Q2: Does climate drive lake-landscape coherence?

Jonathan Walter, Grace Wilkinson, Rachel Fleck, Michael Pace

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This document organizes for openness and reproducibility analyses of the influence of climate .

Data import

In the Q1 manuscript, we output time series from coherent lake-landscape pairs. These are loaded here. We also load time series of three major climate indices (ENSO, PDO, NAO) and local temperature and precipitation.

```
#load coherent lakes data
load("~/Box Sync/NSF EAGER Synchrony/Data/RData files/q2_coherent_lakes.RData")
#load climate index time series
mei.raw<-read.csv("/Users/jonathanwalter/Documents/Research/DATA/ClimateIndices/mei_monthly_1979_2019.cs
pdo.raw<-read.csv("/Users/jonathanwalter/Documents/Research/DATA/ClimateIndices/pdo_monthly_1950_2019.cs
nao.raw<-read.csv("/Users/jonathanwalter/Documents/Research/DATA/ClimateIndices/nao_monthly_1950_2019.cs

mei.gs<-mei.raw[mei.raw$mm >=5 & mei.raw$mm <=9,]
pdo.gs<-pdo.raw[pdo.raw$mm >=5 & pdo.raw$mm <=9,]
nao.gs<-nao.raw[nao.raw$mm >=5 & nao.raw$mm <=9,]

mei.gs<-aggregate(mei.gs$mei,list(mei.gs$yyyy),FUN="mean")
names(mei.gs)<-c("year","mei")
pdo.gs<-aggregate(pdo.gs$PDO,list(pdo.gs$yyyy),FUN="mean")
names(pdo.gs)<-c("year","pdo")
nao.gs<-aggregate(nao.gs$NAO,list(nao.gs$yyyy),FUN="mean")
names(nao.gs)<-c("year","nao")

for(ii in 1:length(coherentlakes.st$lakedata)){
  coherentlakes.st$lakedata[[ii]]<-rbind(coherentlakes.st$lakedata[[ii]],
                                      mei.gs$mei[mei.gs$year %in% colnames(coherentlakes.st$lakedata
                                      pdo.gs$pdo[pdo.gs$year %in% colnames(coherentlakes.st$lakedata
                                      nao.gs$nao[nao.gs$year %in% colnames(coherentlakes.st$lakedata
  rownames(coherentlakes.st$lakedata[[ii]])<-c("chla","ndvi","mei","pdo","nao")
}

for(ii in 1:length(coherentlakes.lt$lakedata)){
  coherentlakes.lt$lakedata[[ii]]<-rbind(coherentlakes.lt$lakedata[[ii]],
                                      mei.gs$mei[mei.gs$year %in% colnames(coherentlakes.lt$lakedata
                                      pdo.gs$pdo[pdo.gs$year %in% colnames(coherentlakes.lt$lakedata
                                      nao.gs$nao[nao.gs$year %in% colnames(coherentlakes.lt$lakedata
  rownames(coherentlakes.lt$lakedata[[ii]])<-c("chla","ndvi","mei","pdo","nao")
}

#add local weather
ppt.files<-paste0("/Users/jonathanwalter/Documents/Research/DATA/PRISM_4km2_gridded/ppt/PRISM_ppt_stabl
                  rep(1989:2018,each=5),
                  rep(c("05","06","07","08","09"),times=30),
```

```
                  "_bil.bil")
ppt<-stack(ppt.files)


tavg.files<-c(paste0("/Users/jonathanwalter/Documents/Research/DATA/PRISM_4km2_gridded/tmean/PRISM_tmean
                  rep(1989:2016,each=5),
                  rep(c("05","06","07","08","09"),times=28),
                  "_bil.bil"),
              paste0("/Users/jonathanwalter/Documents/Research/DATA/PRISM_4km2_gridded/tmean/PRISM_tmean
                  rep(2017:2018,each=5),
                  rep(c("05","06","07","08","09"),times=2),
                  "_bil.bil"))
tavg<-stack(tavg.files)

coherentlakes.st<-addPRISMts(coherentlakes.st, ppt, var="ppt")
coherentlakes.st<-addPRISMts(coherentlakes.st, tavg, var="tmean")
coherentlakes.lt<-addPRISMts(coherentlakes.lt, ppt, var="ppt")
coherentlakes.lt<-addPRISMts(coherentlakes.lt, tavg, var="tmean")
```

Analyses

a) Are lakes and landscapes coherent with the same climate variables? b) Do climate variables explain a similar amount of variability in coherent lakes as the landscape does? c) does this differ by timescale?

First, do coherences with climate variables

```
lakeXclim.st<-data.frame(lagoslakeid=names(coherentlakes.st$lakedata),
                         mei.coh=rep(NA, length(coherentlakes.st$lakedata)),
                         mei.p=rep(NA, length(coherentlakes.st$lakedata)),
                         mei.phi=rep(NA, length(coherentlakes.st$lakedata)),
                         nao.coh=rep(NA, length(coherentlakes.st$lakedata)),
                         nao.p=rep(NA, length(coherentlakes.st$lakedata)),
                         nao.phi=rep(NA, length(coherentlakes.st$lakedata)),
                         pdo.coh=rep(NA, length(coherentlakes.st$lakedata)),
                         pdo.p=rep(NA, length(coherentlakes.st$lakedata)),
                         pdo.phi=rep(NA, length(coherentlakes.st$lakedata)),
                         ppt.coh=rep(NA, length(coherentlakes.st$lakedata)),
                         ppt.p=rep(NA, length(coherentlakes.st$lakedata)),
                         ppt.phi=rep(NA, length(coherentlakes.st$lakedata)),
                         tavg.coh=rep(NA, length(coherentlakes.st$lakedata)),
                         tavg.p=rep(NA, length(coherentlakes.st$lakedata)),
                         tavg.phi=rep(NA, length(coherentlakes.st$lakedata)))
landXclim.st<-lakeXclim.st

lakeXclim.lt<-data.frame(lagoslakeid=names(coherentlakes.lt$lakedata),
                         mei.coh=rep(NA, length(coherentlakes.lt$lakedata)),
                         mei.p=rep(NA, length(coherentlakes.lt$lakedata)),
                         mei.phi=rep(NA, length(coherentlakes.lt$lakedata)),
                         nao.coh=rep(NA, length(coherentlakes.lt$lakedata)),
                         nao.p=rep(NA, length(coherentlakes.lt$lakedata)),
                         nao.phi=rep(NA, length(coherentlakes.lt$lakedata)),
                         pdo.coh=rep(NA, length(coherentlakes.lt$lakedata)),
                         pdo.p=rep(NA, length(coherentlakes.lt$lakedata)),
```

```
                         pdo.phi=rep(NA, length(coherentlakes.lt$lakedata)),
                         ppt.coh=rep(NA, length(coherentlakes.lt$lakedata)),
                         ppt.p=rep(NA, length(coherentlakes.lt$lakedata)),
                         ppt.phi=rep(NA, length(coherentlakes.lt$lakedata)),
                         tavg.coh=rep(NA, length(coherentlakes.lt$lakedata)),
                         tavg.p=rep(NA, length(coherentlakes.lt$lakedata)),
                         tavg.phi=rep(NA, length(coherentlakes.lt$lakedata)))
landXclim.lt<-lakeXclim.lt

# lakes, short timescales
NN=length(coherentlakes.st$lakedata)
ts=c(2,4)
for(ii in 1:NN){
  vars<-rownames(coherentlakes.st$lakedata[[ii]])
  yy<-as.numeric(colnames(coherentlakes.st$lakedata[[ii]]))
  clnd<-cleandat(coherentlakes.st$lakedata[[ii]],yy,clev=5)$cdat

  cohXmei<-coh(clnd[vars=="chla",], clnd[vars=="mei"], yy, norm="powall", sigmethod="fast")
  cohXnao<-coh(clnd[vars=="chla",], clnd[vars=="nao"], yy, norm="powall", sigmethod="fast")
  cohXpdo<-coh(clnd[vars=="chla",], clnd[vars=="pdo"], yy, norm="powall", sigmethod="fast")
  cohXppt<-coh(clnd[vars=="chla",], clnd[vars=="ppt"], yy, norm="powall", sigmethod="fast")
  cohXtavg<-coh(clnd[vars=="chla",], clnd[vars=="tavg"], yy, norm="powall", sigmethod="fast")

  cohXmei<-bandtest.coh(cohXmei,ts)
  cohXnao<-bandtest.coh(cohXnao,ts)
  cohXpdo<-bandtest.coh(cohXpdo,ts)
  cohXppt<-bandtest.coh(cohXppt,ts)
  cohXtavg<-bandtest.coh(cohXtavg,ts)

  lakeXclim.st$mei.coh[ii]<-cohXmei$bandp$mn_coh
  lakeXclim.st$mei.p[ii]<-cohXmei$bandp$p_val
  lakeXclim.st$mei.phi[ii]<-cohXmei$bandp$mn_phs
  lakeXclim.st$nao.coh[ii]<-cohXnao$bandp$mn_coh
  lakeXclim.st$nao.p[ii]<-cohXnao$bandp$p_val
  lakeXclim.st$nao.phi[ii]<-cohXnao$bandp$mn_phs
  lakeXclim.st$pdo.coh[ii]<-cohXpdo$bandp$mn_coh
  lakeXclim.st$pdo.p[ii]<-cohXpdo$bandp$p_val
  lakeXclim.st$pdo.phi[ii]<-cohXpdo$bandp$mn_phs
  lakeXclim.st$ppt.coh[ii]<-cohXppt$bandp$mn_coh
  lakeXclim.st$ppt.p[ii]<-cohXppt$bandp$p_val
  lakeXclim.st$ppt.phi[ii]<-cohXppt$bandp$mn_phs
  lakeXclim.st$tavg.coh[ii]<-cohXtavg$bandp$mn_coh
  lakeXclim.st$tavg.p[ii]<-cohXtavg$bandp$p_val
  lakeXclim.st$tavg.phi[ii]<-cohXtavg$bandp$mn_phs
}

#land, short timescales
NN=length(coherentlakes.st$lakedata)
ts=c(2,4)
for(ii in 1:NN){
  vars<-rownames(coherentlakes.st$lakedata[[ii]])
  yy<-as.numeric(colnames(coherentlakes.st$lakedata[[ii]]))
  clnd<-cleandat(coherentlakes.st$lakedata[[ii]],yy,clev=5)$cdat
```

```r
  cohXmei<-coh(clnd[vars=="ndvi",], clnd[vars=="mei"], yy, norm="powall", sigmethod="fast")
  cohXnao<-coh(clnd[vars=="ndvi",], clnd[vars=="nao"], yy, norm="powall", sigmethod="fast")
  cohXpdo<-coh(clnd[vars=="ndvi",], clnd[vars=="pdo"], yy, norm="powall", sigmethod="fast")
  cohXppt<-coh(clnd[vars=="ndvi",], clnd[vars=="ppt"], yy, norm="powall", sigmethod="fast")
  cohXtavg<-coh(clnd[vars=="ndvi",], clnd[vars=="tavg"], yy, norm="powall", sigmethod="fast")

  cohXmei<-bandtest.coh(cohXmei,ts)
  cohXnao<-bandtest.coh(cohXnao,ts)
  cohXpdo<-bandtest.coh(cohXpdo,ts)
  cohXppt<-bandtest.coh(cohXppt,ts)
  cohXtavg<-bandtest.coh(cohXtavg,ts)

  landXclim.st$mei.coh[ii]<-cohXmei$bandp$mn_coh
  landXclim.st$mei.p[ii]<-cohXmei$bandp$p_val
  landXclim.st$mei.phi[ii]<-cohXmei$bandp$mn_phs
  landXclim.st$nao.coh[ii]<-cohXnao$bandp$mn_coh
  landXclim.st$nao.p[ii]<-cohXnao$bandp$p_val
  landXclim.st$nao.phi[ii]<-cohXnao$bandp$mn_phs
  landXclim.st$pdo.coh[ii]<-cohXpdo$bandp$mn_coh
  landXclim.st$pdo.p[ii]<-cohXpdo$bandp$p_val
  landXclim.st$pdo.phi[ii]<-cohXpdo$bandp$mn_phs
  landXclim.st$ppt.coh[ii]<-cohXppt$bandp$mn_coh
  landXclim.st$ppt.p[ii]<-cohXppt$bandp$p_val
  landXclim.st$ppt.phi[ii]<-cohXppt$bandp$mn_phs
  landXclim.st$tavg.coh[ii]<-cohXtavg$bandp$mn_coh
  landXclim.st$tavg.p[ii]<-cohXtavg$bandp$p_val
  landXclim.st$tavg.phi[ii]<-cohXtavg$bandp$mn_phs
}

#lakes, long timescales
NN=length(coherentlakes.lt$lakedata)
ts=c(4,Inf)
for(ii in 1:NN){
  vars<-rownames(coherentlakes.lt$lakedata[[ii]])
  yy<-as.numeric(colnames(coherentlakes.lt$lakedata[[ii]]))
  clnd<-cleandat(coherentlakes.lt$lakedata[[ii]],yy,clev=5)$cdat

  cohXmei<-coh(clnd[vars=="chla",], clnd[vars=="mei"], yy, norm="powall", sigmethod="fast")
  cohXnao<-coh(clnd[vars=="chla",], clnd[vars=="nao"], yy, norm="powall", sigmethod="fast")
  cohXpdo<-coh(clnd[vars=="chla",], clnd[vars=="pdo"], yy, norm="powall", sigmethod="fast")
  cohXppt<-coh(clnd[vars=="chla",], clnd[vars=="ppt"], yy, norm="powall", sigmethod="fast")
  cohXtavg<-coh(clnd[vars=="chla",], clnd[vars=="tavg"], yy, norm="powall", sigmethod="fast")

  cohXmei<-bandtest.coh(cohXmei,ts)
  cohXnao<-bandtest.coh(cohXnao,ts)
  cohXpdo<-bandtest.coh(cohXpdo,ts)
  cohXppt<-bandtest.coh(cohXppt,ts)
  cohXtavg<-bandtest.coh(cohXtavg,ts)

  lakeXclim.lt$mei.coh[ii]<-cohXmei$bandp$mn_coh
  lakeXclim.lt$mei.p[ii]<-cohXmei$bandp$p_val
  lakeXclim.lt$mei.phi[ii]<-cohXmei$bandp$mn_phs
  lakeXclim.lt$nao.coh[ii]<-cohXnao$bandp$mn_coh
```

```r
  lakeXclim.lt$nao.p[ii]<-cohXnao$bandp$p_val
  lakeXclim.lt$nao.phi[ii]<-cohXnao$bandp$mn_phs
  lakeXclim.lt$pdo.coh[ii]<-cohXpdo$bandp$mn_coh
  lakeXclim.lt$pdo.p[ii]<-cohXpdo$bandp$p_val
  lakeXclim.lt$pdo.phi[ii]<-cohXpdo$bandp$mn_phs
  lakeXclim.lt$ppt.coh[ii]<-cohXppt$bandp$mn_coh
  lakeXclim.lt$ppt.p[ii]<-cohXppt$bandp$p_val
  lakeXclim.lt$ppt.phi[ii]<-cohXppt$bandp$mn_phs
  lakeXclim.lt$tavg.coh[ii]<-cohXtavg$bandp$mn_coh
  lakeXclim.lt$tavg.p[ii]<-cohXtavg$bandp$p_val
  lakeXclim.lt$tavg.phi[ii]<-cohXtavg$bandp$mn_phs
}

#land, long timescales
NN=length(coherentlakes.lt$lakedata)
ts=c(4,Inf)
for(ii in 1:NN){
  vars<-rownames(coherentlakes.lt$lakedata[[ii]])
  yy<-as.numeric(colnames(coherentlakes.lt$lakedata[[ii]]))
  clnd<-cleandat(coherentlakes.lt$lakedata[[ii]],yy,clev=5)$cdat

  cohXmei<-coh(clnd[vars=="ndvi",], clnd[vars=="mei"], yy, norm="powall", sigmethod="fast")
  cohXnao<-coh(clnd[vars=="ndvi",], clnd[vars=="nao"], yy, norm="powall", sigmethod="fast")
  cohXpdo<-coh(clnd[vars=="ndvi",], clnd[vars=="pdo"], yy, norm="powall", sigmethod="fast")
  cohXppt<-coh(clnd[vars=="ndvi",], clnd[vars=="ppt"], yy, norm="powall", sigmethod="fast")
  cohXtavg<-coh(clnd[vars=="ndvi",], clnd[vars=="tavg"], yy, norm="powall", sigmethod="fast")

  cohXmei<-bandtest.coh(cohXmei,ts)
  cohXnao<-bandtest.coh(cohXnao,ts)
  cohXpdo<-bandtest.coh(cohXpdo,ts)
  cohXppt<-bandtest.coh(cohXppt,ts)
  cohXtavg<-bandtest.coh(cohXtavg,ts)

  landXclim.lt$mei.coh[ii]<-cohXmei$bandp$mn_coh
  landXclim.lt$mei.p[ii]<-cohXmei$bandp$p_val
  landXclim.lt$mei.phi[ii]<-cohXmei$bandp$mn_phs
  landXclim.lt$nao.coh[ii]<-cohXnao$bandp$mn_coh
  landXclim.lt$nao.p[ii]<-cohXnao$bandp$p_val
  landXclim.lt$nao.phi[ii]<-cohXnao$bandp$mn_phs
  landXclim.lt$pdo.coh[ii]<-cohXpdo$bandp$mn_coh
  landXclim.lt$pdo.p[ii]<-cohXpdo$bandp$p_val
  landXclim.lt$pdo.phi[ii]<-cohXpdo$bandp$mn_phs
  landXclim.lt$ppt.coh[ii]<-cohXppt$bandp$mn_coh
  landXclim.lt$ppt.p[ii]<-cohXppt$bandp$p_val
  landXclim.lt$ppt.phi[ii]<-cohXppt$bandp$mn_phs
  landXclim.lt$tavg.coh[ii]<-cohXtavg$bandp$mn_coh
  landXclim.lt$tavg.p[ii]<-cohXtavg$bandp$p_val
  landXclim.lt$tavg.phi[ii]<-cohXtavg$bandp$mn_phs
}

# test correlation between coherence of lakes and coherence of land
cor.test(lakeXclim.st$mei.coh,landXclim.st$mei.coh)
```

```
##
```

```
##  Pearson's product-moment correlation
##
## data:  lakeXclim.st$mei.coh and landXclim.st$mei.coh
## t = 1.3414, df = 7, p-value = 0.2217
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.3028733  0.8585029
## sample estimates:
##       cor
## 0.4522076
```

```
cor.test(lakeXclim.st$nao.coh,landXclim.st$nao.coh)
```

```
##
##  Pearson's product-moment correlation
##
## data:  lakeXclim.st$nao.coh and landXclim.st$nao.coh
## t = 0.68977, df = 7, p-value = 0.5125
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.4947335  0.7848954
## sample estimates:
##       cor
## 0.2522773
```

```
cor.test(lakeXclim.st$pdo.coh,landXclim.st$pdo.coh)
```

```
##
##  Pearson's product-moment correlation
##
## data:  lakeXclim.st$pdo.coh and landXclim.st$pdo.coh
## t = -0.57848, df = 7, p-value = 0.5811
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.7686794  0.5249961
## sample estimates:
##        cor
## -0.2135995
```

```
cor.test(lakeXclim.st$ppt.coh,landXclim.st$ppt.coh)
```

```
##
##  Pearson's product-moment correlation
##
## data:  lakeXclim.st$ppt.coh and landXclim.st$ppt.coh
## t = 1.3166, df = 7, p-value = 0.2294
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.3104692  0.8562821
## sample estimates:
##       cor
## 0.4455124
```

```
cor.test(lakeXclim.st$tavg.coh,landXclim.st$tavg.coh)
```

```
##
##  Pearson's product-moment correlation
```

```
##
## data:  lakeXclim.st$tavg.coh and landXclim.st$tavg.coh
## t = 0.25192, df = 7, p-value = 0.8083
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.6075812  0.7139652
## sample estimates:
##        cor
## 0.09478832
```

```
# no significant correlations at short timescales

cor.test(lakeXclim.lt$mei.coh,landXclim.lt$mei.coh)
```

```
##
##  Pearson's product-moment correlation
##
## data:  lakeXclim.lt$mei.coh and landXclim.lt$mei.coh
## t = 3.5536, df = 13, p-value = 0.003532
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.2962014 0.8930793
## sample estimates:
##       cor
## 0.7019546
```

```
cor.test(lakeXclim.lt$nao.coh,landXclim.lt$nao.coh)
```

```
##
##  Pearson's product-moment correlation
##
## data:  lakeXclim.lt$nao.coh and landXclim.lt$nao.coh
## t = 1.2218, df = 13, p-value = 0.2435
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.2289608  0.7155634
## sample estimates:
##       cor
## 0.3209451
```

```
cor.test(lakeXclim.lt$pdo.coh,landXclim.lt$pdo.coh)
```

```
##
##  Pearson's product-moment correlation
##
## data:  lakeXclim.lt$pdo.coh and landXclim.lt$pdo.coh
## t = 2.496, df = 13, p-value = 0.02679
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.08035359 0.83731218
## sample estimates:
##       cor
## 0.5691874
```

```
cor.test(lakeXclim.lt$ppt.coh,landXclim.lt$ppt.coh)
```

```
##
```

```
##  Pearson's product-moment correlation
##
## data:  lakeXclim.lt$ppt.coh and landXclim.lt$ppt.coh
## t = 2.5375, df = 13, p-value = 0.02477
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.08972716 0.84011223
## sample estimates:
##       cor
## 0.5755361
```

```r
cor.test(lakeXclim.lt$tavg.coh,landXclim.lt$tavg.coh)
```

```
##
##  Pearson's product-moment correlation
##
## data:  lakeXclim.lt$tavg.coh and landXclim.lt$tavg.coh
## t = 2.6555, df = 13, p-value = 0.0198
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.1160012 0.8477532
## sample estimates:
##       cor
## 0.5930247
```

```r
# mostly significant correlations at long timescales
```

Coherence with climate variables was essentially uncorrelated between lakes and the landscape at short timescales, albeit with a small (n=9) number of lakes. However, at long timescales coherence with climate variables tended to be significantly and positively correlated between lakes and the landscape.

Second, find out how much variability in lakes is explained by coherence with the landscape

```r
## Short timescales

#2851 - Walloon Lake
yy<-as.numeric(colnames(coherentlakes.st$lakedata$`2851`))
dat<-list(cleandat(coherentlakes.st$lakedata$`2851`[1,],yy,clev=5)$cdat,
          cleandat(coherentlakes.st$lakedata$`2851`[2,],yy,clev=5)$cdat)
wlm.lakeland.2851<-wlm(dat,yy,1,2,norm="powall")
syncexpl(wlm.lakeland.2851)
```

```
##    timescales sync   syncexpl    crossterms       resids      pred1
## 1    2.000000    1 0.28094517  0.000000e+00 7.190548e-01 0.28094517
## 2    2.100000    1 0.29252904 -1.110223e-16 7.074710e-01 0.29252904
## 3    2.205000    1 0.33409520  0.000000e+00 6.659048e-01 0.33409520
## 4    2.315250    1 0.36313549  1.110223e-16 6.368645e-01 0.36313549
## 5    2.431013    1 0.34047259 -1.110223e-16 6.595274e-01 0.34047259
## 6    2.552563    1 0.26852449 -1.110223e-16 7.314755e-01 0.26852449
## 7    2.680191    1 0.17826774  1.110223e-16 8.217323e-01 0.17826774
## 8    2.814201    1 0.21474800 -1.110223e-16 7.852520e-01 0.21474800
## 9    2.954911    1 0.43319824  1.110223e-16 5.668018e-01 0.43319824
## 10   3.102656    1 0.62835519  0.000000e+00 3.716448e-01 0.62835519
## 11   3.257789    1 0.72060507 -1.110223e-16 2.793949e-01 0.72060507
## 12   3.420679    1 0.61616738 -5.551115e-17 3.838326e-01 0.61616738
## 13   3.591713    1 0.53963731 -1.665335e-16 4.603627e-01 0.53963731
## 14   3.771298    1 0.49036041  3.330669e-16 5.096396e-01 0.49036041
```

```
## 15   3.959863    1 0.56522470  1.110223e-16 4.347753e-01 0.56522470
## 16   4.157856    1 0.65964015 -1.665335e-16 3.403599e-01 0.65964015
## 17   4.365749    1 0.70502782  5.551115e-17 2.949722e-01 0.70502782
## 18   4.584037    1 0.50726791 -1.665335e-16 4.927321e-01 0.50726791
## 19   4.813238    1 0.18046422  0.000000e+00 8.195358e-01 0.18046422
## 20   5.053900    1 0.03067756 -1.110223e-16 9.693224e-01 0.03067756
## 21   5.306595    1 0.57135321 -1.110223e-16 4.286468e-01 0.57135321
## 22   5.571925    1 0.81397070 -3.053113e-16 1.860293e-01 0.81397070
## 23   5.850521    1 0.86684596  5.551115e-17 1.331540e-01 0.86684596
## 24   6.143048    1 0.93629436 -6.938894e-17 6.370564e-02 0.93629436
## 25   6.450200    1 0.94606764 -5.828671e-16 5.393236e-02 0.94606764
## 26   6.772710    1 0.96570688 -4.093947e-16 3.429312e-02 0.96570688
## 27   7.111345    1 0.99469333  1.231654e-16 5.306668e-03 0.99469333
## 28   7.466913    1 0.99791162  2.242130e-16 2.088385e-03 0.99791162
## 29   7.840258    1 1.00000000 -4.440892e-16 3.081488e-33 1.00000000
## 30   8.232271    1 1.00000000 -5.007418e-32 5.007418e-32 1.00000000
```

Third, find out how much variability in lakes is explained by coherence with variables the landscape is coherent with