabilities
##
```

```
## data:  tbl
## X-squared = 155.09, df = 2, p-value < 2.2e-16
```

```
Tecnicas_name <- c("GP","CP","TOPSIS","MOP","VIKOR","ELECTRE","PROMETHEE","AHP","ANP","DE
A",
                "MAUT","WEIGHTED","SMAA","FUZZY.MCDM","OTRO.MCDM")
db$Tecnicas <- NA
for(i in 1:length(Tecnicas_name)){
  db$Tecnicas[db[,Tecnicas_name[i]] > 0 ] <- Tecnicas_name[i]}
db$Tecnicas[rowSums(db[,Tecnicas_name], na.rm=TRUE) > 1] <- NA
tbl <- table(db$Campo, db$Tecnicas)
barplot(as.matrix(tbl), beside = TRUE, las=2, col=c(2:4), ylab="Número de artículos",
       main = "Técnicas", cex.main=0.8, cex.axis=0.8, cex.names = 0.7, cex.lab=0.8)
legend("topright",rownames(tbl), fill=c(2:4))
```

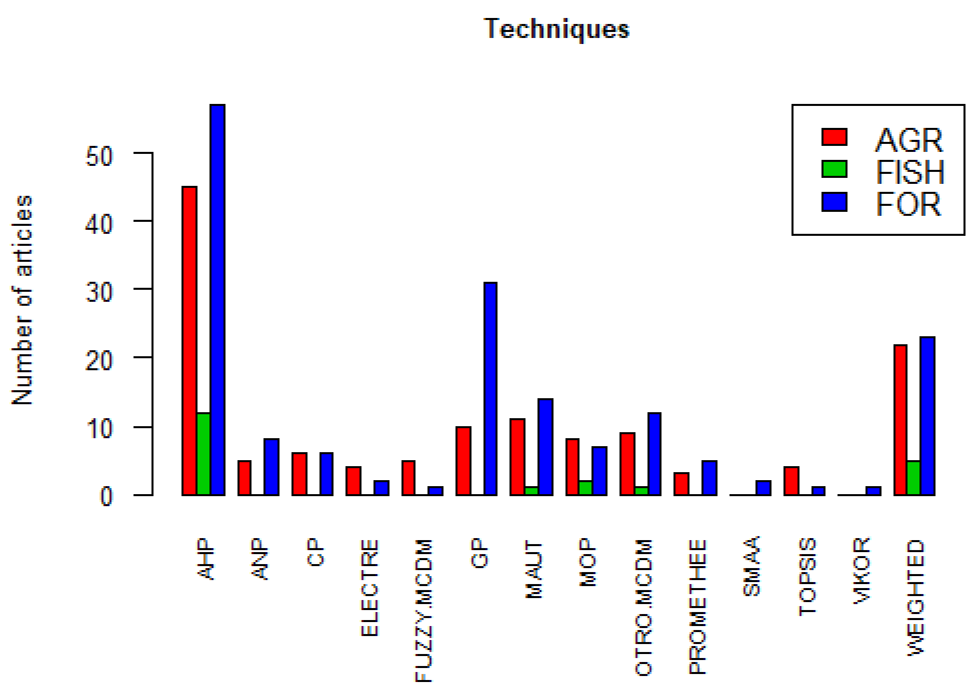



```
fisher.test(tbl,simulate.p.value=TRUE)#,B=1e7)
```

```
##
##  Fisher's Exact Test for Count Data with simulated p-value (based
##  on 2000 replicates)
##
## data:  tbl
## p-value = 0.0004998
## alternative hypothesis: two.sided
```

```
Tecnicas_sinDEA_name <- c("GP","CP","TOPSIS","MOP","VIKOR","ELECTRE","PROMETHEE","AHP","A
NP",
```

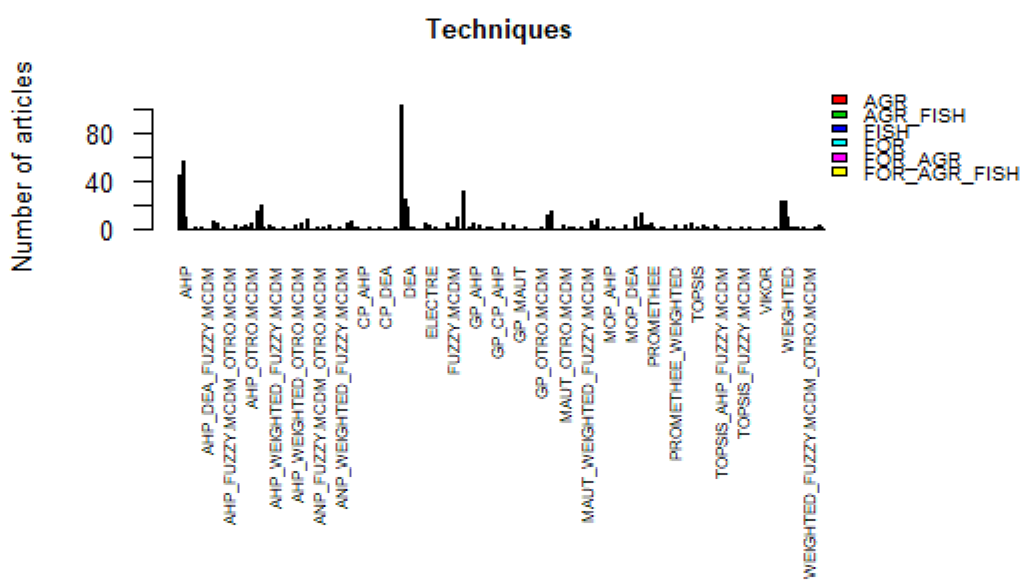
```
                "MAUT","WEIGHTED","SMAA","FUZZY.MCDM","OTRO.MCDM")
db$Tecnicas_sinDEA <- NA
for(i in 1:length(Tecnicas_sinDEA_name)){
  db$Tecnicas_sinDEA[db[,Tecnicas_sinDEA_name[i]] > 0 ] <- Tecnicas_sinDEA_name[i]}
db$Tecnicas_sinDEA[rowSums(db[,Tecnicas_sinDEA_name], na.rm=TRUE) > 1] <- NA
tbl <- table(db$Campo, db$Tecnicas_sinDEA)
barplot(as.matrix(tbl), beside = TRUE, las=2, col=c(2:4), ylab="Número de artículos",
       main = "Técnicas", cex.main=0.8, cex.axis=0.8, cex.names = 0.7, cex.lab=0.8)
legend("topright",rownames(tbl), fill=c(2:4))
```




```
fisher.test(tbl,simulate.p.value=TRUE)#,B=1e7)

##
##  Fisher's Exact Test for Count Data with simulated p-value (based
##  on 2000 replicates)
##
## data:  tbl
## p-value = 0.2484
## alternative hypothesis: two.sided

db$Campo_mixtos <- db$Campo
db$Campo_mixtos[(db$FOR > 0 & db$AGR > 0) ] <- "FOR_AGR"
db$Campo_mixtos[(db$FOR > 0 & db$FISH > 0) ] <- "FOR_FISH"
db$Campo_mixtos[(db$AGR > 0 & db$FISH > 0) ] <- "AGR_FISH"
db$Campo_mixtos[(db$FOR > 0 & db$AGR > 0 & db$FISH > 0) ] <- "FOR_AGR_FISH"
table(db$Campo_mixtos)
```

```
##
##          AGR     AGR_FISH        FISH         FOR     FOR_AGR
##          291            1          57         243          30
## FOR_AGR_FISH
##            1
```

```
db$Tecnicas_mixto <- db$Tecnicas
a <- db[,Tecnicas_name ]
obs_greater1_tech <-  rowSums(a) > 1 # to identify observations with more than 1 technique
for(i in 1:nrow(a)){
  if(obs_greater1_tech[i] == TRUE){
    db$Tecnicas_mixto[i] <- paste(colnames(a)[which(a[i,] %in% 1)], collapse = "_")
  }
}
tbl <- table(db$Campo_mixtos, db$Tecnicas_mixto)
par(mar=c(12.1, 4.1, 4.1, 5.1))
barplot(as.matrix(tbl), beside = TRUE, las=2, col=c(2:7), ylab="Número de artículos",
      main = "Técnicas", cex.main=0.8, cex.axis=0.8, cex.names = 0.5, cex.lab=0.8)
legend(400,120,rownames(tbl), fill=c(2:7), cex=0.6,bty = "n", xpd=TRUE)
```




```
fisher.test(tbl,simulate.p.value=TRUE)#,B=1e7)
```

```
##
##  Fisher's Exact Test for Count Data with simulated p-value (based
##  on 2000 replicates)
##
## data:  tbl
```

```
## p-value = 0.0004998
## alternative hypothesis: two.sided

par(mar=c(5, 4, 4, 2) + 0.1)
```

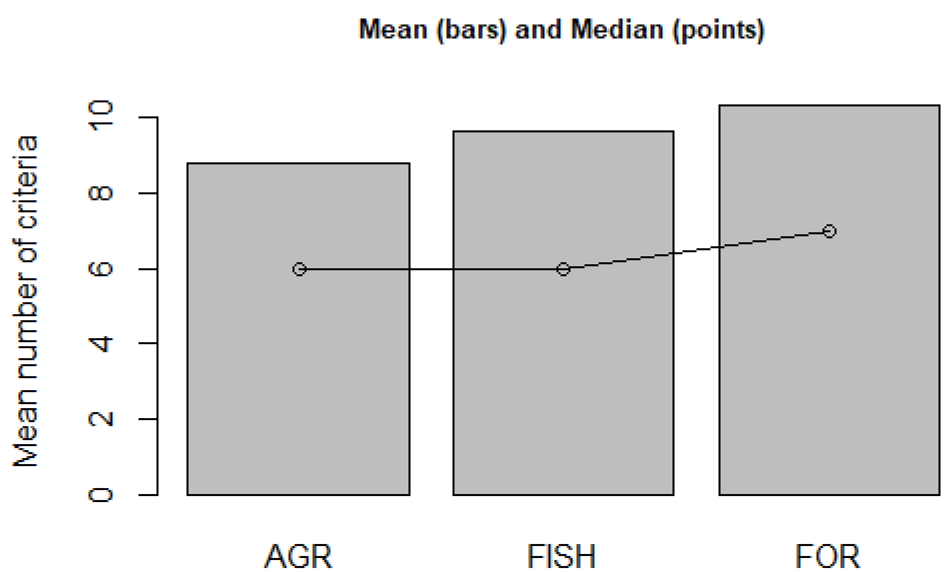
Hypothesis 2

2. The number of criteria used in MCDM problems is similar in the three fields (Agriculture, Forestry and Fishery)

==> We accept the Hypothesis

==> We cannot reject the null hypothesis that they are equal.

```
tbl_mean <- aggregate(db[, c("nº.criterios")], list(db$Campo), mean, na.rm=TRUE)
tbl_median <- aggregate(db[, c("nº.criterios")], list(db$Campo), median, na.rm=TRUE)
df.bar <- barplot(tbl_mean$x, names.arg = tbl_mean$Group.1, ylab="Número medio de criterios",
             main="Media (barras) y Mediana (puntos)", cex.main=0.8)
lines(x = df.bar, y = tbl_median$x); points(x = df.bar, y = tbl_median$x)
```




```
summary(aov(db$nº.criterios ~ db$Campo))

##              Df Sum Sq Mean Sq F value Pr(>F)
## db$Campo      2    297   148.6   1.255  0.286
## Residuals   569  67358   118.4
## 56 observations deleted due to missingness
```

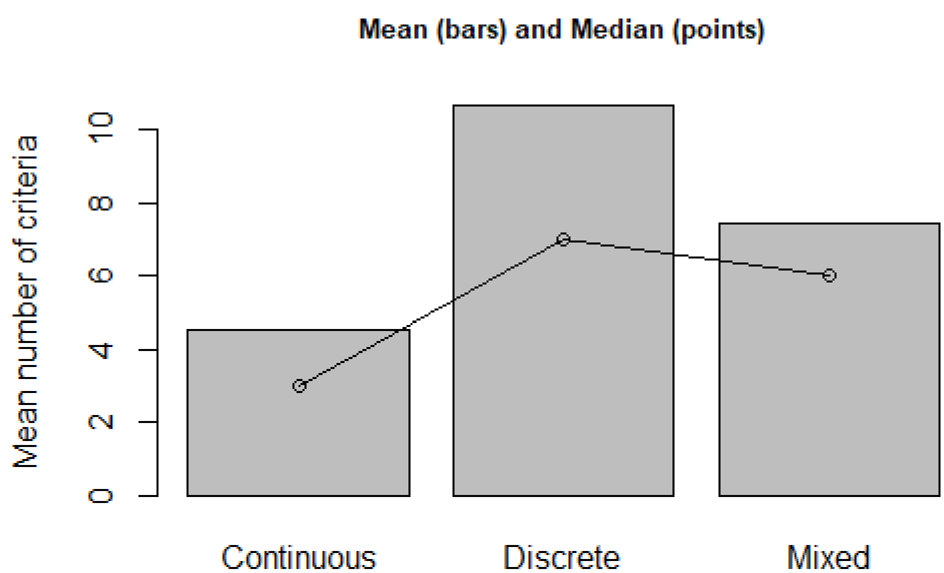
Hypothesis 3

3. The number of criteria is lower in continuous problems than in discrete problems.

==> We accept the Hypothesis

==> We reject the null hypothesis the fact that they are equal. The number of criteria in continuous is less than in discrete.

```
Continuos <- c("GP","CP","TOPSIS","MOP","VIKOR")
Discretos <-
c("ELECTRE","PROMETHEE","AHP","ANP","DEA","MAUT","WEIGHTED","SMAA","FUZZY.MCDM","
OTRO.MCDM")
Continuos0 <- rowSums(db[,Continuos]); Continuos0[Continuos0 >0] <- 1; db$Continuos <- Continuos0
Discretos0 <- rowSums(db[,Discretos]); Discretos0[Discretos0 >0] <- 1; db$Discretos <- Discretos0
db$Cont_Disc <- NA; db$Cont_Disc[db$Continuos > 0] <- "Continuo"; db$Cont_Disc[db$Discretos > 0] <-
"Discreto";
db$Cont_Disc[db$Continuos > 0 & db$Discretos > 0] <- "Mixto"
tbl_mean <- aggregate(db[, c("nº.criterios")], list(db$Cont_Disc), mean, na.rm=TRUE)
tbl_median <- aggregate(db[, c("nº.criterios")], list(db$Cont_Disc), median, na.rm=TRUE)
df.bar <- barplot(tbl_mean$x, names.arg = tbl_mean$Group.1, ylab="Número medio de criterios",
        main="Media (barras) y Mediana (puntos)", cex.main=0.8)
lines(x = df.bar, y = tbl_median$x); points(x = df.bar, y = tbl_median$x)
```




```
a <- db$Cont_Disc; a[a=="Mixto"] <- NA
t.test(db$nº.criterios ~ a)

##
##  Welch Two Sample t-test
```

```
##
## data:  db$nº.criterios by a
## t = -9.1647, df = 442.38, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -7.460490 -4.825736
## sample estimates:
## mean in group Continuo mean in group Discreto
##               4.513514              10.656627
```

```
t.test(db$nº.criterios ~ a, alternative = "less")
```

```
##
##  Welch Two Sample t-test
##
## data:  db$nº.criterios by a
## t = -9.1647, df = 442.38, p-value < 2.2e-16
## alternative hypothesis: true difference in means is less than 0
## 95 percent confidence interval:
##       -Inf -5.038247
## sample estimates:
## mean in group Continuo mean in group Discreto
##               4.513514              10.656627
```

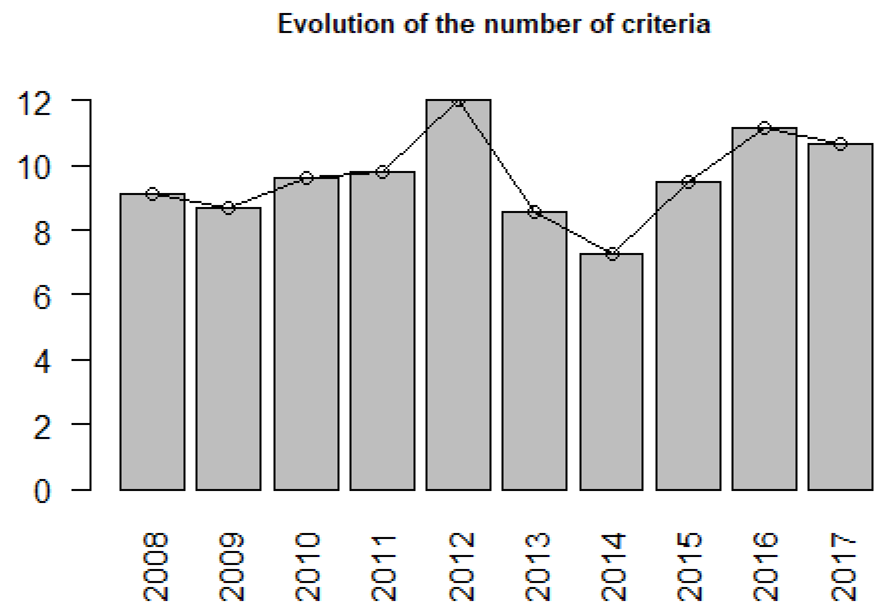
```
summary(aov(db$nº.criterios ~ db$Cont_Disc))
```

```
##               Df Sum Sq Mean Sq F value   Pr(>F)
## db$Cont_Disc   2   2609  1304.7   9.993 5.38e-05 ***
## Residuals    601  78467   130.6
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 24 observations deleted due to missingness
```

```
summary(db$nº.criterios)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##   1.000   4.000   6.000   9.724  11.000 133.000      22
```

```
tbl_mean <- aggregate(db[, c("nº.criterios")], list(db$year), mean, na.rm=TRUE)
df.bar <- barplot(tbl_mean$x, las=2, main="Evolución del número total de criterios", cex.main=0.8,
                  names.arg = tbl_mean$Group.1)
lines(x = df.bar, y = tbl_mean$x); points(x = df.bar, y = tbl_mean$x)
```




```
tbl1.2008_2012 <- tbl_mean [1:5,];tbl1.2013_2017 <- tbl_mean [6:10,]
mean(tbl1.2008_2012[,2]); mean(tbl1.2013_2017[,2])

## [1] 9.834254

## [1] 9.421236

t.test(tbl1.2008_2012[,2], tbl1.2013_2017[,2]) # No hay un cambio significativo en el número de criterios

##
##  Welch Two Sample t-test
##
## data:  tbl1.2008_2012[, 2] and tbl1.2013_2017[, 2]
## t = 0.4532, df = 7.6871, p-value = 0.6629
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -1.703506  2.529543
## sample estimates:
## mean of x mean of y
##  9.834254  9.421236
```

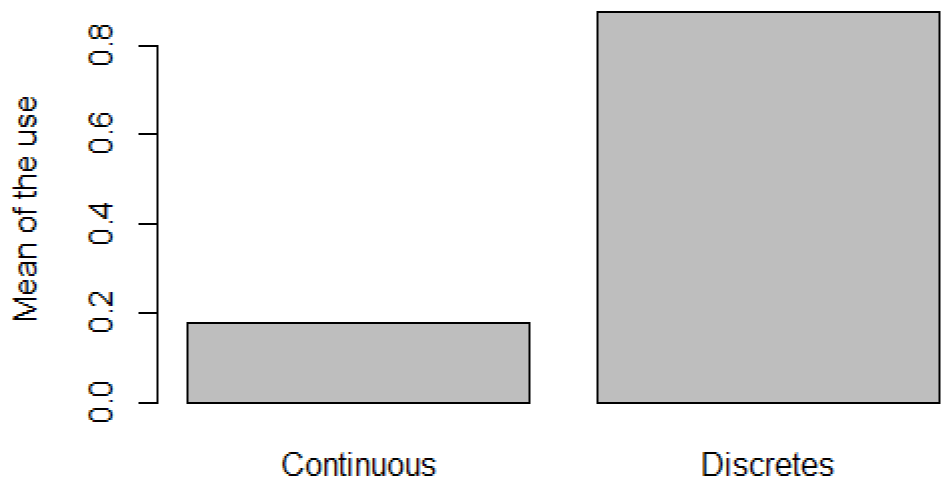
Hypothesis 4

4. There seems to be less use of MCDM techniques that apply to continuous problems than others that can only be applied to discrete problems.

==> We accept the Hypothesis.

==> There is less use of techniques that apply to Continuous than Discrete problems

```
barplot(c(mean(db$Continuos), mean(db$Discretos)), names.arg = c("Continuos", "Discretos"), ylab="Me
dia de uso")
```




```
t.test(db$Continuos, db$Discretos)

##
##  Welch Two Sample t-test
##
## data:  db$Continuos and db$Discretos
## t = -34.541, df = 1233.1, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.7370668 -0.6578377
## sample estimates:
## mean of x mean of y
## 0.1751592 0.8726115
```

Hypothesis 5

5. There is no relationship between the use of a particular MCDM technique and the fact that the case studies are from one or from several countries.

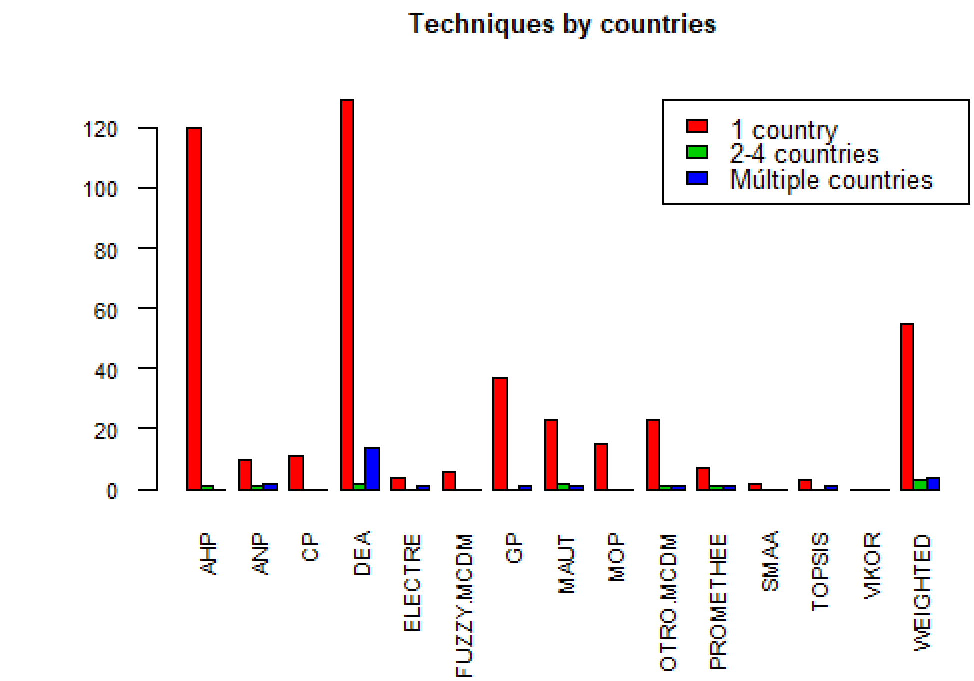
==> We reject the Hypothesis.

==> There exists a significant difference between the use of techniques and the number of countries. This may be because there are many techniques or groups of techniques and because in some techniques, the proportion of the number of countries is quite different.

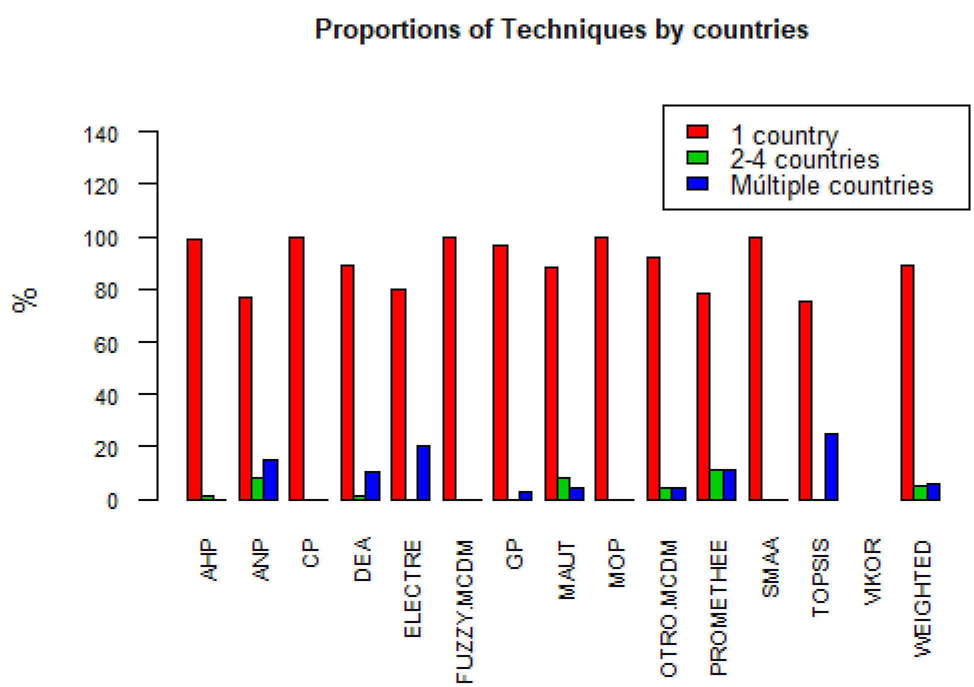
```
db$Numero_paises[db$Numero_paises==0] <- NA; db$Numero_paises <- as.character(db$Numero_paise
s)
db$Numero_paises_3Cat <- NA
db$Numero_paises_3Cat[db$Numero_paises == "1"] <- "1 country"
db$Numero_paises_3Cat[db$Numero_paises == "2" |db$Numero_paises == "3" |db$Numero_paises == "4
"] <- "2-4 countries"
db$Numero_paises_3Cat[db$Numero_paises == "Multiple countries"] <- "Multiple countries"
table(db$Tecnicas, db$Numero_paises_3Cat)
```

```
##
##            1 country 2-4 countries Multiple countries
##   AHP            120             1                  0
##   ANP             10             1                  2
##   CP              11             0                  0
##   DEA            129             2                 14
##   ELECTRE          4             0                  1
##   FUZZY.MCDM       6             0                  0
##   GP              37             0                  1
##   MAUT            23             2                  1
##   MOP             14             0                  0
##   OTRO.MCDM       23             1                  1
##   PROMETHEE        7             1                  1
##   SMAA             2             0                  0
##   TOPSIS           3             0                  1
##   VIKOR            0             0                  0
##   WEIGHTED        54             3                  4
```

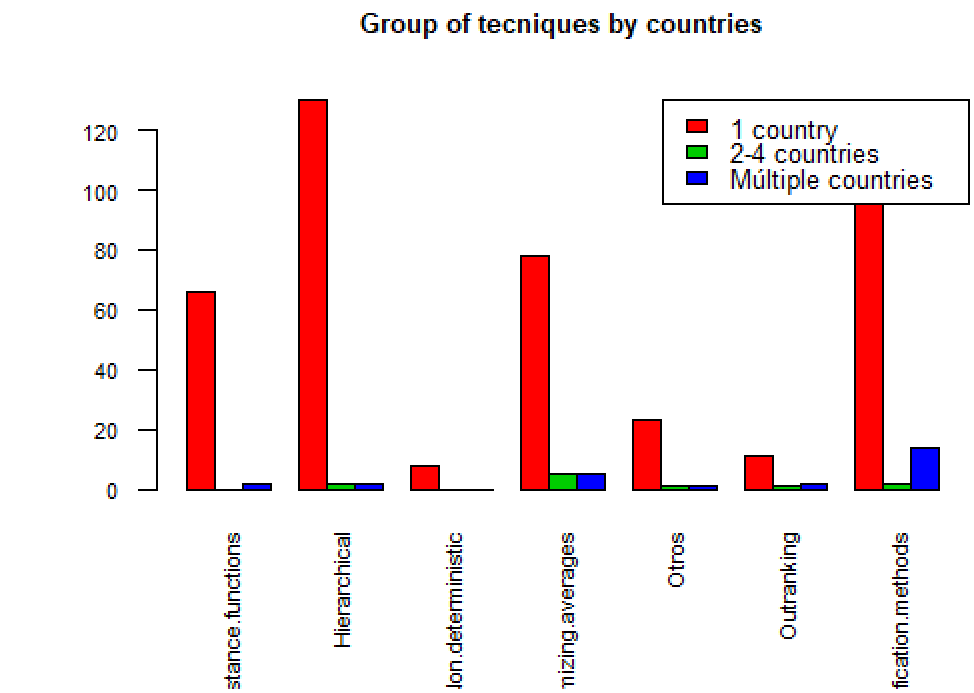
```
barplot(as.matrix(t(table(db$Tecnicas, db$Numero_paises_3Cat))), beside=T, las=2, col=(2:4), cex.names=
0.7, cex.axis = 0.7,
      main = "Técnicas por countries", cex.main=0.8)
legend("topright",c("1 country", "2-4 countries", "Multiple countries"), fill=c(2:4), cex=0.8)
```



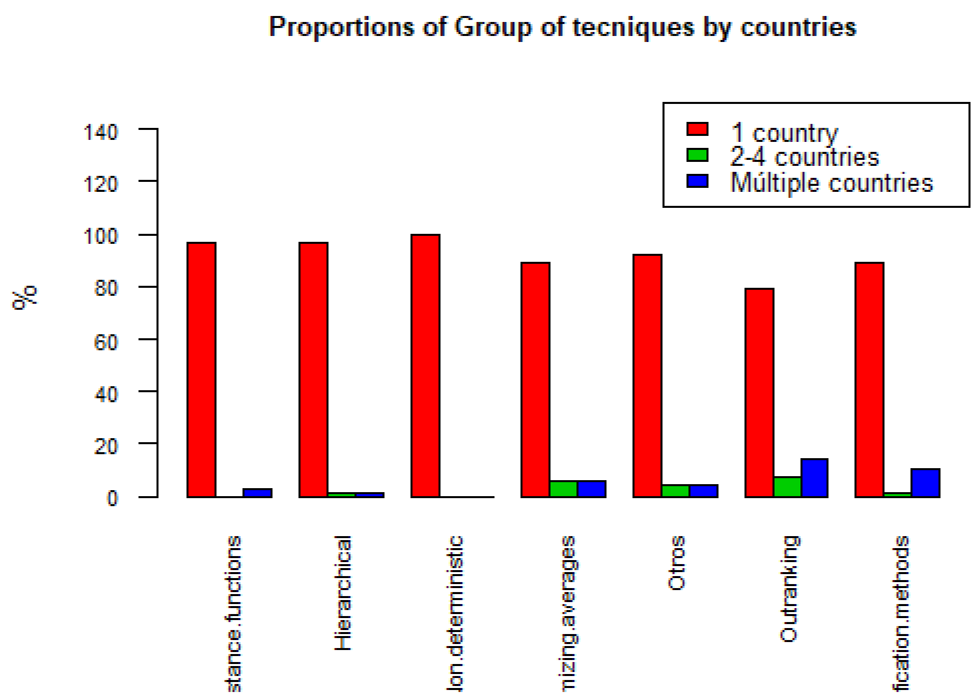

```
barplot(as.matrix(t(round(table(db$Tecnicas, db$Numero_paises_3Cat) / rowSums(table(db$Tecnicas, d
b$Numero_paises_3Cat)),2)*100)), beside=T, las=2, col=(2:4), cex.names= 0.7, cex.axis = 0.7,
      main = "Proporciones de Técnicas por countries", cex.main=0.8, ylab="%", ylim=c(0,150))
legend("topright",c("1 country", "2-4 countries", "Multiple countries"), fill=c(2:4), cex=0.8)
```



```
fisher.test(table(db$Tecnicas, db$Numero_paises_3Cat),simulate.p.value=TRUE)

##
##  Fisher's Exact Test for Count Data with simulated p-value (based
##  on 2000 replicates)
##
## data:  table(db$Tecnicas, db$Numero_paises_3Cat)
## p-value = 0.007996
## alternative hypothesis: two.sided

Distance.functions <- c("GP","CP","TOPSIS","MOP","VIKOR")
Outranking <- c("ELECTRE","PROMETHEE")
Hierarchical <- c("AHP","ANP")
Ranking.and.classification.methods <- "DEA"
Optimizing.averages <- c("MAUT","WEIGHTED")
Non.deterministic <- c("SMAA","FUZZY.MCDM")
Otros <- c("OTRO.MCDM")
db$Tecnicas_Grupos <- NA
db$Tecnicas_Grupos[which(db$Tecnicas %in% Distance.functions)] <- "Distance.functions"
db$Tecnicas_Grupos[which(db$Tecnicas %in% Outranking)] <- "Outranking"
db$Tecnicas_Grupos[which(db$Tecnicas %in% Hierarchical)] <- "Hierarchical"
db$Tecnicas_Grupos[which(db$Tecnicas %in% Ranking.and.classification.methods)] <- "Ranking.and.cla
ssification.methods"
db$Tecnicas_Grupos[which(db$Tecnicas %in% Optimizing.averages)] <- "Optimizing.averages"
db$Tecnicas_Grupos[which(db$Tecnicas %in% Non.deterministic)] <- "Non.deterministic"
db$Tecnicas_Grupos[which(db$Tecnicas %in% Otros)] <- "Otros"
table(db$Tecnicas_Grupos, db$Numero_paises_3Cat)

##
##                                      1 country 2-4 countries Multiple countries
##   Distance.functions                        65             0                  2
##   Hierarchical                             130             2                  2
##   Non.deterministic                          8             0                  0
##   Optimizing.averages                       77             5                  5
##   Otros                                     23             1                  1
##   Outranking                                11             1                  2
##   Ranking.and.classification.methods       129             2                 14

barplot(as.matrix(t(table(db$Tecnicas_Grupos, db$Numero_paises_3Cat))), beside=T, las=2, col=(2:4), cex
.names= 0.7, cex.axis = 0.7,
        main = "Grupos de Técnicas por countries", cex.main=0.8)
legend("topright",c("1 country", "2-4 countries", "Multiple countries"), fill=c(2:4), cex=0.8)
```




```
barplot(as.matrix(t(round(table(db$Tecnicas_Grupos, db$Numero_paises_3Cat) / rowSums(table(db$Te
cnicas_Grupos, db$Numero_paises_3Cat)),2)*100)), beside=T, las=2, col=(2:4), cex.names= 0.7, cex.axis = 0.
7,
      main = "Proporciones de Grupos de Técnicas por countries", cex.main=0.8, ylab="%", ylim=c(0,150))
legend("topright",c("1 country", "2-4 countries", "Multiple countries"), fill=c(2:4), cex=0.8)
```



```r
fisher.test(table(db$Tecnicas_Grupos, db$Numero_paises_3Cat),simulate.p.value=TRUE)
```

```
##
##  Fisher's Exact Test for Count Data with simulated p-value (based
##  on 2000 replicates)
##
## data:  table(db$Tecnicas_Grupos, db$Numero_paises_3Cat)
## p-value = 0.02149
## alternative hypothesis: two.sided
```

```r
fit <- multinom(Tecnicas_Grupos ~ Numero_paises_3Cat, data = db)
```

```
## # weights:  28 (18 variable)
## initial  value 934.036872
## iter  10 value 774.855185
## iter  20 value 769.965454
## iter  30 value 769.933996
## final  value 769.933907
## converged
```

```r
summary(fit)
```

```
## Call:
## multinom(formula = Tecnicas_Grupos ~ Numero_paises_3Cat, data = db)
##
## Coefficients:
##                                  (Intercept)
## Hierarchical                       0.6931180
## Non.deterministic                 -2.0953305
## Optimizing.averages                0.1694081
## Otros                             -1.0388386
## Outranking                        -1.7764343
## Ranking.and.classification.methods 0.6854186
##                                  Numero_paises_3Cat2-4 paÃses
## Hierarchical                                        11.927648
## Non.deterministic                                   -4.379108
## Optimizing.averages                                 13.367685
## Otros                                               12.966480
## Outranking                                          13.704184
## Ranking.and.classification.methods                  11.935356
##                                  Numero_paises_3CatMÃºltiples paÃses
## Hierarchical                                              -0.6941672
## Non.deterministic                                        -11.6008832
## Optimizing.averages                                        0.7462232
## Otros                                                      0.3447363
## Outranking                                                 1.7758651
## Ranking.and.classification.methods                         1.2598160
##
## Std. Errors:
```

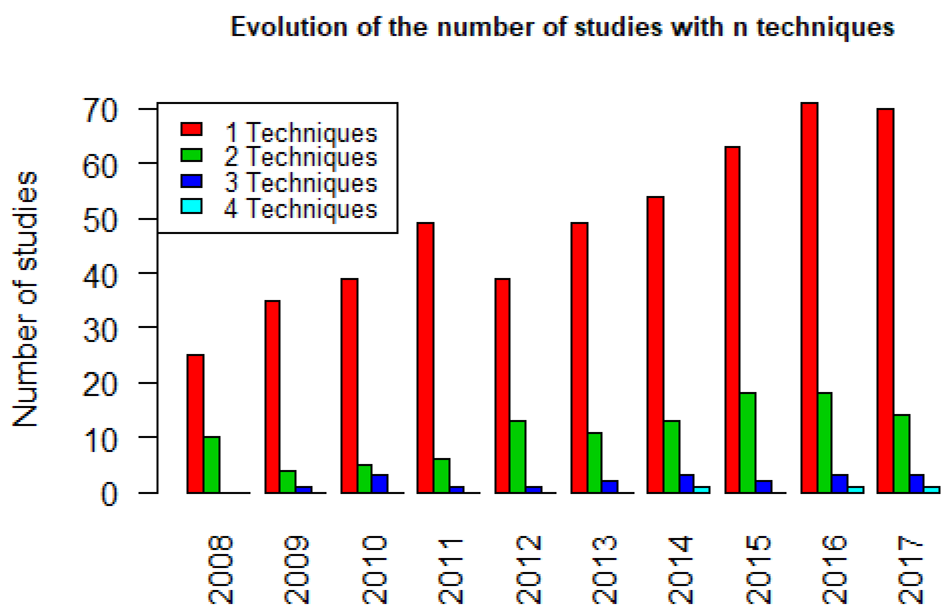
```
##                                     (Intercept)
## Hierarchical                          0.1519105
## Non.deterministic                     0.3747407
## Optimizing.averages                   0.1684379
## Otros                                 0.2426100
## Outranking                            0.3260167
## Ranking.and.classification.methods    0.1521061
##                                     Numero_paises_3Cat2-4 paÃses
## Hierarchical                                        6.626728e-01
## Non.deterministic                                   7.742127e-07
## Optimizing.averages                                 5.121540e-01
## Otros                                               8.721243e-01
## Outranking                                          8.882524e-01
## Ranking.and.classification.methods                  6.626978e-01
##                                     Numero_paises_3CatMÃºltiples paÃses
## Hierarchical                                                 1.0114098
## Non.deterministic                                          665.9457003
## Optimizing.averages                                          0.8532568
## Otros                                                        1.2485341
## Outranking                                                   1.0516272
## Ranking.and.classification.methods                           0.7708701
##
## Residual Deviance: 1539.868
## AIC: 1575.868
```

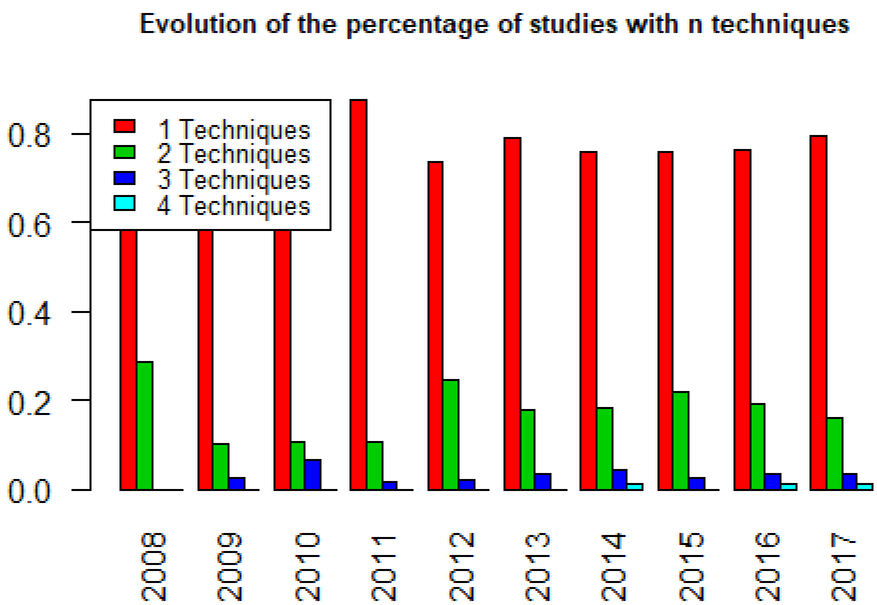
Hypothesis 6

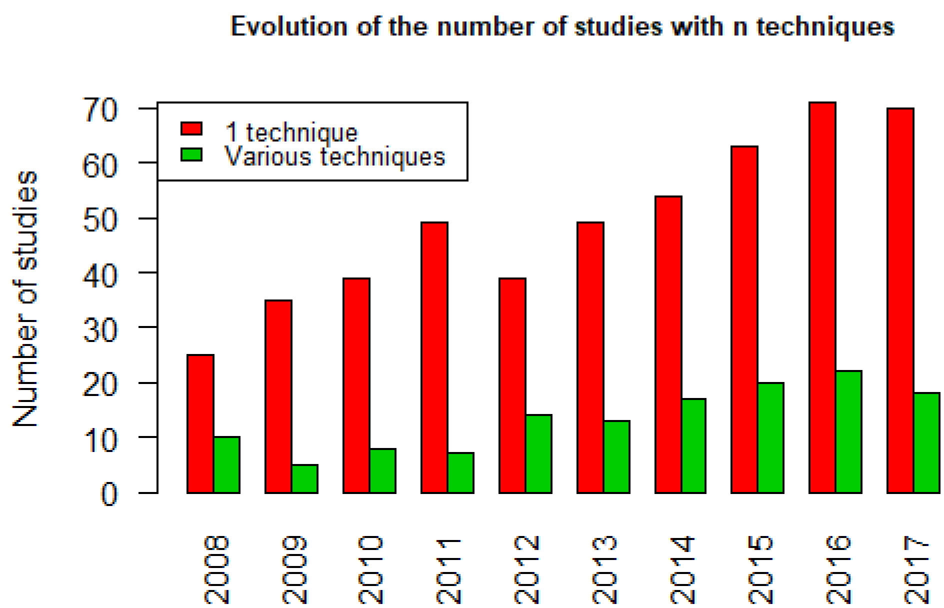
6. The use in the same problem of several MCDM techniques simultaneously has increased over time

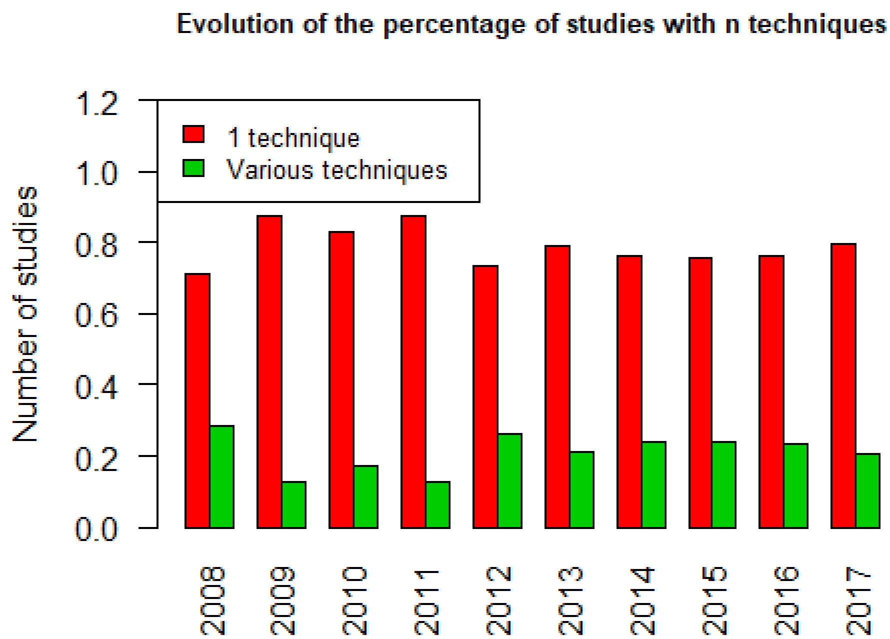
==> The hypothesis is accepted with some nuances.

The number of total studies has increased. So has the number of studies with GDM and MCDM (significantly), but the proportion of papers with GDM and MCDM has decreased (not significant)



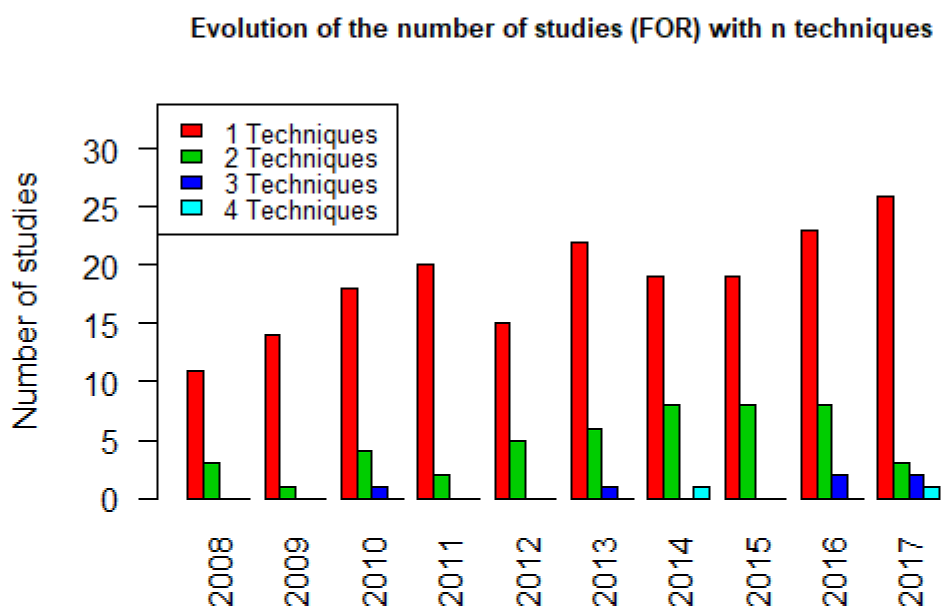

Evolution of the percentage of studies with n techniques
1 Techniques
2 Techniques
3 Techniques
4 Techniques
0.0
0.2
0.4
0.6
0.8
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017

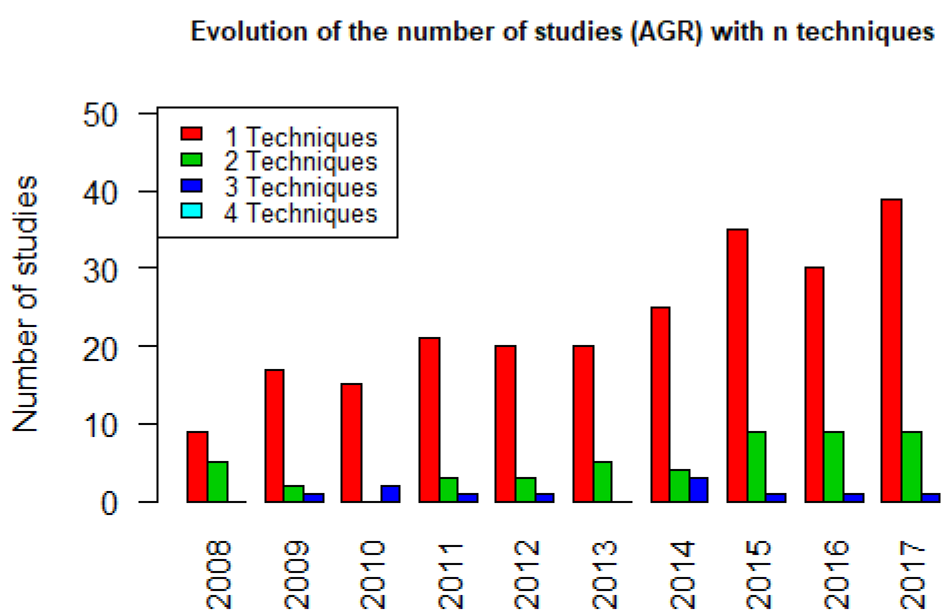

Evolution of the number of studies with n techniques
1 technique
Various techniques
Number of studies
0
10
20
30
40
50
60
70
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017

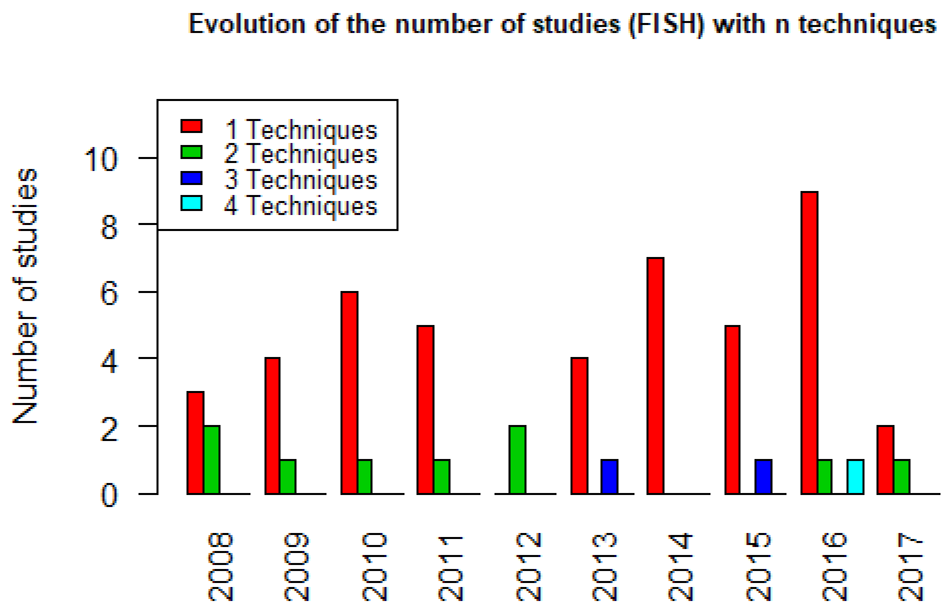



```
> mean(tbl2.2008_2012[1,]); mean(tbl2.2013_2017[1,])
[1] 37.4
[1] 61.4
> t.test(tbl2.2008_2012[1,], tbl2.2013_2017[1,])

        Welch Two Sample t-test

data:  tbl2.2008_2012[1, ] and tbl2.2013_2017[1, ]
t = -4.1269, df = 7.895, p-value = 0.003408
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -37.44166 -10.55834
sample estimates:
mean of x mean of y
     37.4      61.4

> mean(tbl2.2008_2012[2,]); mean(tbl2.2013_2017[2,])
[1] 8.8
[1] 18
> t.test(tbl2.2008_2012[2,], tbl2.2013_2017[2,])

        Welch Two Sample t-test

data:  tbl2.2008_2012[2, ] and tbl2.2013_2017[2, ]
t = -4.271, df = 7.9994, p-value = 0.002721
```

alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -14.167349 -4.232651
sample estimates:
mean of x mean of y
      8.8   18.0







Evolution of the number of studies (FISH) with n techniques
1 Techniques
2 Techniques
3 Techniques
4 Techniques
Number of studies
0
2
4
6
8
10
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017

Hypothesis 7

7. A) The works are usually normalized, independently of the field to be used.
7. B) The works are usually normalized, independently of the multicriteria technique to be used.

==> We accept the Hypothesis in regards to the field (18 A). In regards to the techniques (18 B), we reject the hypothesis.

==> Regarding the field, the normalization does not vary significantly. Regarding the techniques, the normalization varies significantly. This may be due to the high number of techniques or group of techniques.

```
table(db$normalización, db$Campo)

##
##     AGR FISH FOR
##   0 156   32 112
##   1 135   25 131

chisq.test(table(db$normalización, db$Campo))

##
##  Pearson's Chi-squared test
##
## data:  table(db$normalización, db$Campo)
## X-squared = 3.7245, df = 2, p-value = 0.1553

table(db$normalización, db$Tecnicas)

##
##     AHP ANP  CP DEA ELECTRE FUZZY.MCDM  GP MAUT MOP OTRO.MCDM PROMETHEE
##   0  41   3   4 126       3          3  19   14   9        16         4
##   1  83  10   8  19       3          3  22   12   6        10         5
##
##     SMAA TOPSIS VIKOR WEIGHTED
##   0    1      1     1       25
##   1    1      4     0       36

fisher.test(table(db$normalización, db$Tecnicas),simulate.p.value=TRUE)

##
##  Fisher's Exact Test for Count Data with simulated p-value (based
##  on 2000 replicates)
##
## data:  table(db$normalización, db$Tecnicas)
## p-value = 0.0004998
## alternative hypothesis: two.sided

table(db$normalización, db$Tecnicas_Grupos)

##
##     Distance.functions Hierarchical Non.deterministic Optimizing.averages
```

```
##   0              34         44              4               39
##   1              40         93              4               48
##
##     Otros Outranking Ranking.and.classification.methods
##   0    16        7                          126
##   1    10        8                           19
```

```
fisher.test(table(db$normalización, db$Tecnicas_Grupos),simulate.p.value=TRUE)
```

```
##
##  Fisher's Exact Test for Count Data with simulated p-value (based
##  on 2000 replicates)
##
## data:  table(db$normalización, db$Tecnicas_Grupos)
## p-value = 0.0004998
## alternative hypothesis: two.sided
```

Hypothesis 8

8. A) The justification of why the method is chosen is not usually given, whatever the method used.
8. B) The justification of why the method is chosen is not usually given, whatever the area where it is applied.

==> We reject the Hypothesis for the method used (significant differences) and we accept it for the country (there are significant differences).

==> 7 percent of studies justify the chosen method. By techniques or groups of techniques there are significant differences. By country there are no significant differences.

```
table(db$X.justificación.técnica.elección.)

##
##   0   1
## 583  45

mydf <- data.frame(Sin_justification = table(db$lugar.caso.de.estudio.1, db$X.justificación.técnica.elecció
n.)[,1],
             With_justification = table(db$lugar.caso.de.estudio.1, db$X.justificación.técnica.elección.)[,2])
mydf$Prop_With_Just <- as.numeric(as.character(mydf$With_justification)) /
  (as.numeric(as.character(mydf$With_justification)) + as.numeric(as.character(mydf$Sin_justification)))
# Para ver el orden de los countries por Número de Estudios Con Justificación
data.frame(Country= rownames(mydf[order(mydf$With_justification),]), With_justification =mydf[order
(mydf$With_justification),"With_justification"])

##                                        Country With_justification
## 1          10 case study regions across Europe                  0
## 2                      10 countries distintos                  0
## 3        12 casos de estudio en countries Europeos                  0
## 4                      14 countries de Europa                  0
## 5                         15 EU Countries                  0
## 6                           180 countries                  0
## 7                      19 EU Member States                  0
## 8               23 OECD Countries and Turkey                  0
## 9             25 European Union (EU) countries                  0
## 10                      25 countries de la UE                  0
## 11         27 countries of the European Union                  0
## 12                     31 countries de Europa                  0
## 13                  33 countries of the world                  0
## 14                  39 SubSaharian countries                  0
## 15                      4 countries de Europa                  0
## 16               5 countries de Centroamérica                  0
## 17                 5 countries de la UE yUSA                  0
## 18                         5 countries UE                  0
## 19                     8  countries de Europa                  0
## 20                           88 countries                  0
## 21                                Algeria                  0
## 22                                Austria                  0
```

```
## 23                    Belgium        0
## 24                   Bulgaria        0
## 25                      Chile        0
## 26                   Colombia        0
## 27                 Costa Rica        0
## 28                    Croatia        0
## 29                       Cuba        0
## 30             Czech Republic        0
## 31                    Denmark        0
## 32                    Ecuador        0
## 33                      Egypt        0
## 34                   Ethiopia        0
## 35                    Finland        0
## 36                      Ghana        0
## 37                  Indonesia        0
## 38                    Ireland        0
## 39                     Israel        0
## 40                    Jamaica        0
## 41                      Japan        0
## 42                      Kenya        0
## 43                 Kyrgyzstan        0
## 44                       Laos        0
## 45                 Madagascar        0
## 46                   Malaysia        0
## 47                     Mexico        0
## 48                    Morocco        0
## 49                      Nepal        0
## 50                New Zealand        0
## 51                    Nigeria        0
## 52                     Norway        0
## 53                       Oman        0
## 54  Papua Nueva Guinea y muchas islas de la Polinesia        0
## 55                   Portugal        0
## 56             Reunion Island        0
## 57                    Romania        0
## 58                     Russia        0
## 59                     Rwanda        0
## 60               Saudi Arabia        0
## 61                     Serbia        0
## 62               Sierra Leone        0
## 63  six European case study locations        0
## 64                   Slovenia        0
## 65               South Africa        0
## 66                South Korea        0
## 67                  Sri Lanka        0
## 68                     Sweden        0
## 69                   Tanzania        0
## 70                   Thailand        0
```

```
## 71                                todo el mundo              0
## 72                                     Tunisia              0
## 73                                      Turkey              0
## 74                                     Uruguay              0
## 75                                  Uzbekistan              0
## 76                                     Vietnam              0
## 77                                    Zimbabwe              0
## 78                                                          1
## 79              27 European Union (EU) countries              1
## 80                         33 African countries              1
## 81                                   Argentina              1
## 82                                   Australia              1
## 83                                      Brazil              1
## 84                                     Chipre              1
## 85                                   Finlandia              1
## 86                                      France              1
## 87                                     Georgia              1
## 88                                     Germany              1
## 89                                      Greece              1
## 90                                       India              1
## 91                                   Lithuania              1
## 92                                 Netherlands              1
## 93                                    Pakistan              1
## 94                                    Slovakia              1
## 95                                 Switzerland              1
## 96                                       Syria              1
## 97                                      Taiwan              1
## 98                                          UK              1
## 99                                         USA              1
## 100                                 Bangladesh              2
## 101                                     Canada              2
## 102                                      Spain              3
## 103                                      China              4
## 104                                      Italy              4
## 105                                       Iran              8
```

```
# Para ver el orden de los countries por Proporción de Estudios Con Justificación
data.frame(Country= rownames(mydf[order(mydf$Prop_With_Just),]), Prop_With_Just =round(mydf[order(mydf$Prop_With_Just),"Prop_With_Just"],3))
```

```
##                                      Country Prop_With_Just
## 1         10 case study regions across Europe          0.000
## 2                    10 countries distintos          0.000
## 3     12 casos de estudio en countries Europeos          0.000
## 4                    14 countries de Europa          0.000
## 5                          15 EU Countries          0.000
## 6                            180 countries          0.000
## 7                        19 EU Member States          0.000
```

```
## 8                    23 OECD Countries and Turkey         0.000
## 9                  25 European Union (EU) countries         0.000
## 10                         25 countries de la UE         0.000
## 11                27 countries of the European Union         0.000
## 12                         31 countries de Europa         0.000
## 13                      33 countries of the world         0.000
## 14                      39 SubSaharian countries         0.000
## 15                          4 countries de Europa         0.000
## 16                    5 countries de Centroamérica         0.000
## 17                     5 countries de la UE yUSA         0.000
## 18                               5 countries UE         0.000
## 19                         8  countries de Europa         0.000
## 20                                88 countries         0.000
## 21                                    Algeria         0.000
## 22                                    Austria         0.000
## 23                                    Belgium         0.000
## 24                                   Bulgaria         0.000
## 25                                      Chile         0.000
## 26                                   Colombia         0.000
## 27                                 Costa Rica         0.000
## 28                                    Croatia         0.000
## 29                                       Cuba         0.000
## 30                             Czech Republic         0.000
## 31                                    Denmark         0.000
## 32                                    Ecuador         0.000
## 33                                      Egypt         0.000
## 34                                   Ethiopia         0.000
## 35                                    Finland         0.000
## 36                                      Ghana         0.000
## 37                                  Indonesia         0.000
## 38                                    Ireland         0.000
## 39                                     Israel         0.000
## 40                                    Jamaica         0.000
## 41                                      Japan         0.000
## 42                                      Kenya         0.000
## 43                                 Kyrgyzstan         0.000
## 44                                       Laos         0.000
## 45                                 Madagascar         0.000
## 46                                   Malaysia         0.000
## 47                                     Mexico         0.000
## 48                                    Morocco         0.000
## 49                                      Nepal         0.000
## 50                                New Zealand         0.000
## 51                                    Nigeria         0.000
## 52                                     Norway         0.000
## 53                                       Oman         0.000
## 54  Papua Nueva Guinea y muchas islas de la Polinesia         0.000
## 55                                   Portugal         0.000
```

```
## 56                          Reunion Island         0.000
## 57                                Romania         0.000
## 58                                 Russia         0.000
## 59                                 Rwanda         0.000
## 60                           Saudi Arabia         0.000
## 61                                 Serbia         0.000
## 62                           Sierra Leone         0.000
## 63       six European case study locations         0.000
## 64                               Slovenia         0.000
## 65                           South Africa         0.000
## 66                            South Korea         0.000
## 67                              Sri Lanka         0.000
## 68                                 Sweden         0.000
## 69                               Tanzania         0.000
## 70                               Thailand         0.000
## 71                          todo el mundo         0.000
## 72                                Tunisia         0.000
## 73                                 Turkey         0.000
## 74                                Uruguay         0.000
## 75                             Uzbekistan         0.000
## 76                                Vietnam         0.000
## 77                               Zimbabwe         0.000
## 78                                    USA         0.021
## 79                                  India         0.042
## 80                                 Brazil         0.050
## 81                                                0.062
## 82                                 Greece         0.062
## 83                                  Spain         0.064
## 84                              Australia         0.067
## 85                                 France         0.083
## 86                                  China         0.087
## 87                            Netherlands         0.091
## 88                                     UK         0.100
## 89                                 Canada         0.118
## 90                                   Iran         0.138
## 91                                  Italy         0.154
## 92                                 Taiwan         0.167
## 93                             Bangladesh         0.182
## 94                              Argentina         0.200
## 95                                Germany         0.200
## 96                              Finlandia         0.250
## 97                              Lithuania         0.333
## 98                               Pakistan         0.333
## 99                            Switzerland         0.333
## 100      27 European Union (EU) countries         0.500
## 101                   33 African countries         1.000
## 102                                Chipre         1.000
## 103                               Georgia         1.000
```

```
## 104                                Slovakia        1.000
## 105                                  Syria        1.000
```

```
fisher.test(table(db$lugar.caso.de.estudio.1, db$X.justificación.técnica.elección.),simulate.p.value=TRUE)
```

```
##
##  Fisher's Exact Test for Count Data with simulated p-value (based
##  on 2000 replicates)
##
## data:  table(db$lugar.caso.de.estudio.1, db$X.justificación.técnica.elección.)
## p-value = 0.4168
## alternative hypothesis: two.sided
```

```
mydf <- data.frame(Sin_justification = table(db$Tecnicas, db$X.justificación.técnica.elección.)[,1],
              With_justification = table(db$Tecnicas, db$X.justificación.técnica.elección.)[,2])
mydf$Prop_With_Just <- as.numeric(as.character(mydf$With_justification)) /
 (as.numeric(as.character(mydf$With_justification)) + as.numeric(as.character(mydf$Sin_justification)))
data.frame(Country= rownames(mydf[order(mydf$With_justification),]), With_justification =mydf[order
(mydf$With_justification),"With_justification"])
```

```
##      Country With_justification
## 1        ANP                  0
## 2         CP                  0
## 3  FUZZY.MCDM                 0
## 4        MOP                  0
## 5       SMAA                  0
## 6      VIKOR                  0
## 7    WEIGHTED                 0
## 8     ELECTRE                 1
## 9       MAUT                  1
## 10    TOPSIS                  1
## 11        GP                  3
## 12  OTRO.MCDM                 3
## 13  PROMETHEE                 3
## 14       AHP                  8
## 15       DEA                 13
```

```
data.frame(Country= rownames(mydf[order(mydf$Prop_With_Just),]), Prop_With_Just =round(mydf[or
der(mydf$Prop_With_Just),"Prop_With_Just"],3))
```

```
##      Country Prop_With_Just
## 1        ANP        0.000
## 2         CP        0.000
## 3  FUZZY.MCDM       0.000
## 4        MOP        0.000
## 5       SMAA        0.000
## 6      VIKOR        0.000
## 7    WEIGHTED       0.000
```

```
## 8        MAUT         0.038
## 9         AHP         0.065
## 10         GP         0.073
## 11        DEA         0.090
## 12  OTRO.MCDM         0.115
## 13    ELECTRE         0.167
## 14     TOPSIS         0.200
## 15  PROMETHEE         0.333

table(db$Tecnicas, db$X.justificación.técnica.elección.)

##
##               0   1
##   AHP       116   8
##   ANP        13   0
##   CP         12   0
##   DEA       132  13
##   ELECTRE     5   1
##   FUZZY.MCDM   6   0
##   GP         38   3
##   MAUT       25   1
##   MOP        15   0
##   OTRO.MCDM  23   3
##   PROMETHEE   6   3
##   SMAA        2   0
##   TOPSIS      4   1
##   VIKOR       1   0
##   WEIGHTED   61   0

fisher.test(table(db$Tecnicas, db$X.justificación.técnica.elección.),simulate.p.value=TRUE)

##
##  Fisher's Exact Test for Count Data with simulated p-value (based
##  on 2000 replicates)
##
## data:  table(db$Tecnicas, db$X.justificación.técnica.elección.)
## p-value = 0.04898
## alternative hypothesis: two.sided

mydf <- data.frame(Sin_justification = table(db$Tecnicas_Grupos, db$X.justificación.técnica.elección.)[,1],
               With_justification = table(db$Tecnicas_Grupos, db$X.justificación.técnica.elección.)[,2])
mydf$Prop_With_Just <- as.numeric(as.character(mydf$With_justification)) /
  (as.numeric(as.character(mydf$With_justification)) + as.numeric(as.character(mydf$Sin_justification)))

data.frame(Country= rownames(mydf[order(mydf$With_justification),]), With_justification =mydf[order
(mydf$With_justification),"With_justification"])

##                         Country With_justification
## 1                 Non.deterministic                0
```

```
## 2          Optimizing.averages          1
## 3                 Otros           3
## 4           Distance.functions          4
## 5                Outranking          4
## 6              Hierarchical          8
## 7 Ranking.and.classification.methods          13
```

```r
data.frame(Country= rownames(mydf[order(mydf$Prop_With_Just),]), Prop_With_Just =round(mydf[order(mydf$Prop_With_Just),"Prop_With_Just"],3))
```

```
##                      Country Prop_With_Just
## 1            Non.deterministic        0.000
## 2          Optimizing.averages        0.011
## 3           Distance.functions        0.054
## 4                 Hierarchical        0.058
## 5 Ranking.and.classification.methods        0.090
## 6                        Otros        0.115
## 7                   Outranking        0.267
```

```r
table(db$Tecnicas_Grupos, db$X.justificación.técnica.elección.)
```

```
##
##                                      0   1
##   Distance.functions                70   4
##   Hierarchical                     129   8
##   Non.deterministic                  8   0
##   Optimizing.averages               86   1
##   Otros                             23   3
##   Outranking                        11   4
##   Ranking.and.classification.methods 132  13
```

```r
fisher.test(table(db$Tecnicas_Grupos, db$X.justificación.técnica.elección.),simulate.p.value=TRUE)
```

```
##
##  Fisher's Exact Test for Count Data with simulated p-value (based
##  on 2000 replicates)
##
## data:  table(db$Tecnicas_Grupos, db$X.justificación.técnica.elección.)
## p-value = 0.01599
## alternative hypothesis: two.sided
```

Hypothesis 9

9. AHP and weighted MCDM always go together.

==> We reject the Hypothesis.

==> There is no significant relationship between the use of AHP and WEIGHTED

```
summary(glm(db$WEIGHTED ~ db$AHP, family="binomial"))

##
## Call:
## glm(formula = db$WEIGHTED ~ db$AHP, family = "binomial")
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.7053  -0.7053  -0.6450  -0.6450   1.8289
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -1.4643     0.1265 -11.580   <2e-16 ***
## db$AHP        0.1997     0.2067   0.967    0.334
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 626.84  on 627  degrees of freedom
## Residual deviance: 625.91  on 626  degrees of freedom
## AIC: 629.91
##
## Number of Fisher Scoring iterations: 4

summary(glm(db$AHP ~ db$WEIGHTED, family="binomial"))

##
## Call:
## glm(formula = db$AHP ~ db$WEIGHTED, family = "binomial")
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.9844  -0.9082  -0.9082   1.4729   1.4729
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -0.67234    0.09426  -7.133 9.84e-13 ***
## db$WEIGHTED  0.19974    0.20665   0.967    0.334
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 810.94  on 627  degrees of freedom
## Residual deviance: 810.02  on 626  degrees of freedom
## AIC: 814.02
##
## Number of Fisher Scoring iterations: 4
```

```r
table(db$WEIGHTED,db$AHP); chisq.test(table(db$WEIGHTED,db$AHP))
```

```
##
##       0   1
##   0 333 170
##   1  77  48
```

```
##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  table(db$WEIGHTED, db$AHP)
## X-squared = 0.74384, df = 1, p-value = 0.3884
```

Hypothesis 10

10. Given the inclusion of methods such as AHP and weighted MCDM in different GIS packages, it seems sensible to point out that there is a positive relationship between the use of AHP and its application to spatial problems.

==> We accept the Hypothesis.

==> Those studies that use AHP or WEIGHTED have a greater chance of using GIS. We reject the null hypothesis that they are equal.

```
db$AHP_WEIGHTED <- db$AHP; db$AHP_WEIGHTED[db$WEIGHTED > 0] <- 1
summary(glm(db$GIS ~ db$AHP, family="binomial"))

##
## Call:
## glm(formula = db$GIS ~ db$AHP, family = "binomial")
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -1.1696  -0.6862  -0.6862   1.1852   1.7674
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -1.3264     0.1213 -10.935  < 2e-16 ***
## db$AHP        1.3080     0.1818   7.194 6.31e-13 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 776.50  on 627  degrees of freedom
## Residual deviance: 723.37  on 626  degrees of freedom
## AIC: 727.37
##
## Number of Fisher Scoring iterations: 4

summary(glm(db$GIS ~ db$WEIGHTED, family="binomial"))

##
## Call:
## glm(formula = db$GIS ~ db$WEIGHTED, family = "binomial")
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -1.3987  -0.7241  -0.7241   0.9712   1.7129
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -1.2048     0.1059 -11.382  < 2e-16 ***
```

```
## db$WEIGHTED   1.7114     0.2128   8.041 8.93e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 776.50  on 627  degrees of freedom
## Residual deviance: 708.78  on 626  degrees of freedom
## AIC: 712.78
##
## Number of Fisher Scoring iterations: 4
```

```
summary(glm(db$GIS ~ db$AHP_WEIGHTED, family="binomial"))
```

```
##
## Call:
## glm(formula = db$GIS ~ db$AHP_WEIGHTED, family = "binomial")
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -1.1745  -0.5516  -0.5516   1.1803   1.9789
##
## Coefficients:
##                 Estimate Std. Error z value Pr(>|z|)
## (Intercept)      -1.8058     0.1574 -11.473   <2e-16 ***
## db$AHP_WEIGHTED   1.7991     0.1958   9.189   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 776.50  on 627  degrees of freedom
## Residual deviance: 680.04  on 626  degrees of freedom
## AIC: 684.04
##
## Number of Fisher Scoring iterations: 4
```

```
table(db$GIS,db$AHP); chisq.test(table(db$GIS,db$AHP))
```

```
##
##       0   1
##   0 324 110
##   1  86 108
```

```
##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  table(db$GIS, db$AHP)
## X-squared = 53.07, df = 1, p-value = 3.219e-13
```

```
table(db$GIS,db$WEIGHTED); chisq.test(table(db$GIS,db$WEIGHTED))

##
##       0   1
##   0 387  47
##   1 116  78

##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  table(db$GIS, db$WEIGHTED)
## X-squared = 70.743, df = 1, p-value < 2.2e-16

table(db$GIS,db$AHP_WEIGHTED); chisq.test(table(db$GIS,db$AHP_WEIGHTED))

##
##       0   1
##   0 286 148
##   1  47 147

##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  table(db$GIS, db$AHP_WEIGHTED)
## X-squared = 91.804, df = 1, p-value < 2.2e-16
```

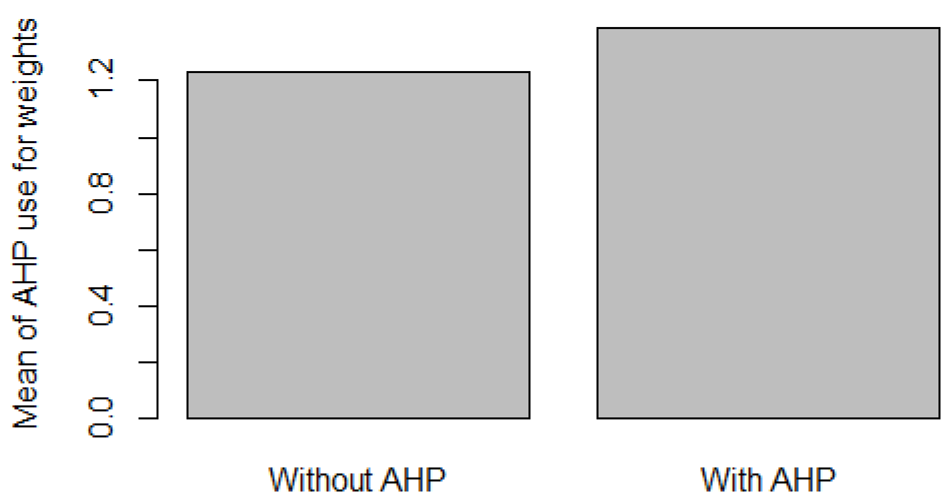
Hypothesis 11

11. AHP is used mostly to obtain weights from a set of stakeholders and / or experts and apply these weights to solve the problem in question.

==> We accept the Hypothesis.

==> Most times that AHP is used it is used to obtain weights

```
table(db$AHP); table(db$pesos.AHP.ANP); table(db$AHP, db$pesos.AHP.ANP)

##
##   0   1
## 410 218

##
##   0   1
## 415 213

##
##       0   1
##   0 396  14
##   1  19 199

tbl_mean <- aggregate(db[, c("AHP")], list(db$pesos.AHP.ANP), mean, na.rm=TRUE)
df.bar <- barplot(tbl_mean$x, names.arg = c("Sin AHP","Con AHP"), ylab="Media de uso de AHP para pe
sos")
```




```
chisq.test(table(db$pesos.AHP.ANP, db$AHP))
```

```
##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  table(db$pesos.AHP.ANP, db$AHP)
## X-squared = 486.38, df = 1, p-value < 2.2e-16
```

```
summary(glm(db$AHP ~ db$pesos.AHP.ANP, family="binomial"))
```

```
##
## Call:
## glm(formula = db$AHP ~ db$pesos.AHP.ANP, family = "binomial")
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -2.3333  -0.3061  -0.3061   0.3688   2.4835
##
## Coefficients:
##                  Estimate Std. Error z value Pr(>|z|)
## (Intercept)       -3.0370     0.2348  -12.93   <2e-16 ***
## db$pesos.AHP.ANP   5.6912     0.3628   15.69   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 810.94  on 627  degrees of freedom
## Residual deviance: 257.58  on 626  degrees of freedom
## AIC: 261.58
##
## Number of Fisher Scoring iterations: 5
```

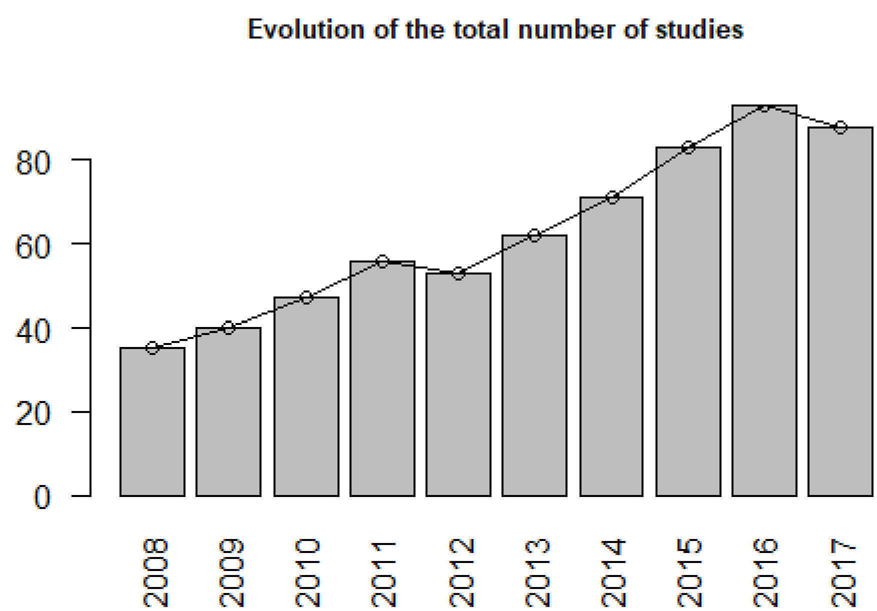
Hypothesis 12

12. Hybridization of MCDM and GDM is increasing over time.

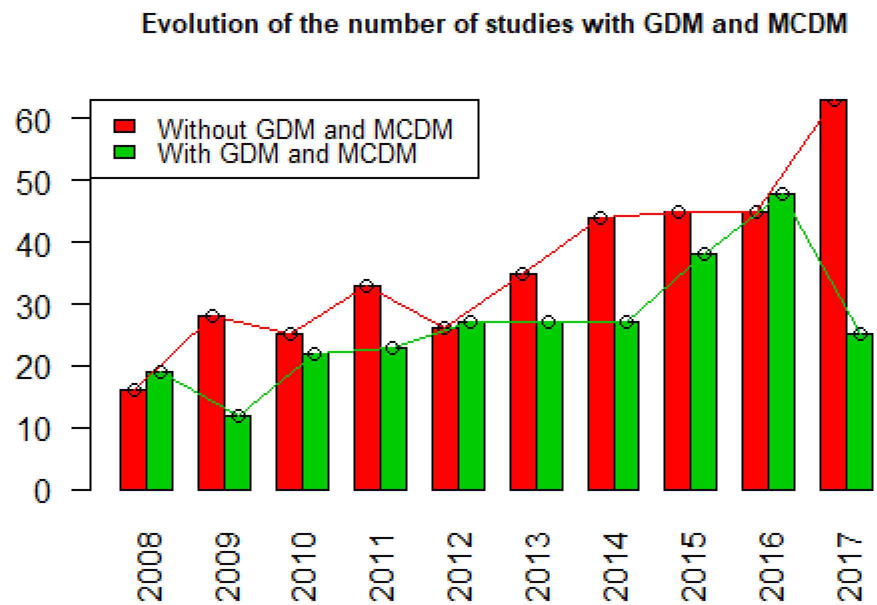
==> We accept the Hypothesis with some nuances.

==> Yes that is growing but with some nuances. The number of total studies has increased. The number of studies with GDM and MCDM has also (significantly) but the proportion of studies with GDM and MCDM has decreased (it is not significant)

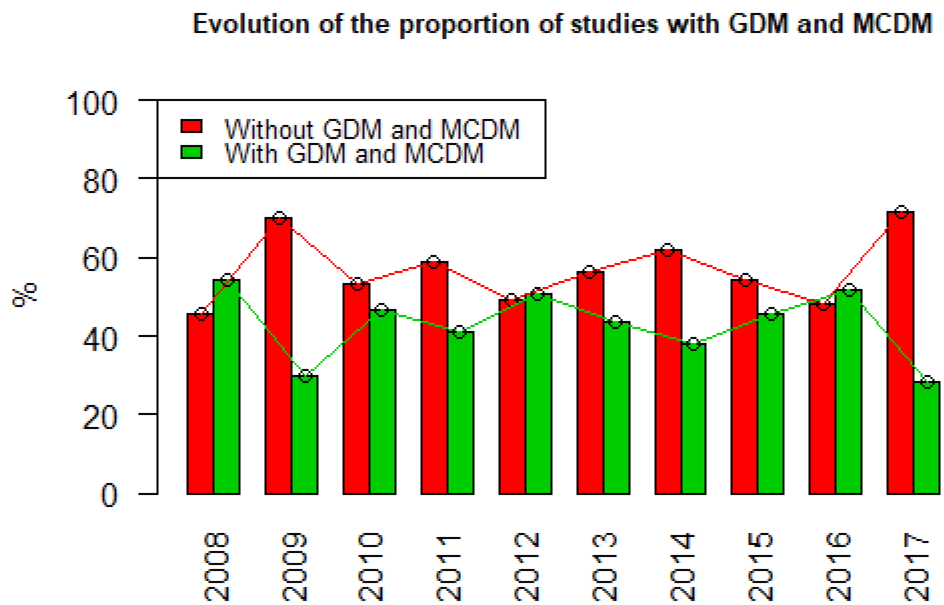
```
df.bar <- barplot(table(db$year), las=2, main="Evolución del número total de trabajos", cex.main=0.8)
lines(x = df.bar, y = table(db$year)); points(x = df.bar, y = table(db$year))
```




```
tbl1 <- as.matrix(table(db$GDM_MCDM, db$year))
df.bar <- barplot(tbl1, beside=T, col=c(2:3),las=2, main="Evolución del número de trabajos con GDM y MC
DM", cex.main=0.8)
lines(x = df.bar[1,], y = tbl1[1,], col=2);points(x = df.bar[1,], y = tbl1[1,])
lines(x = df.bar[2,], y = tbl1[2,], col=3);points(x = df.bar[2,], y = tbl1[2,])
legend("topleft",c("Sin GDM y MCDM","Con GDM y MCDM"), fill=c(2:3), cex=0.8)
```




```
tbl2 <- rbind(table(db$GDM_MCDM, db$year)[1,] / (colSums(table(db$GDM_MCDM, db$year))),
         table(db$GDM_MCDM, db$year)[2,] / (colSums(table(db$GDM_MCDM, db$year))))
df.bar <- barplot(tbl2*100, beside=T, col=c(2:3),las=2, main="Evolución de la proporción de trabajos con G
DM y MCDM",
              ylim=c(0,100), ylab="%", cex.main=0.8)
lines(x = df.bar[1,], y = tbl2[1,]*100, col=2);points(x = df.bar[1,], y = tbl2[1,]*100)
lines(x = df.bar[2,], y = tbl2[2,]*100, col=3);points(x = df.bar[2,], y = tbl2[2,]*100)
legend("topleft",c("Sin GDM y MCDM","Con GDM y MCDM"), fill=c(2:3), cex=0.8)
```




```
tbl1.2008_2012 <- tbl1 [,1:5];tbl1.2013_2017 <- tbl1 [,6:10]
tbl2.2008_2012 <- tbl2 [,1:5];tbl2.2013_2017 <- tbl2 [,6:10]
mean(tbl1.2008_2012[2,]); mean(tbl1.2013_2017[2,])

## [1] 20.6

## [1] 33

t.test(tbl1.2008_2012[2,], tbl1.2013_2017[2,])

##
##  Welch Two Sample t-test
##
## data:  tbl1.2008_2012[2, ] and tbl1.2013_2017[2, ]
## t = -2.4527, df = 6.3478, p-value = 0.04742
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -24.6083607  -0.1916393
## sample estimates:
## mean of x mean of y
##      20.6      33.0

mean(tbl2.2008_2012[2,]); mean(tbl2.2013_2017[2,])

## [1] 0.4462181

## [1] 0.4147634
```

```
t.test(tbl2.2008_2012[2,], tbl2.2013_2017[2,])

##
##  Welch Two Sample t-test
##
## data:  tbl2.2008_2012[2, ] and tbl2.2013_2017[2, ]
## t = 0.54233, df = 7.9444, p-value = 0.6025
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.1024540  0.1653634
## sample estimates:
## mean of x mean of y
## 0.4462181 0.4147634
```

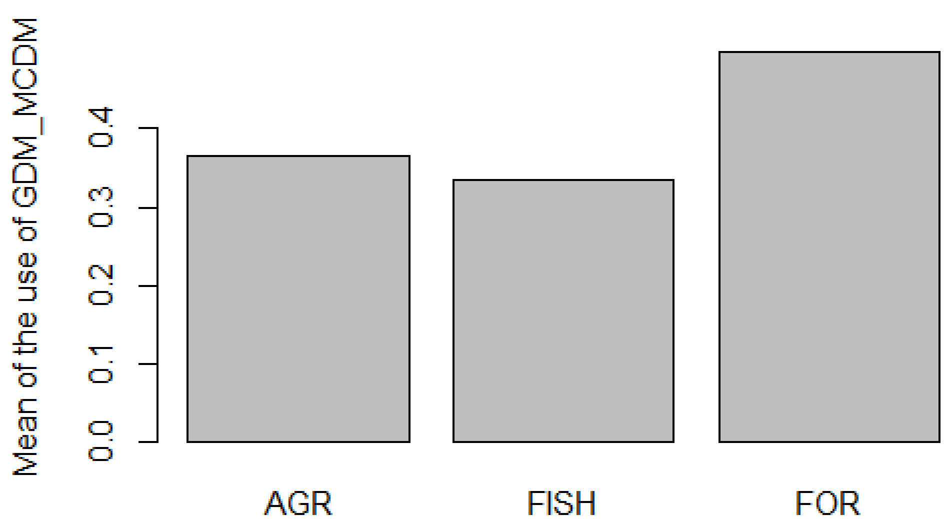
Hypothesis 13

13. Given the nature of the forestry problems, it seems that the hybridization of GDM + MCDM techniques could be more frequent in forestry.

==> We accept the Hypothesis

==> We reject the null hypothesis that they are equal.

```
db$MCDM_n <- rowSums(db[,Tecnicas_name])
db$GDM_MCDM <- 0; db$GDM_MCDM[db$GDM > 0 & db$MCDM_n > 0] <- 1
table(db$GDM); table(db$GDM_MCDM);table(db$Campo,db$GDM_MCDM)

##
##   0   1
## 360 268

##
##   0   1
## 360 268

##
##          0   1
##   AGR  185 106
##   FISH  38  19
##   FOR  122 121

tbl_mean <- aggregate(db[, c("GDM_MCDM")], list(db$Campo), mean, na.rm=TRUE)
df.bar <- barplot(tbl_mean$x, names.arg = tbl_mean$Group.1, ylab="Media de uso de GDM_MCDM")
```



```
chisq.test(table(db$Campo,db$GDM_MCDM))

##
##  Pearson's Chi-squared test
##
## data:  table(db$Campo, db$GDM_MCDM)
## X-squared = 11.524, df = 2, p-value = 0.003145
```

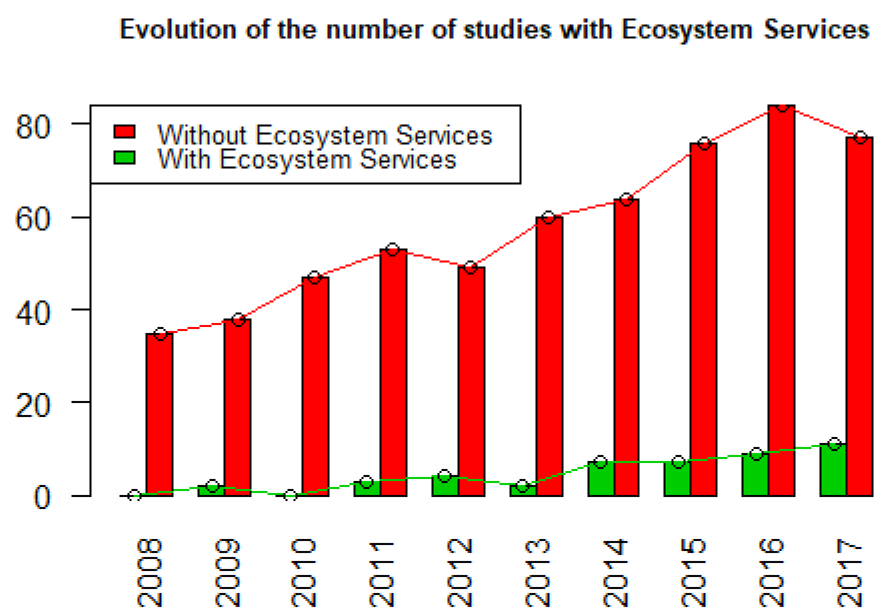
Hypothesis 14

14. The concepts of ecosystem services, climate change and sustainability are recent and has only become important in recent years.

==> We accept the Hypothesis for Ecosystem Services and Climate Change. We cannot accept it for Sustainability.

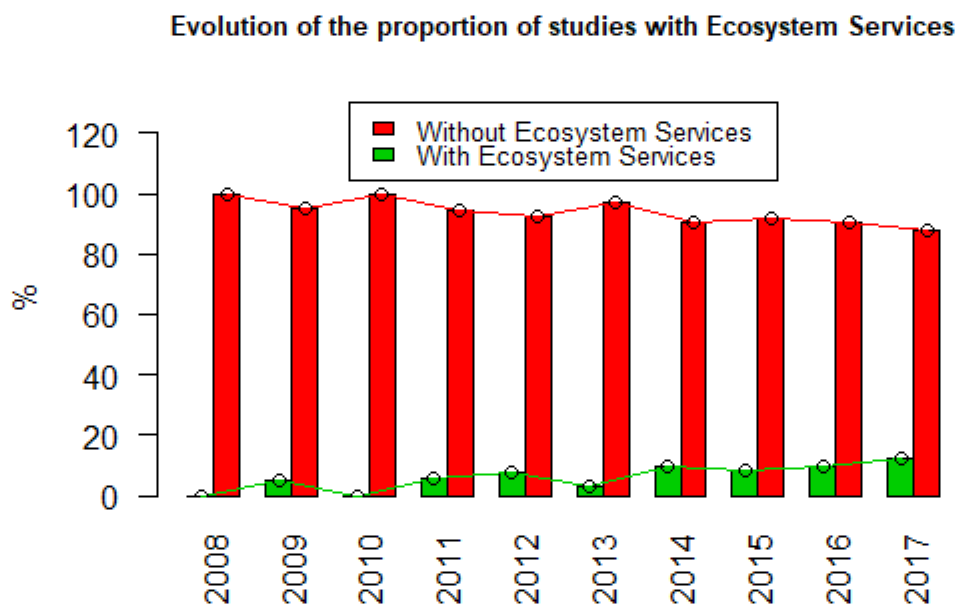
==> We accept the Hypothesis for Ecosystem Services and Climate Change (for both the number and the proportion). For sustainability, despite having increased the total number significantly, the proportion has decreased.

```
db$ecosystem.services <- "Sin Ecosystem Services"; db$ecosystem.services[db$nº.ecosystem.serv. > 0] <- "
Con Ecosystem Services"
tbl1 <- as.matrix(table(db$ecosystem.services, db$year))
df.bar <- barplot(tbl1, beside=T, col=c(3,2),las=2, main="Evolución del número de trabajos con Ecosystem
Services", cex.main=0.8)
lines(x = df.bar[1,], y = tbl1[1,], col=3);points(x = df.bar[1,], y = tbl1[1,])
lines(x = df.bar[2,], y = tbl1[2,], col=2);points(x = df.bar[2,], y = tbl1[2,])
legend("topleft",c("Sin Ecosystem Services","Con Ecosystem Services"), fill=c(2:3), cex=0.8)
```



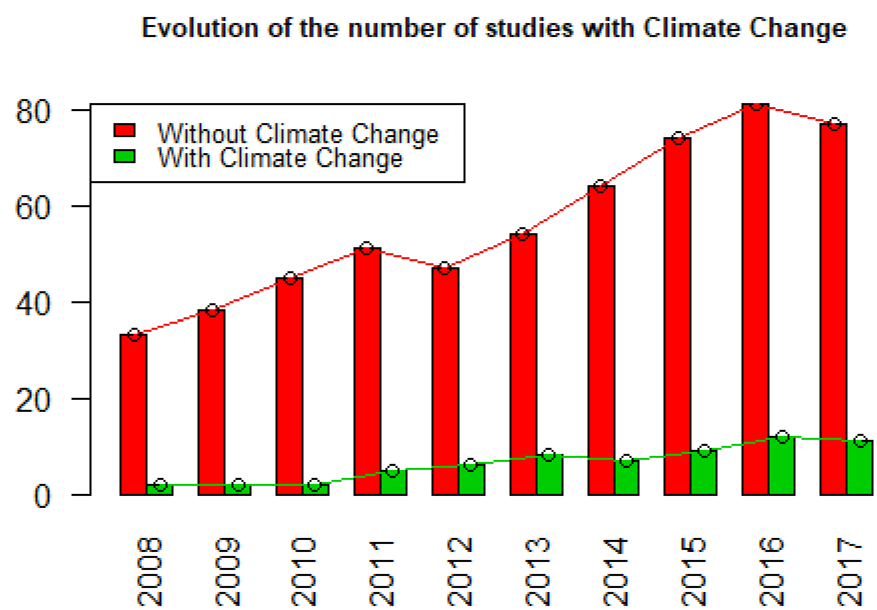

```
tbl2 <- rbind(table(db$ecosystem.services, db$year)[1,] / (colSums(table(db$ecosystem.services, db$year)
)),
         table(db$ecosystem.services, db$year)[2,] / (colSums(table(db$ecosystem.services, db$year))))
df.bar <- barplot(tbl2*100, beside=T, col=c(3,2),las=2, main="Evolución de la proporción de trabajos con Ec
osystem Services",
           ylim=c(0,130), ylab="%", cex.main=0.8)
lines(x = df.bar[1,], y = tbl2[1,]*100, col=3);points(x = df.bar[1,], y = tbl2[1,]*100)
```

```
lines(x = df.bar[2,], y = tbl2[2,]*100, col=2);points(x = df.bar[2,], y = tbl2[2,]*100)
legend("top",c("Sin Ecosystem Services","Con Ecosystem Services"), fill=c(2:3), cex=0.8)
```



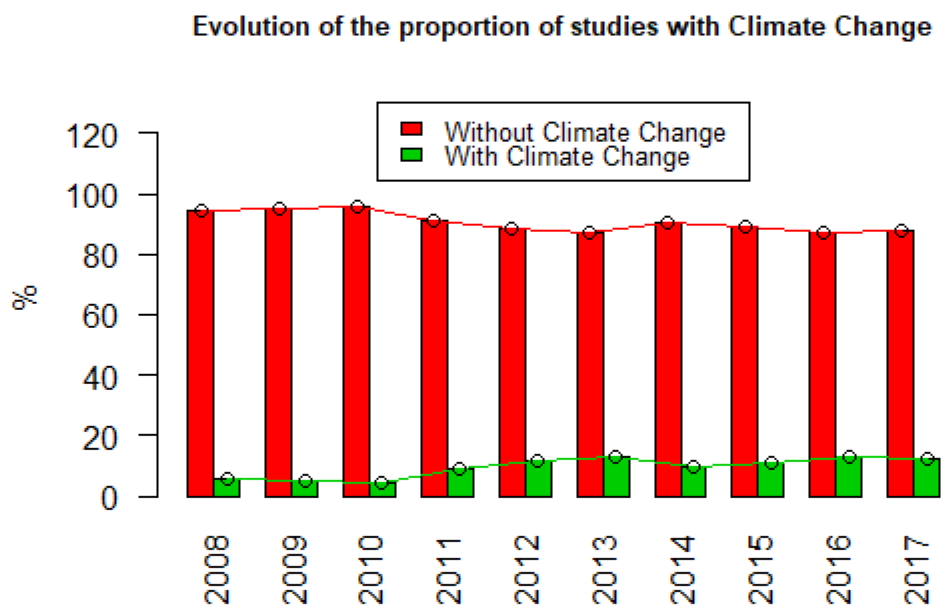

```
tbl1.2008_2012 <- tbl1 [,1:5];tbl1.2013_2017 <- tbl1 [,6:10]
tbl2.2008_2012 <- tbl2 [,1:5];tbl2.2013_2017 <- tbl2 [,6:10]
mean(tbl1.2008_2012[1,]); mean(tbl1.2013_2017[1,])

## [1] 1.8

## [1] 7.2

t.test(tbl1.2008_2012[1,], tbl1.2013_2017[1,])

##
##  Welch Two Sample t-test
##
## data:  tbl1.2008_2012[1, ] and tbl1.2013_2017[1, ]
## t = -3.182, df = 6.1132, p-value = 0.01855
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -9.533978 -1.266022
## sample estimates:
## mean of x mean of y
##       1.8       7.2

mean(tbl2.2008_2012[1,]); mean(tbl2.2013_2017[1,])

## [1] 0.03580863
```

```
## [1] 0.08739223

t.test(tbl2.2008_2012[1,], tbl2.2013_2017[1,])

##
##  Welch Two Sample t-test
##
## data:  tbl2.2008_2012[1, ] and tbl2.2013_2017[1, ]
## t = -2.3881, df = 8, p-value = 0.04399
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.101394108 -0.001773104
## sample estimates:
##  mean of x  mean of y
## 0.03580863 0.08739223

tbl1 <- as.matrix(table(db$cambio.climático, db$year))
df.bar <- barplot(tbl1, beside=T, col=c(2:3),las=2, main="Evolución del número de trabajos con Climate Ch
ange", cex.main=0.8)
lines(x = df.bar[1,], y = tbl1[1,], col=2);points(x = df.bar[1,], y = tbl1[1,])
lines(x = df.bar[2,], y = tbl1[2,], col=3);points(x = df.bar[2,], y = tbl1[2,])
legend("topleft",c("Sin Climate Change","Con Climate Change"), fill=c(2:3), cex=0.8)
```



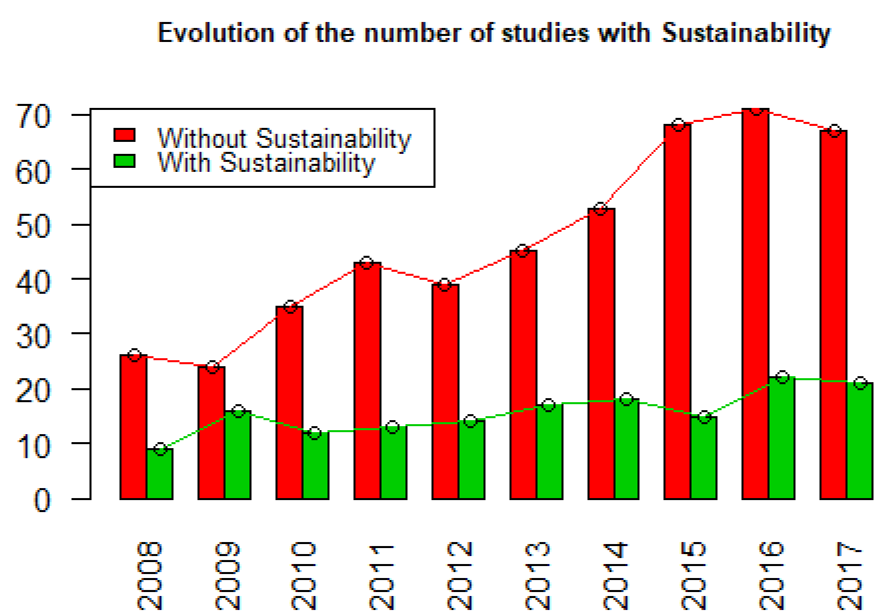

```
tbl2 <- rbind(table(db$cambio.climático, db$year)[1,] / (colSums(table(db$cambio.climático, db$year))),
          table(db$cambio.climático, db$year)[2,] / (colSums(table(db$cambio.climático, db$year))))
df.bar <- barplot(tbl2*100, beside=T, col=c(2:3),las=2, main="Evolución de la proporción de trabajos con Cl
imate Change",
```

```
              ylim=c(0,130), ylab="%", cex.main=0.8)
lines(x = df.bar[1,], y = tbl2[1,]*100, col=2);points(x = df.bar[1,], y = tbl2[1,]*100)
lines(x = df.bar[2,], y = tbl2[2,]*100, col=3);points(x = df.bar[2,], y = tbl2[2,]*100)
legend("top",c("Sin Climate Change","Con Climate Change"), fill=c(2:3), cex=0.8)
```



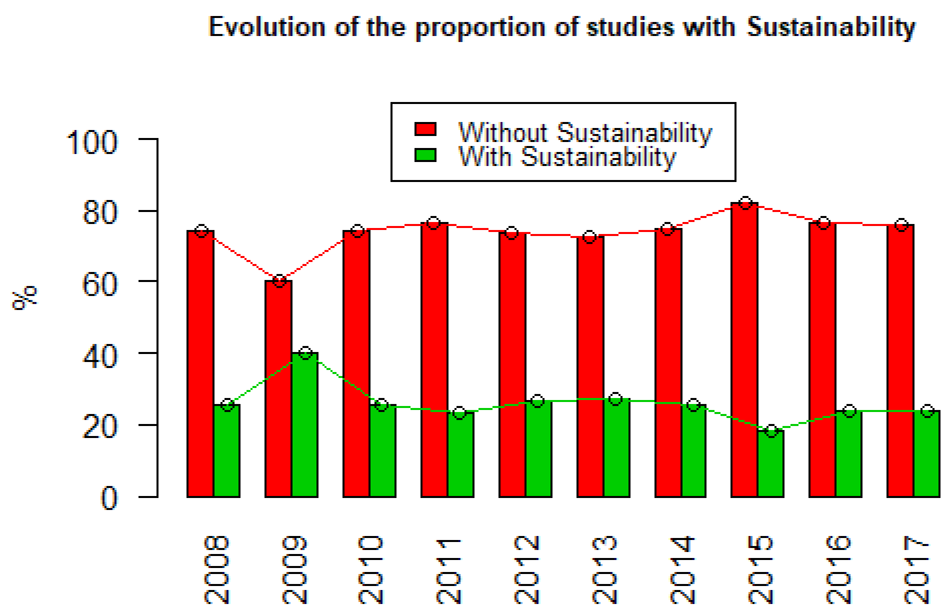

```
tbl1.2008_2012 <- tbl1 [,1:5];tbl1.2013_2017 <- tbl1 [,6:10]
tbl2.2008_2012 <- tbl2 [,1:5];tbl2.2013_2017 <- tbl2 [,6:10]
mean(tbl1.2008_2012[2,]); mean(tbl1.2013_2017[2,])

## [1] 3.4

## [1] 9.4

t.test(tbl1.2008_2012[2,], tbl1.2013_2017[2,])

##
##  Welch Two Sample t-test
##
## data:  tbl1.2008_2012[2, ] and tbl1.2013_2017[2, ]
## t = -4.714, df = 7.9696, p-value = 0.001529
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -8.937012 -3.062988
## sample estimates:
## mean of x mean of y
##       3.4       9.4

mean(tbl2.2008_2012[2,]); mean(tbl2.2013_2017[2,])
```

```
## [1] 0.07043786

## [1] 0.118018

t.test(tbl2.2008_2012[2,], tbl2.2013_2017[2,])

##
##  Welch Two Sample t-test
##
## data:  tbl2.2008_2012[2, ] and tbl2.2013_2017[2, ]
## t = -3.2385, df = 5.6361, p-value = 0.01937
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.08410046 -0.01105973
## sample estimates:
##  mean of x  mean of y
## 0.07043786 0.11801796

tbl1 <- as.matrix(table(db$sustainability, db$year))
df.bar <- barplot(tbl1, beside=T, col=c(2:3),las=2, main="Evolución del número de trabajos con Sustainabili
ty", cex.main=0.8)
lines(x = df.bar[1,], y = tbl1[1,], col=2);points(x = df.bar[1,], y = tbl1[1,])
lines(x = df.bar[2,], y = tbl1[2,], col=3);points(x = df.bar[2,], y = tbl1[2,])
legend("topleft",c("Sin Sustainability","Con Sustainability"), fill=c(2:3), cex=0.8)
```




```
tbl2 <- rbind(table(db$sustainability, db$year)[1,] / (colSums(table(db$sustainability, db$year))),
          table(db$sustainability, db$year)[2,] / (colSums(table(db$sustainability, db$year))))
```

```r
df.bar <- barplot(tbl2*100, beside=T, col=c(2:3),las=2, main="Evolución de la proporción de trabajos con Su
stainability",
              ylim=c(0,110), ylab="%", cex.main=0.8)
lines(x = df.bar[1,], y = tbl2[1,]*100, col=2);points(x = df.bar[1,], y = tbl2[1,]*100)
lines(x = df.bar[2,], y = tbl2[2,]*100, col=3);points(x = df.bar[2,], y = tbl2[2,]*100)
legend("top",c("Sin Sustainability","Con Sustainability"), fill=c(2:3), cex=0.8)
```




```r
tbl1.2008_2012 <- tbl1 [,1:5];tbl1.2013_2017 <- tbl1 [,6:10]
tbl2.2008_2012 <- tbl2 [,1:5];tbl2.2013_2017 <- tbl2 [,6:10]
mean(tbl1.2008_2012[2,]); mean(tbl1.2013_2017[2,])

## [1] 12.8

## [1] 18.6

t.test(tbl1.2008_2012[2,], tbl1.2013_2017[2,])

##
##  Welch Two Sample t-test
##
## data:  tbl1.2008_2012[2, ] and tbl1.2013_2017[2, ]
## t = -3.3486, df = 7.91, p-value = 0.01027
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -9.80204 -1.79796
## sample estimates:
```

```
## mean of x mean of y
##      12.8      18.6

mean(tbl2.2008_2012[2,]); mean(tbl2.2013_2017[2,])

## [1] 0.2817512

## [1] 0.2367266

t.test(tbl2.2008_2012[2,], tbl2.2013_2017[2,])

##
##  Welch Two Sample t-test
##
## data:  tbl2.2008_2012[2, ] and tbl2.2013_2017[2, ]
## t = 1.3311, df = 5.9955, p-value = 0.2315
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.03775933  0.12780842
## sample estimates:
## mean of x mean of y
## 0.2817512 0.2367266
```

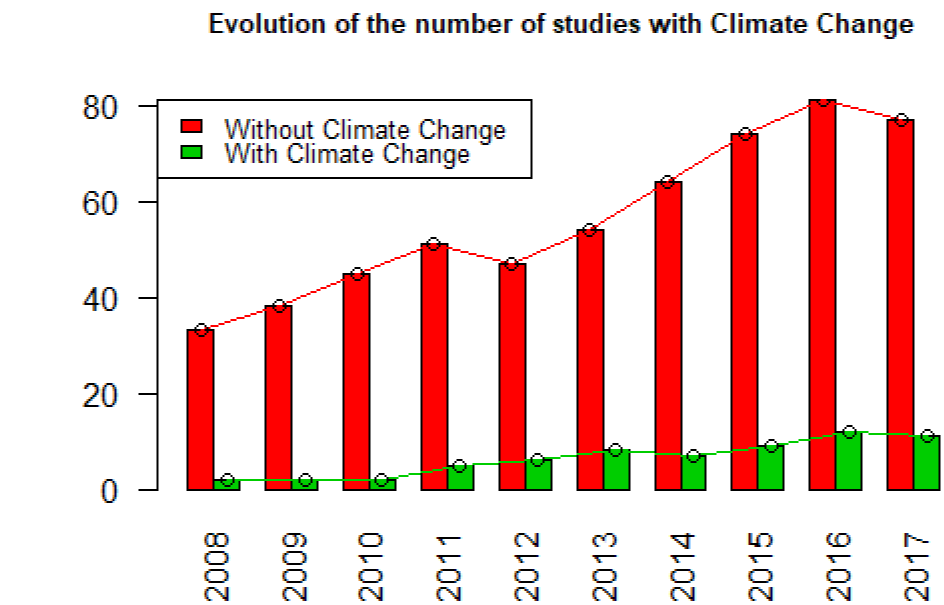
Hypothesis 15

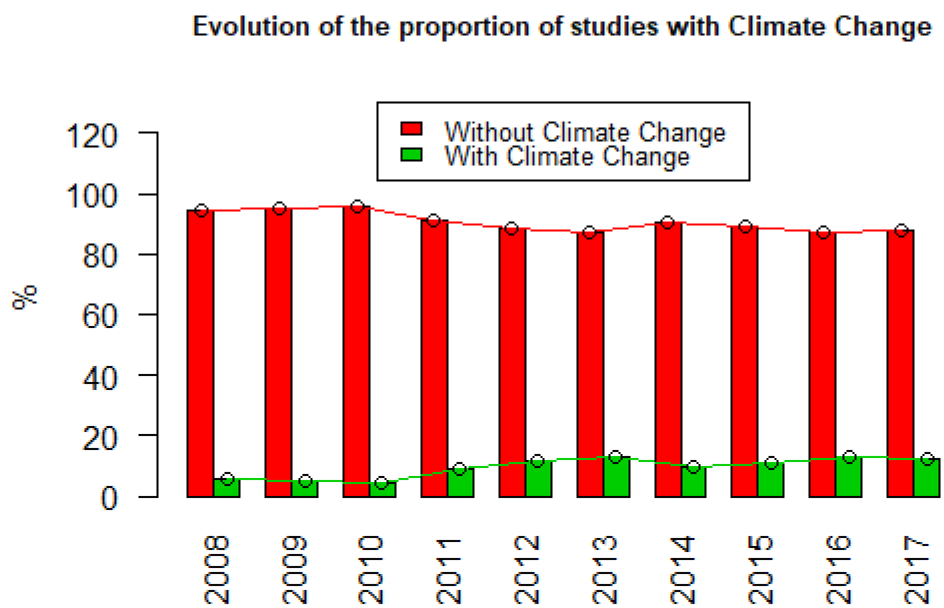
15. The topics that have been included to be relevant, are only relevant in the last years of the period.

==> In general, we reject the Hypothesis.

==> In most cases, we reject the Hypothesis. See graphs and test results one by one.

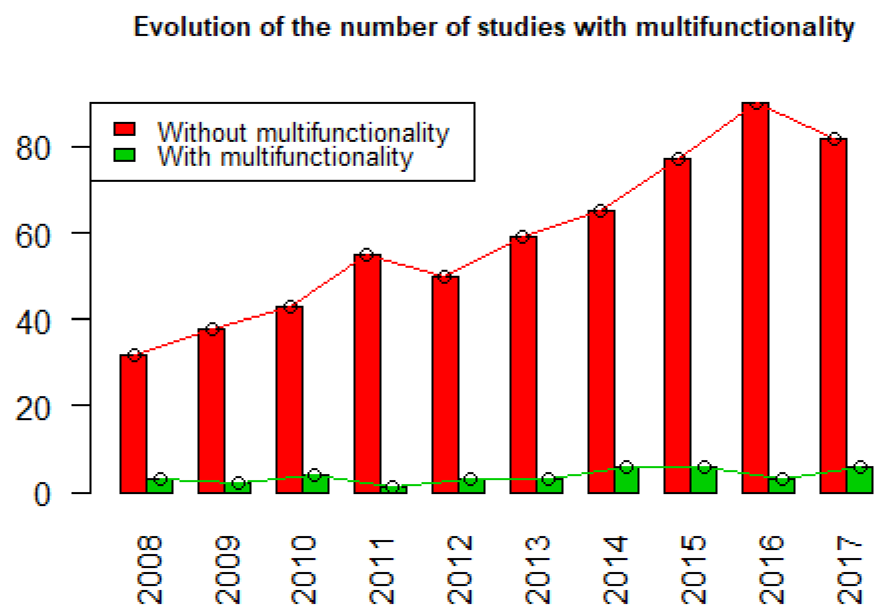
```
topics <- c("cambio.climático","multifunctionality","multiple.use","sustainability","bioeconomy","CSR..res
pons..Social.corp..",
        "certification","protected.areas","life.cycle")
for (i in 1:length(topics)){
  my_topic <- topics[i]
  tbl1 <- as.matrix(table(db[,my_topic], db$year))
  df.bar <- barplot(tbl1, beside=T, col=c(2:3),las=2, main=paste("Evolución del número de trabajos con", my
_topic), cex.main=0.8)
  lines(x = df.bar[1,], y = tbl1[1,], col=2);points(x = df.bar[1,], y = tbl1[1,])
  lines(x = df.bar[2,], y = tbl1[2,], col=3);points(x = df.bar[2,], y = tbl1[2,])
  legend("topleft",legend = c(paste("Sin", my_topic),paste("Con", my_topic)), fill=c(2:3), cex=0.8)
  tbl2 <- rbind(table(db[,my_topic], db$year)[1,] / (colSums(table(db[,my_topic], db$year))),
          table(db[,my_topic], db$year)[2,] / (colSums(table(db[,my_topic], db$year))))
  df.bar <- barplot(tbl2*100, beside=T, col=c(2:3),las=2, main=paste("Evolución de la proporción de trabajos
con", my_topic),
            ylim=c(0,130), ylab="%", cex.main=0.8)
  lines(x = df.bar[1,], y = tbl2[1,]*100, col=2);points(x = df.bar[1,], y = tbl2[1,]*100)
  lines(x = df.bar[2,], y = tbl2[2,]*100, col=3);points(x = df.bar[2,], y = tbl2[2,]*100)
  legend("top",legend = c(paste("Sin", my_topic),paste("Con", my_topic)), fill=c(2:3), cex=0.8)
  tbl1.2008_2012 <- tbl1 [,1:5];tbl1.2013_2017 <- tbl1 [,6:10]
  tbl2.2008_2012 <- tbl2 [,1:5];tbl2.2013_2017 <- tbl2 [,6:10]
  mean(tbl1.2008_2012[2,]); mean(tbl1.2013_2017[2,])
  print(t.test(tbl1.2008_2012[2,], tbl1.2013_2017[2,]))
  mean(tbl2.2008_2012[2,]); mean(tbl2.2013_2017[2,])
  print(t.test(tbl2.2008_2012[2,], tbl2.2013_2017[2,]))
}
```

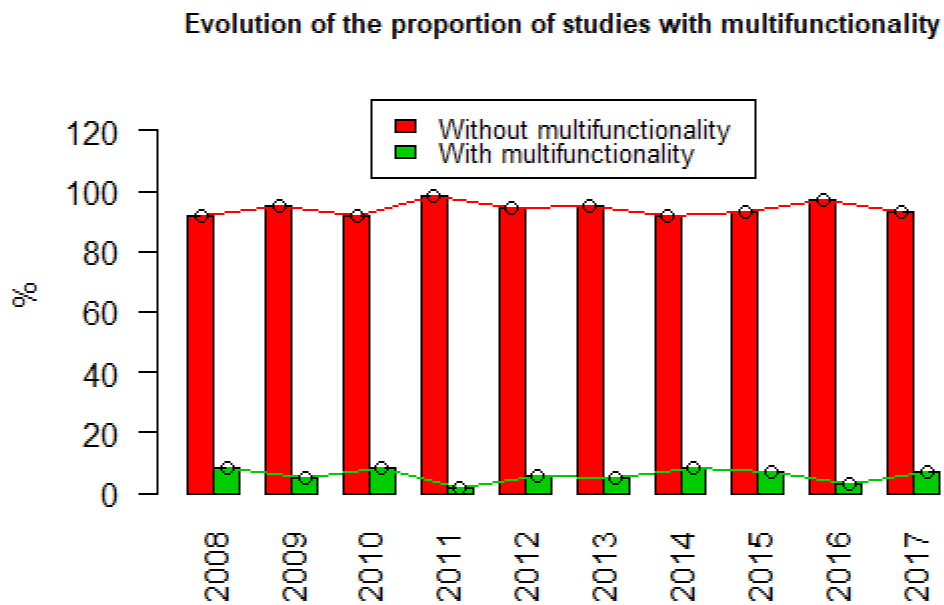




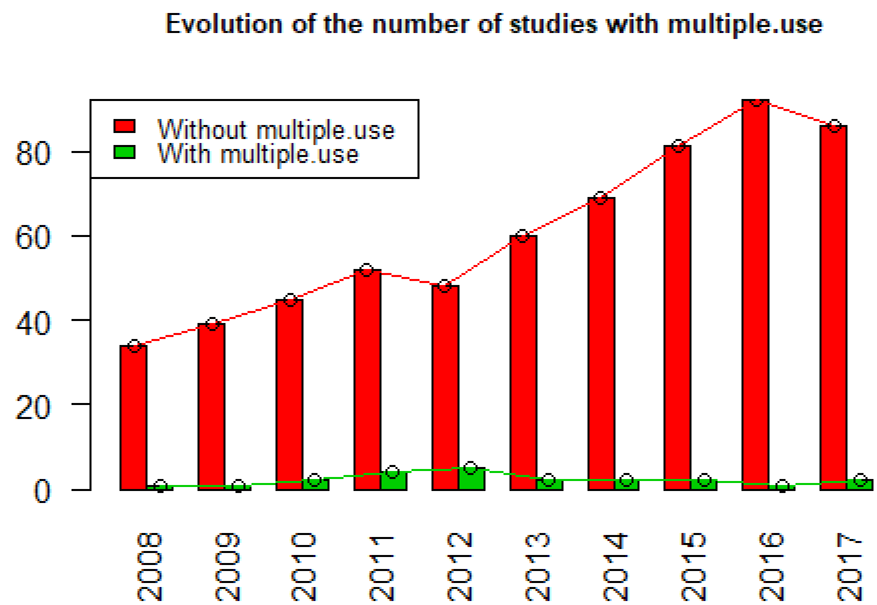

```
##
##  Welch Two Sample t-test
##
## data:  tbl1.2008_2012[2, ] and tbl1.2013_2017[2, ]
## t = -4.714, df = 7.9696, p-value = 0.001529
```

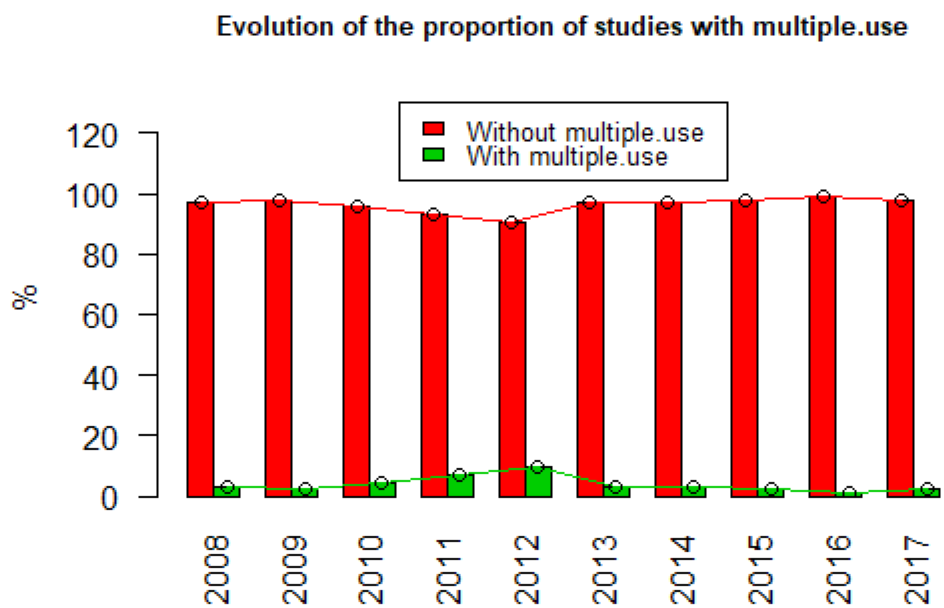
```
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -8.937012 -3.062988
## sample estimates:
## mean of x mean of y
##       3.4       9.4
##
##
##  Welch Two Sample t-test
##
## data:  tbl2.2008_2012[2, ] and tbl2.2013_2017[2, ]
## t = -3.2385, df = 5.6361, p-value = 0.01937
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.08410046 -0.01105973
## sample estimates:
##  mean of x  mean of y
## 0.07043786 0.11801796
```





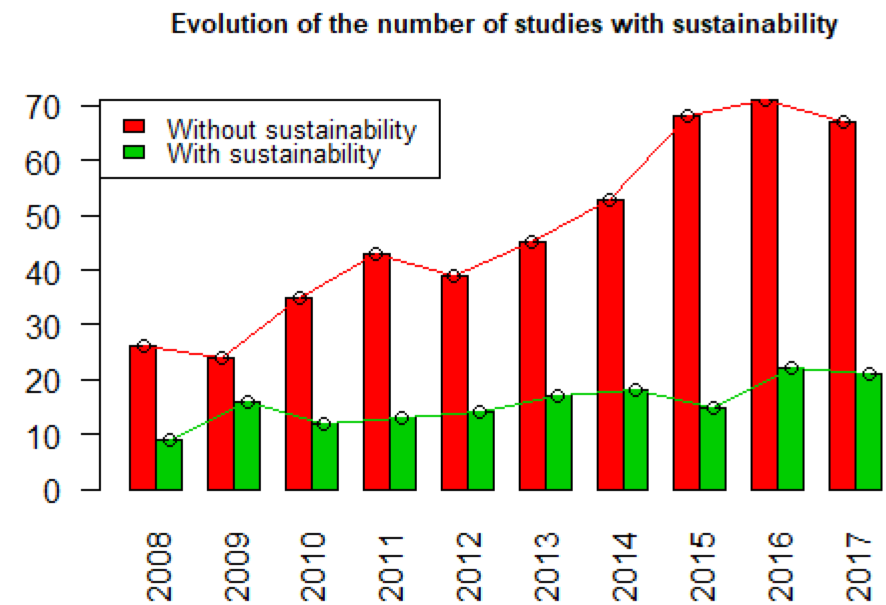

```
##
##  Welch Two Sample t-test
##
## data:  tbl1.2008_2012[2, ] and tbl1.2013_2017[2, ]
## t = -2.4597, df = 7.1269, p-value = 0.04289
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -4.30737111 -0.09262889
## sample estimates:
## mean of x mean of y
##       2.6       4.8
##
##
##  Welch Two Sample t-test
##
## data:  tbl2.2008_2012[2, ] and tbl2.2013_2017[2, ]
## t = -0.13226, df = 7.3472, p-value = 0.8983
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.03869656  0.03455992
## sample estimates:
##  mean of x  mean of y
## 0.05905632 0.06112464
```

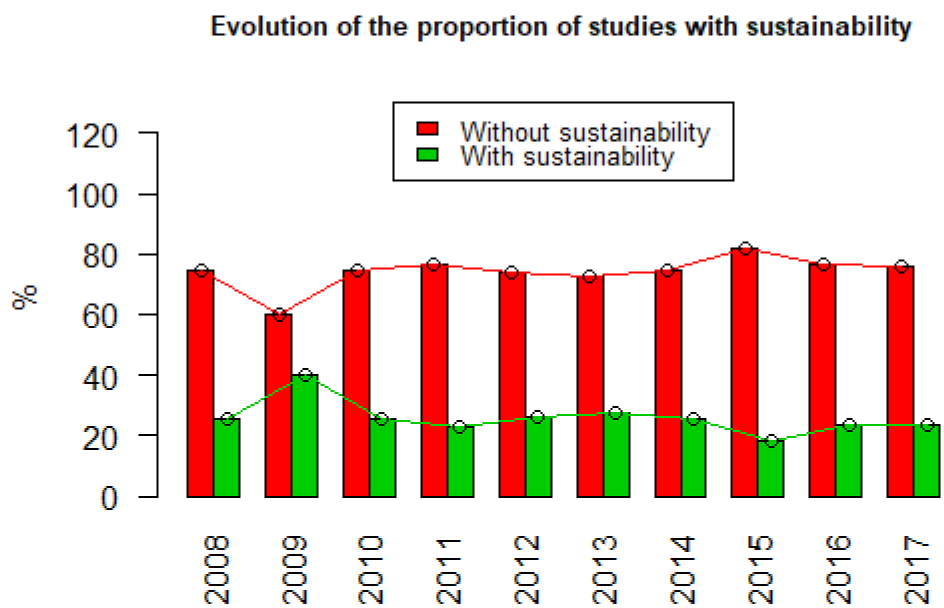





```
##
##  Welch Two Sample t-test
##
## data:  tbl1.2008_2012[2, ] and tbl1.2013_2017[2, ]
## t = 0.95618, df = 4.4831, p-value = 0.3877
```

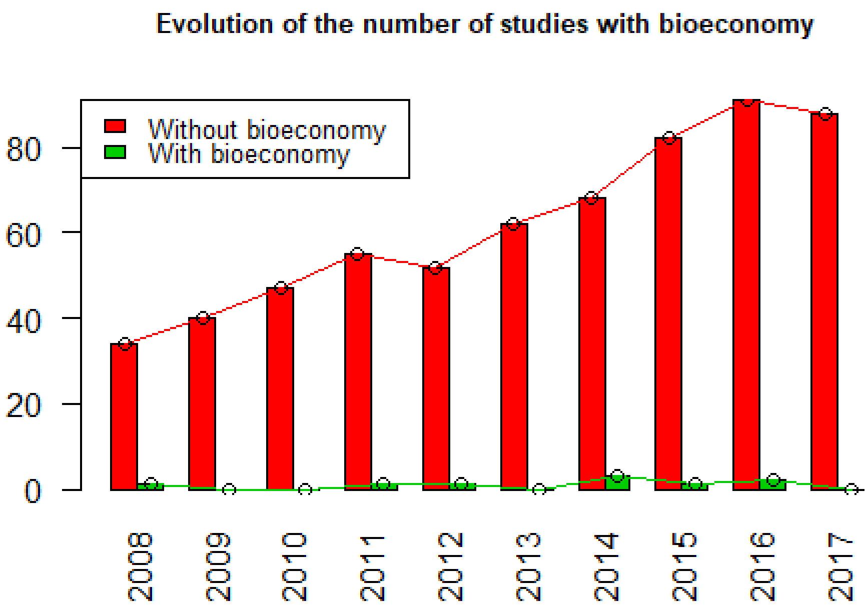
```
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -1.427477  3.027477
## sample estimates:
## mean of x mean of y 
##       2.6       1.8 
## 
## 
##  Welch Two Sample t-test
## 
## data:  tbl2.2008_2012[2, ] and tbl2.2013_2017[2, ]
## t = 2.0882, df = 4.5892, p-value = 0.09611
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.00762321  0.06517897
## sample estimates:
##  mean of x  mean of y 
## 0.05237856 0.02360069
```

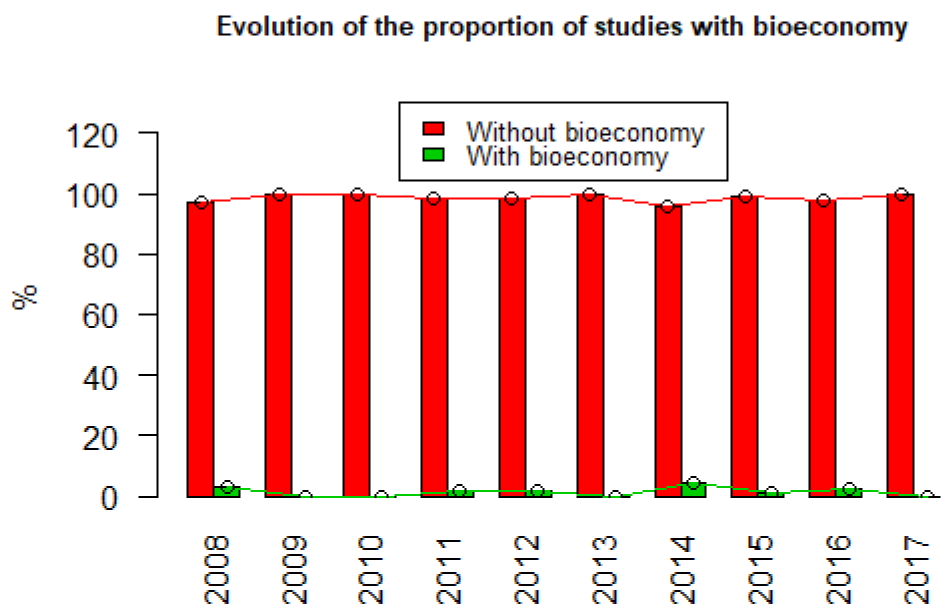





```
##
##  Welch Two Sample t-test
##
## data:  tbl1.2008_2012[2, ] and tbl1.2013_2017[2, ]
## t = -3.3486, df = 7.91, p-value = 0.01027
```

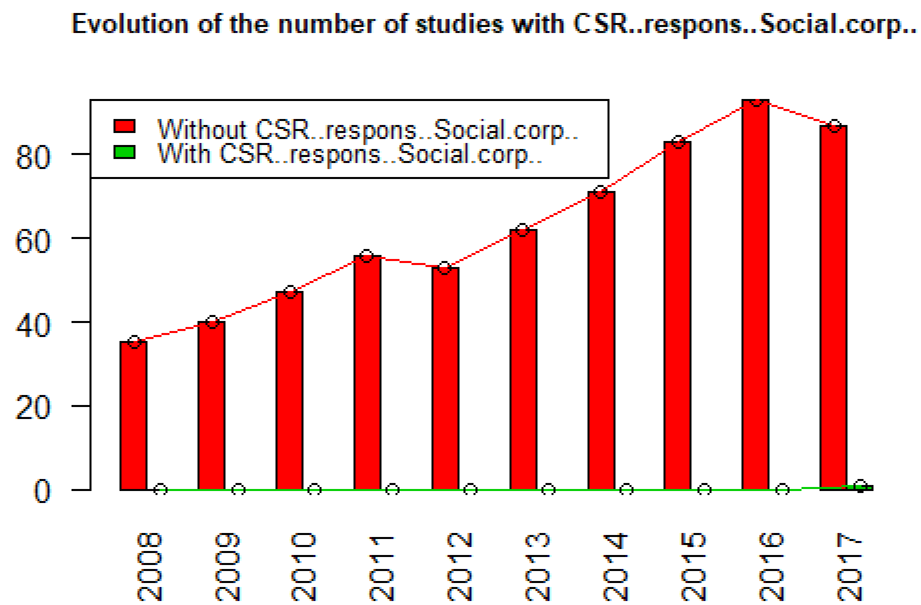
```
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -9.80204 -1.79796
## sample estimates:
## mean of x mean of y
##      12.8      18.6
##
##
##  Welch Two Sample t-test
##
## data:  tbl2.2008_2012[2, ] and tbl2.2013_2017[2, ]
## t = 1.3311, df = 5.9955, p-value = 0.2315
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.03775933  0.12780842
## sample estimates:
## mean of x mean of y
## 0.2817512 0.2367266
```

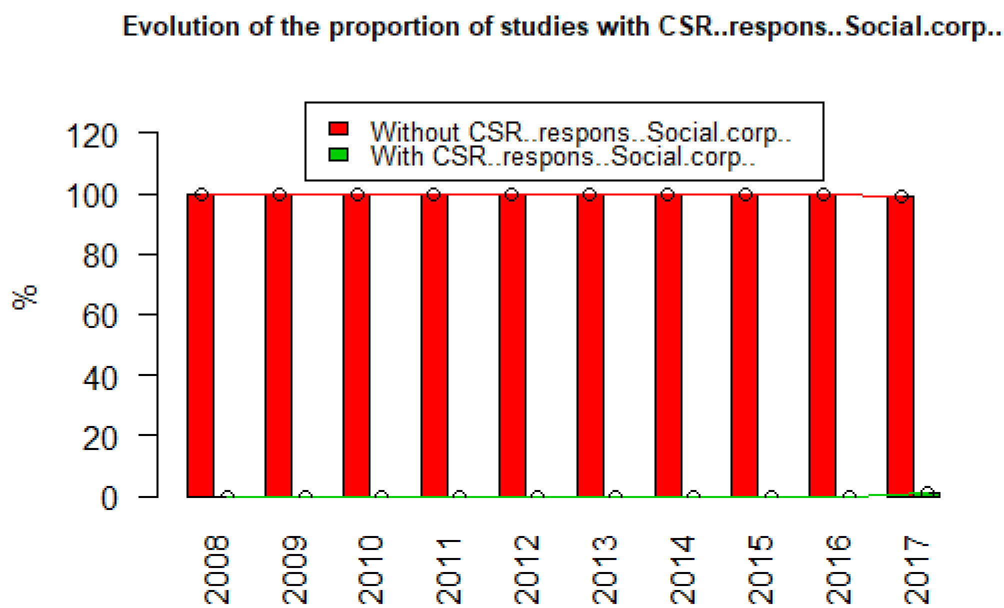





```
##
##  Welch Two Sample t-test
##
## data:  tbl1.2008_2012[2, ] and tbl1.2013_2017[2, ]
## t = -0.94868, df = 5.3691, p-value = 0.3835
```

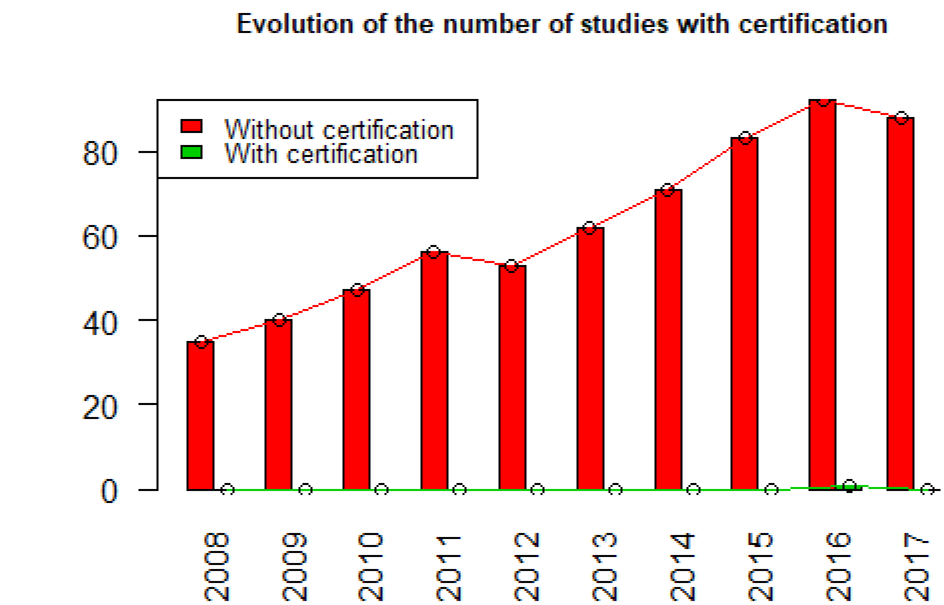
```
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -2.1927285  0.9927285
## sample estimates:
## mean of x mean of y
##       0.6       1.2
##
##
##  Welch Two Sample t-test
##
## data:  tbl2.2008_2012[2, ] and tbl2.2013_2017[2, ]
## t = -0.21669, df = 7.2504, p-value = 0.8344
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.02488138  0.02067715
## sample estimates:
##  mean of x  mean of y
## 0.01305930 0.01516142
```

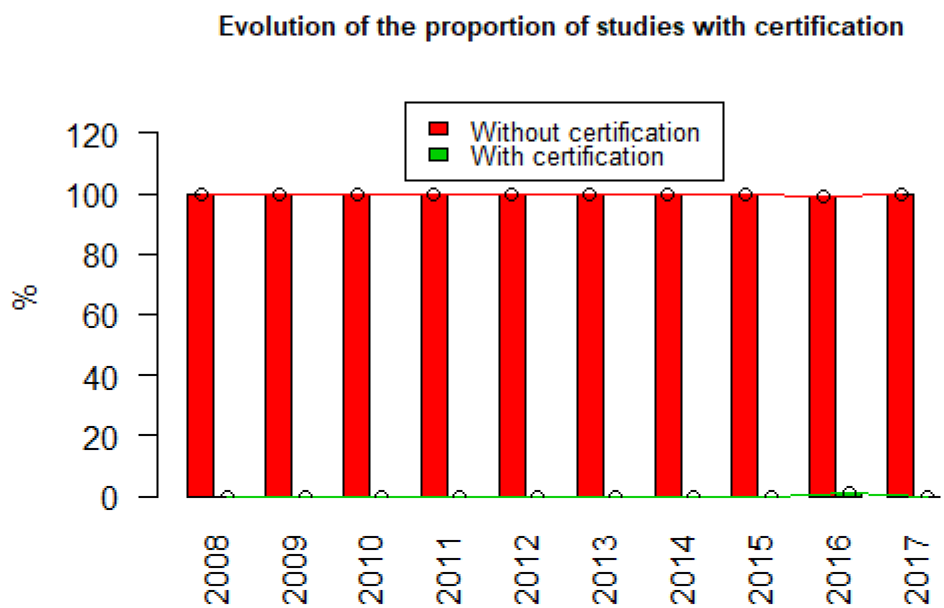





```
##
##  Welch Two Sample t-test
##
## data:  tbl1.2008_2012[2, ] and tbl1.2013_2017[2, ]
## t = -1, df = 4, p-value = 0.3739
```

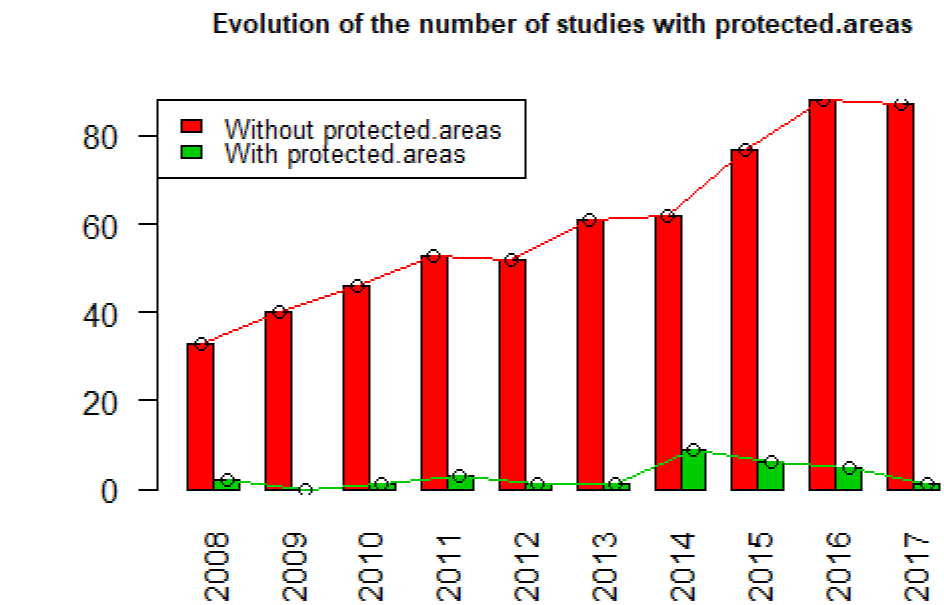
```
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.755289  0.355289
## sample estimates:
## mean of x mean of y
##       0.0       0.2
##
##
##  Welch Two Sample t-test
##
## data:  tbl2.2008_2012[2, ] and tbl2.2013_2017[2, ]
## t = -1, df = 4, p-value = 0.3739
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.008582830  0.004037375
## sample estimates:
##   mean of x   mean of y
## 0.000000000 0.002272727
```

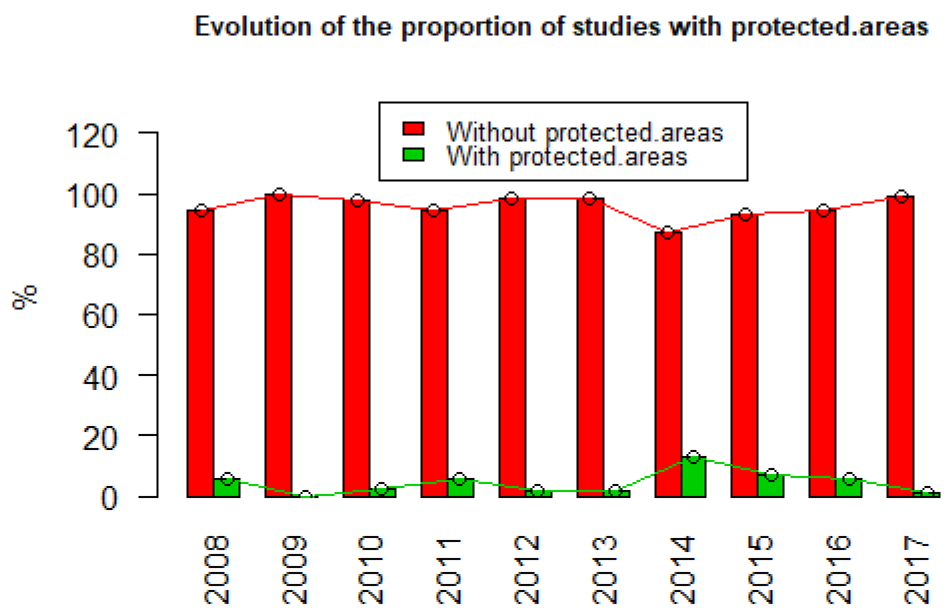





```
##
##  Welch Two Sample t-test
##
## data:  tbl1.2008_2012[2, ] and tbl1.2013_2017[2, ]
## t = -1, df = 4, p-value = 0.3739
```

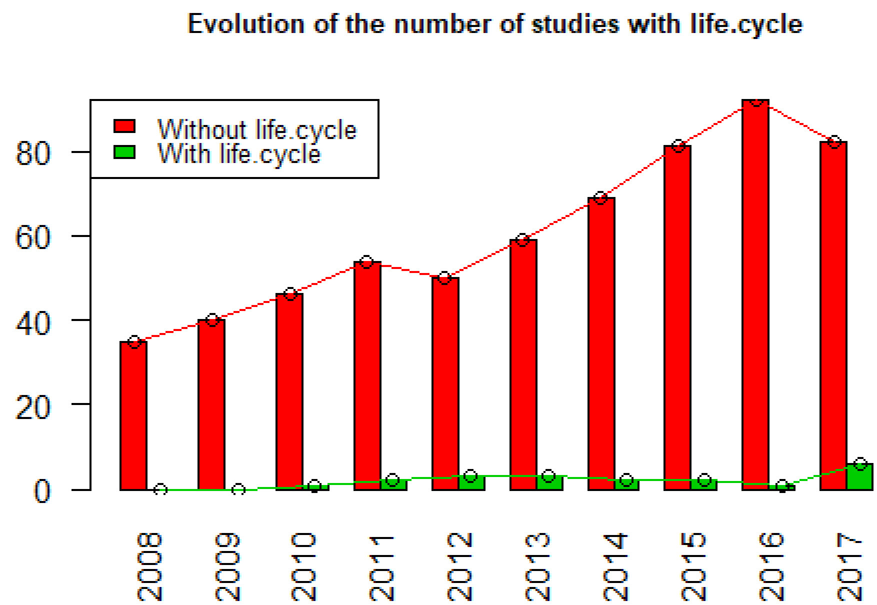
```
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.755289  0.355289
## sample estimates:
## mean of x mean of y
##       0.0       0.2
##
##
##  Welch Two Sample t-test
##
## data:  tbl2.2008_2012[2, ] and tbl2.2013_2017[2, ]
## t = -1, df = 4, p-value = 0.3739
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.008121387  0.003820312
## sample estimates:
##   mean of x   mean of y
## 0.000000000 0.002150538
```

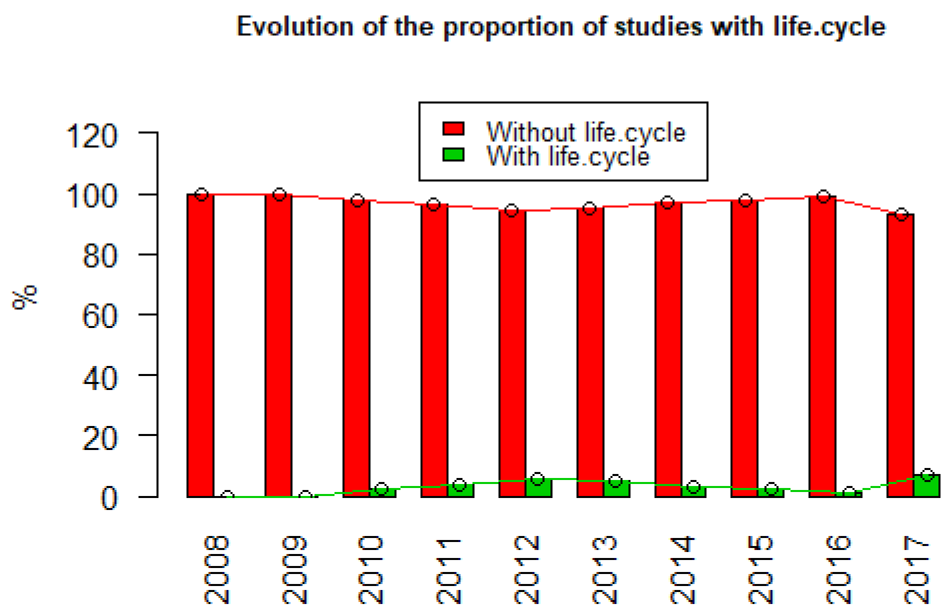





```
##
##  Welch Two Sample t-test
##
## data:  tbl1.2008_2012[2, ] and tbl1.2013_2017[2, ]
## t = -1.8534, df = 4.8708, p-value = 0.1246
```

```
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -7.19427  1.19427
## sample estimates:
## mean of x mean of y
##       1.4       4.4
##
##
##  Welch Two Sample t-test
##
## data:  tbl2.2008_2012[2, ] and tbl2.2013_2017[2, ]
## t = -1.0915, df = 6.0134, p-value = 0.3168
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.08389617  0.03211736
## sample estimates:
##  mean of x  mean of y
## 0.03017176 0.05606117
```






```
##
##  Welch Two Sample t-test
##
## data:  tbl1.2008_2012[2, ] and tbl1.2013_2017[2, ]
## t = -1.5396, df = 7.035, p-value = 0.1673
```

```
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -4.0549147  0.8549147
## sample estimates:
## mean of x mean of y
##       1.2       2.8
##
##
##  Welch Two Sample t-test
##
## data:  tbl2.2008_2012[2, ] and tbl2.2013_2017[2, ]
## t = -0.89177, df = 7.957, p-value = 0.3987
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.04736007  0.02096314
## sample estimates:
##  mean of x  mean of y
## 0.02271893 0.03591740
```

Hypothesis 16

16. There is a higher probability of using GIS hybridized with some MCDM technique in the forestry area than in other areas.

==> We accept the Hypothesis.

==> Those studies within the forestry field are more likely (statistically significant) to use GIS with respect to fishery and with respect to agriculture

```
table(db$FOR, db$GIS)

##
##      0   1
##   0 266  88
##   1 168 106

chisq.test(table(db$FOR, db$GIS))

##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  table(db$FOR, db$GIS)
## X-squared = 13.192, df = 1, p-value = 0.0002811

summary(glm(db$GIS ~ db$FOR, family="binomial"))

##
## Call:
## glm(formula = db$GIS ~ db$FOR, family = "binomial")
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.9891  -0.9891  -0.7560   1.3782   1.6685
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -1.1062     0.1230  -8.995  < 2e-16 ***
## db$FOR        0.6456     0.1747   3.696 0.000219 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 776.50  on 627  degrees of freedom
## Residual deviance: 762.72  on 626  degrees of freedom
## AIC: 766.72
##
## Number of Fisher Scoring iterations: 4
```

```
db$Campo_f <- relevel(as.factor(db$Campo), "FOR")
summary(glm(db$GIS ~ db$Campo_f, family="binomial"))

##
## Call:
## glm(formula = db$GIS ~ db$Campo_f, family = "binomial")
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.9415  -0.9415  -0.7479   1.4333   1.7194
##
## Coefficients:
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)     -0.5839     0.1338  -4.364 1.28e-05 ***
## db$Campo_fAGR   -0.5470     0.1911  -2.862  0.00421 **
## db$Campo_fFISH  -0.6353     0.3429  -1.853  0.06390 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 711.04  on 590  degrees of freedom
## Residual deviance: 701.59  on 588  degrees of freedom
##   (37 observations deleted due to missingness)
## AIC: 707.59
##
## Number of Fisher Scoring iterations: 4
```