**Supplementary material 4 – code for R analyses**

getwd()

setwd("FilePath")

#### installing required packages ##########

install.packages("readr")

install.packages("MASS")

install.packages("pscl")

install.packages("ggplot2")

install.packages("DHARMa")

install.packages("gridExtra")

#### loading required packages ##########

library("readr")

library("MASS")

library("pscl")

library("ggplot2")

library("DHARMa")

library("gridExtra")

###### Reading in data ######################

FullDat<-read\_delim("DATA.csv", delim=",", col\_types=c("f","f","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n","n"), trim\_ws=TRUE)

names(FullDat)

summary(FullDat)

FullDat$Zona<-as.factor(FullDat$Zona)

###### Data exploration #########################

panel.hist <- function(x, ...)

{

 usr <- par("usr")

 par(usr = c(usr[1:2], 0, 1.5) )

 h <- hist(x, plot = FALSE)

 breaks <- h$breaks; nB <- length(breaks)

 y <- h$counts; y <- y/max(y)

 rect(breaks[-nB], 0, breaks[-1], y, col = "cyan", ...)

}

panel.cor <- function(x, y, digits = 2, prefix = "", cex.cor, ...)

{

 par(usr = c(0, 1, 0, 1))

 r <- abs(cor(x, y))

 txt <- format(c(r, 0.123456789), digits = digits)[1]

 txt <- paste0(prefix, txt)

 if(missing(cex.cor)) cex.cor <- 0.8/strwidth(txt)

 text(0.5, 0.5, txt, cex = cex.cor \* r)

}

#### pairs plot of 2 response variables and 3 explanatory variables #############

pairs(FullDat[c(3,23,71,72,74)], lower.panel = panel.smooth,

 upper.panel = panel.cor, cex = 1.5, pch = 24, bg = "light blue", horOdd=TRUE,

 diag.panel = panel.hist, cex.labels = 2, font.labels = 2)

#### Modelling probability of non-zero vegetation (negative binomial GLMs)#######

################################## IVS #########################################

non\_zero <- ifelse(FullDat$ICV > 0, 1, 0)

#ProbVCI <- glm(non\_zero ~ IVS\*DensidadePopulacionalKM2, data = FullDat, family = binomial(link = logit))# interaction not significant

ProbVCI <- glm(non\_zero ~ IVS+DensidadePopulacionalKM2, data = FullDat, family = binomial(link = logit))

summary(ProbVCI)

### model checks ###########################################################

simulationOutput <- simulateResiduals(fittedModel = ProbVCI)

plot(simulationOutput, asFactor = T)

plotResiduals(simulationOutput, FullDat$IVS, quantreg = T)

plotResiduals(simulationOutput, FullDat$DensidadePopulacionalKM2, quantreg = T)

################################## IDHM #########################################

#ProbVCI\_2 <- glm(non\_zero ~ IDHM\*DensidadePopulacionalKM2, data = FullDat, family = binomial(link = logit)) # interaction not significant

ProbVCI\_2 <- glm(non\_zero ~ IDHM+DensidadePopulacionalKM2, data = FullDat, family = binomial(link = logit))

summary(ProbVCI\_2)

### model checks ###########################################################

simulationOutput <- simulateResiduals(fittedModel = ProbVCI\_2)

plot(simulationOutput, asFactor = T)

plotResiduals(simulationOutput, FullDat$IDHM, quantreg = T)

plotResiduals(simulationOutput, FullDat$DensidadePopulacionalKM2, quantreg = T)

#### Figure 2 ##################################################################

#create dummy datasets across the range of values of explanatory variables for VCI

IVS<-rep(seq(min(FullDat$IVS),max(FullDat$IVS),0.01),times=3)

IVS<-sort(IVS,decreasing=F)

DensidadePopulacionalKM2<-rep(mean(FullDat$DensidadePopulacionalKM2),times=length(IVS))

DummyDat<-data.frame(IVS,DensidadePopulacionalKM2)

MeanPred<-predict.glm(ProbVCI,DummyDat,type="response",se=T)

FittedMean<-MeanPred$fit

IDHM<-rep(seq(min(FullDat$IDHM),max(FullDat$IDHM),0.01),times=3)

IDHM<-sort(IDHM,decreasing=F)

DensidadePopulacionalKM2<-rep(mean(FullDat$DensidadePopulacionalKM2),times=length(IDHM))

DummyDat2<-data.frame(IDHM,DensidadePopulacionalKM2)

MeanPred2<-predict.glm(ProbVCI\_2,DummyDat2,type="response",se=T)

FittedMean2<-MeanPred2$fit

DensidadePopulacionalKM2<-seq(min(FullDat$DensidadePopulacionalKM2),max(FullDat$DensidadePopulacionalKM2),676)

DensidadePopulacionalKM2<-sort(DensidadePopulacionalKM2,decreasing=F)

IVS<-rep(mean(FullDat$IVS),times=length(DensidadePopulacionalKM2))

DummyDat3<-data.frame(IVS,DensidadePopulacionalKM2)

MeanPred3<-predict.glm(ProbVCI,DummyDat3,type="response",se=T)

FittedMean3<-MeanPred3$fit

DensidadePopulacionalKM2<-seq(min(FullDat$DensidadePopulacionalKM2),max(FullDat$DensidadePopulacionalKM2),676)

DensidadePopulacionalKM2<-sort(DensidadePopulacionalKM2,decreasing=F)

IDHM<-rep(mean(FullDat$IDHM),times=length(DensidadePopulacionalKM2))

DummyDat4<-data.frame(IDHM,DensidadePopulacionalKM2)

MeanPred4<-predict.glm(ProbVCI\_2,DummyDat4,type="response",se=T)

FittedMean4<-MeanPred4$fit

# plot figures 2a-c #############################################################

par(mfrow=c(2,2))

plot(FullDat$IVS, non\_zero, type="n", xlab="Social Vulnerability Index", ylab="Probability of Non-Zero Vegetation Cover")

points(x=FullDat$IVS, y=non\_zero, pch=19)

lines(DummyDat$IVS, FittedMean, lwd=4)

plot(FullDat$IDHM, non\_zero, type="n", xlab="Human Development Index", ylab="Probability of Non-Zero Vegetation Cover")

points(x=FullDat$IDHM, y=non\_zero, pch=19)

lines(DummyDat2$IDHM, FittedMean2, lwd=4)

plot(FullDat$DensidadePopulacionalKM2, non\_zero, type="n", xlab="Demographic Density", ylab="Probability of Non-Zero Vegetation Cover")

points(x=FullDat$DensidadePopulacionalKM2, y=non\_zero, pch=19)

lines(DummyDat3$DensidadePopulacionalKM2, FittedMean3, lwd=4)

lines(DummyDat4$DensidadePopulacionalKM2, FittedMean4, lwd=4, lty=2)

## Modelling correlation between urban green space and socio-economic indices ##

################################## IVS #########################################

CorrVCI<- glm(ICV ~ IVS\*DensidadePopulacionalKM2, data = subset(FullDat, non\_zero == 1), family = Gamma(link = log))

summary(CorrVCI)

### model checks ###########################################################

simulationOutput <- simulateResiduals(fittedModel = CorrVCI)

plot(simulationOutput, asFactor = T)

plotResiduals(simulationOutput, FullDat$IVS, quantreg = T)

plotResiduals(simulationOutput, FullDat$DensidadePopulacionalKM2, quantreg = T)

CorrVCI\_2<- glm(ICV ~ IDHM\*DensidadePopulacionalKM2, data = subset(FullDat, non\_zero == 1), family = Gamma(link = log))

summary(CorrVCI\_2)

### model checks ###########################################################

simulationOutput <- simulateResiduals(fittedModel = CorrVCI\_2)

plot(simulationOutput, asFactor = T)

plotResiduals(simulationOutput, FullDat$IVS, quantreg = T)

plotResiduals(simulationOutput, FullDat$DensidadePopulacionalKM2, quantreg = T)

#create dummy datasets across the range of values of explanatory variables for VCI

#### LOW DENSITY #####

IVS<-rep(seq(min(FullDat$IVS),max(FullDat$IVS),0.01),times=3)

IVS<-sort(IVS,decreasing=F)

DensidadePopulacionalKM2<-rep(5000,times=length(IVS))

DummyDatLOW<-data.frame(IVS,DensidadePopulacionalKM2)

LowPred<-predict.glm(CorrVCI,DummyDatLOW,type="response",se=T)

FittedLow<-LowPred$fit

IDHM<-rep(seq(min(FullDat$IDHM),max(FullDat$IDHM),0.01),times=3)

IDHM<-sort(IDHM,decreasing=F)

DensidadePopulacionalKM2<-rep(5000,times=length(IDHM))

DummyDatLOW2<-data.frame(IDHM,DensidadePopulacionalKM2)

LowPred2<-predict.glm(CorrVCI\_2,DummyDatLOW2,type="response",se=T)

FittedLow2<-LowPred2$fit

#### MEAN DENSITY #####

IVS<-rep(seq(min(FullDat$IVS),max(FullDat$IVS),0.01),times=3)

IVS<-sort(IVS,decreasing=F)

DensidadePopulacionalKM2<-rep(mean(FullDat$DensidadePopulacionalKM2),times=length(IVS))

DummyDatMEAN<-data.frame(IVS,DensidadePopulacionalKM2)

MeanPred<-predict.glm(CorrVCI,DummyDatMEAN,type="response",se=T)

FittedMean<-MeanPred$fit

IDHM<-rep(seq(min(FullDat$IDHM),max(FullDat$IDHM),0.01),times=3)

IDHM<-sort(IDHM,decreasing=F)

DensidadePopulacionalKM2<-rep(mean(FullDat$DensidadePopulacionalKM2),times=length(IDHM))

DummyDatMEAN2<-data.frame(IDHM,DensidadePopulacionalKM2)

MeanPred2<-predict.glm(CorrVCI\_2,DummyDatMEAN2,type="response",se=T)

FittedMean2<-MeanPred2$fit

#### HIGH DENSITY #####

IVS<-rep(seq(min(FullDat$IVS),max(FullDat$IVS),0.01),times=3)

IVS<-sort(IVS,decreasing=F)

DensidadePopulacionalKM2<-rep(20000,times=length(IVS))

DummyDatHIGH<-data.frame(IVS,DensidadePopulacionalKM2)

HighPred<-predict.glm(CorrVCI,DummyDatHIGH,type="response",se=T)

FittedHigh<-HighPred$fit

IDHM<-rep(seq(min(FullDat$IDHM),max(FullDat$IDHM),0.01),times=3)

IDHM<-sort(IDHM,decreasing=F)

DensidadePopulacionalKM2<-rep(20000,times=length(IDHM))

DummyDatHIGH2<-data.frame(IDHM,DensidadePopulacionalKM2)

HighPred2<-predict.glm(CorrVCI\_2,DummyDatHIGH2,type="response",se=T)

FittedHigh2<-HighPred2$fit

# plot figures 3a-b #############################################################

par(mfrow=c(1,2))

with(FullDat,plot(IVS,ICV, pch=19, col="gray", xlab="Social Vulnerability Index", ylab="Vegetation Cover Index (%)"))

lines(IVS,FittedMean,lty=1,lwd=4)

lines(IVS,FittedLow,lty=2,lwd=4)

lines(IVS,FittedHigh,lty=3,lwd=4)

with(FullDat,plot(IDHM,ICV, pch=19, col="gray", xlab="Human Development Index", ylab="Vegetation Cover Index (%)"))

lines(IDHM,FittedMean2,lty=1,lwd=4)

lines(IDHM,FittedLow2,lty=2,lwd=4)

lines(IDHM,FittedHigh2,lty=3,lwd=4)

################################## VCPI #########################################

################################## IVS #########################################

FullDat$LOGICVH<-log(FullDat$ICVH+0.0001)

CorrVCPI<- glm(LOGICVH ~ IVS+DensidadePopulacionalKM2, data = subset(FullDat, non\_zero == 1), family = gaussian)

summary(CorrVCPI)

### model checks ###########################################################

simulationOutput <- simulateResiduals(fittedModel = CorrVCPI)

plot(simulationOutput, asFactor = T)

plotResiduals(simulationOutput, FullDat$IDHM, quantreg = T)

plotResiduals(simulationOutput, FullDat$DensidadePopulacionalKM2, quantreg = T)

################################## IDHM #########################################

CorrVCPI\_2<- glm(LOGICVH ~ IDHM+DensidadePopulacionalKM2, data = subset(FullDat, non\_zero == 1), family = gaussian)

summary(CorrVCPI\_2)

### model checks ###########################################################

simulationOutput <- simulateResiduals(fittedModel = CorrVCPI\_2)

plot(simulationOutput, asFactor = T)

plotResiduals(simulationOutput, FullDat$IDHM, quantreg = T)

plotResiduals(simulationOutput, FullDat$DensidadePopulacionalKM2, quantreg = T)

#### Figure 4 ##################################################################

#create dummy datasets across the range of values of explanatory variables for VCPI

IVS<-rep(seq(min(FullDat$IVS),max(FullDat$IVS),0.01),times=3)

IVS<-sort(IVS,decreasing=F)

DensidadePopulacionalKM2<-rep(mean(FullDat$DensidadePopulacionalKM2),times=length(IVS))

DummyDat5<-data.frame(IVS,DensidadePopulacionalKM2)

MeanPred5<-predict.glm(CorrVCPI,DummyDat5,type="response",se=T)

FittedMean5<-MeanPred5$fit

IDHM<-rep(seq(min(FullDat$IDHM),max(FullDat$IDHM),0.01),times=3)

IDHM<-sort(IDHM,decreasing=F)

DensidadePopulacionalKM2<-rep(mean(FullDat$DensidadePopulacionalKM2),times=length(IDHM))

DummyDat6<-data.frame(IDHM,DensidadePopulacionalKM2)

MeanPred6<-predict.glm(CorrVCPI\_2,DummyDat6,type="response",se=T)

FittedMean6<-MeanPred6$fit

DensidadePopulacionalKM2<-seq(min(FullDat$DensidadePopulacionalKM2),max(FullDat$DensidadePopulacionalKM2),676)

DensidadePopulacionalKM2<-sort(DensidadePopulacionalKM2,decreasing=F)

IVS<-rep(mean(FullDat$IVS),times=length(DensidadePopulacionalKM2))

DummyDat7<-data.frame(IVS,DensidadePopulacionalKM2)

MeanPred7<-predict.glm(CorrVCPI,DummyDat7,type="response",se=T)

FittedMean7<-MeanPred7$fit

DensidadePopulacionalKM2<-seq(min(FullDat$DensidadePopulacionalKM2),max(FullDat$DensidadePopulacionalKM2),676)

DensidadePopulacionalKM2<-sort(DensidadePopulacionalKM2,decreasing=F)

IDHM<-rep(mean(FullDat$IDHM),times=length(DensidadePopulacionalKM2))

DummyDat8<-data.frame(IDHM,DensidadePopulacionalKM2)

MeanPred8<-predict.glm(CorrVCPI\_2,DummyDat8,type="response",se=T)

FittedMean8<-MeanPred8$fit

# plot figures 4a-c #############################################################

par(mfrow=c(2,2))

with(subset(FullDat, non\_zero == 1), plot(IVS, LOGICVH, type="n", xlab="Social Vulnerability Index", ylab="Log of Vegetation Cover per Inhabitant (m2)"))

with(subset(FullDat, non\_zero == 1), points(x=IVS, y=LOGICVH, pch=19))

lines(DummyDat5$IVS, FittedMean5, lwd=4)

with(subset(FullDat, non\_zero == 1),plot(IDHM, LOGICVH, type="n", xlab="Human Development Index", ylab="Log of Vegetation Cover per Inhabitant (m2)"))

with(subset(FullDat, non\_zero == 1),points(x=IDHM, y=LOGICVH, pch=19))

lines(DummyDat6$IDHM, FittedMean6, lwd=4)

with(subset(FullDat, non\_zero == 1),plot(DensidadePopulacionalKM2, LOGICVH, type="n", xlab="Demographic Density", ylab="Log of Vegetation Cover per Inhabitant (m2)"))

with(subset(FullDat, non\_zero == 1),points(x=DensidadePopulacionalKM2, y=LOGICVH, pch=19))

lines(DummyDat7$DensidadePopulacionalKM2, FittedMean7, lwd=4)

lines(DummyDat8$DensidadePopulacionalKM2, FittedMean8, lwd=4, lty=2)