

Region-Of-Influence approach: some FEH examples

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```
> data(FEH1000)
```

To have some information on these data:

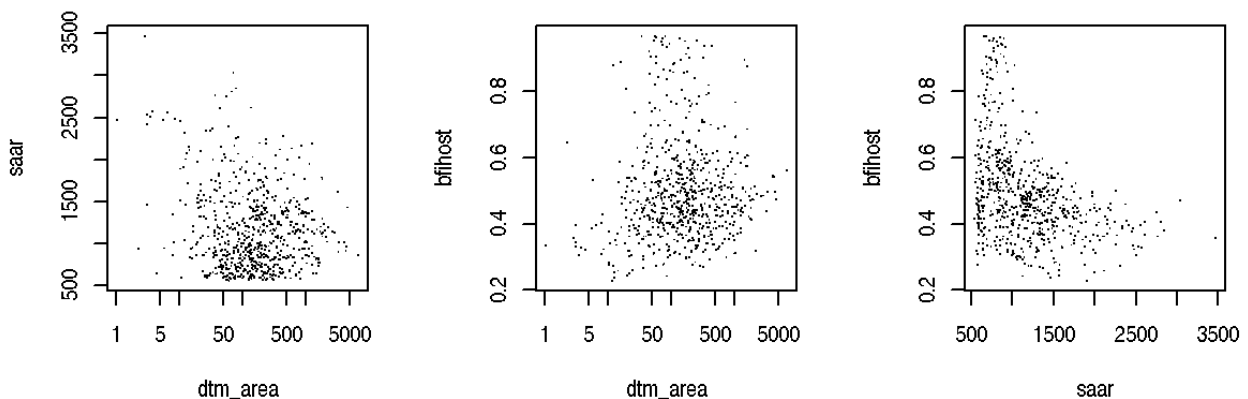
```
> ls()
> help(FEH1000)
```

Criteria used in the FEH to choose stations for pooling groups: $n > 7$; area, saar and bfihost are known; $urbext < 0.025$; $area > 0.5$;

```
> n <- tapply(am[,4],am[,1],length)
> urbext <- cd[, "urbext1990"]
> area <- cd[, "dtm_area"]
> cd696 <- cd[(!is.nan(cd[, "dtm_area"])) & (!is.nan(cd[, "saar"])) &
+           (!is.nan(cd[, "bfihost"])) & (n > 7) & (urbext < 0.025) & (area > 0.5), ]
> fac <- factor(am[, "number"], levels = cd696[, "number"])
> am696 <- am[!is.na(fac), ]
> #nlevels(as.factor(am696[, "number"]))
```

Figure 16.2 pag.157, FEH Vol.3:

```
> layout(matrix(c(1,2,3), 1, 3))
> plot(cd696[c("dtm_area", "saar")], pch=".", cex=2, log="x")
> plot(cd696[c("dtm_area", "bfihost")], pch=".", cex=2, log="x")
> plot(cd696[c("saar", "bfihost")], pch=".", cex=2)
```

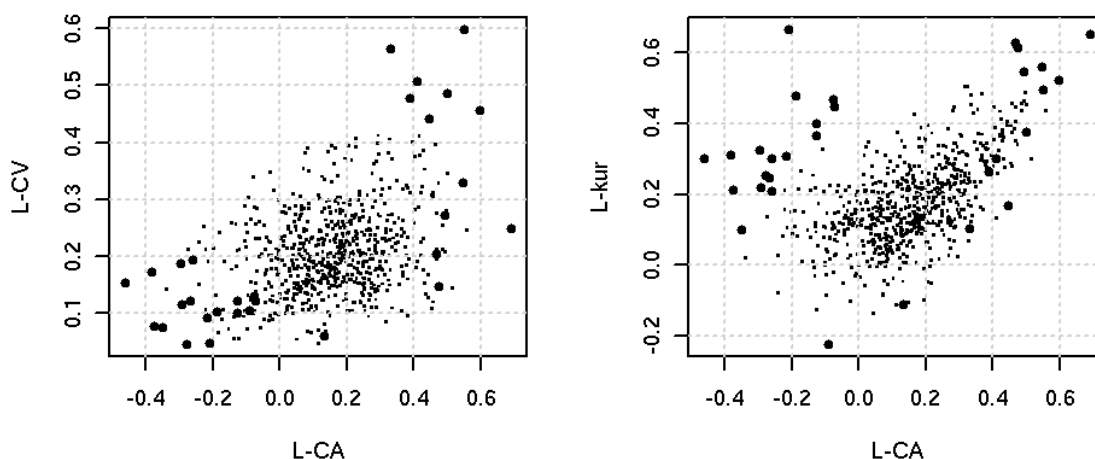


Discordancy measure:

```
> Lmomenti696 <- t(sapply(split(am696[,4],am696[,1]),Lmoments))
> Di <- discordancy(am696[, "am"], am696[, "number"])
```

Sites with discordancy greater than 3:

```
> par(mfrow=c(1,2))
> plot(Lmomenti696[,c("lca","lcv")],xlab="L-CA",ylab="L-CV",pch=".",cex=2); grid()
> points(Lmomenti696[(Di>3),c("lca","lcv")],pch=19,cex=.7)
> plot(Lmomenti696[,c("lca","lkur")],xlab="L-CA",ylab="L-kur",pch=".",cex=2); grid()
> points(Lmomenti696[(Di>3),c("lca","lkur")],pch=19,cex=.7)
> par(mfrow=c(1,1))
```



Region of influence approach (Table 16.2, pag.164, FEH Vol.3) using lnAREA, lnSAAR and BFI-HOST to measure distances among sites:

```
> sd(log(cd696[, "dtm_area"])) # 1.345515 (vs 1.34)
[1] 1.345515

> sd(log(cd696[, "saar"])) # 0.38534 (vs 0.38)
[1] 0.38534

> sd(cd696[, "bfihost"]) # 0.1485239 (vs 0.15)
[1] 0.1485239

> AREAterm <- log(cd696[, "dtm_area"])/(sd(log(cd696[, "dtm_area"]))*sqrt(2))
> SAARterm <- log(cd696[, "saar"])/sd(log(cd696[, "saar"]))
> BFIHOSTterm <- cd696[, "bfihost"]/sd(cd696[, "bfihost"])
> distFEH <- dist(cbind(AREAterm, SAARterm, BFIHOSTterm))
> roi.cd <- data.frame(cbind(AREAterm, SAARterm, BFIHOSTterm))
> row.names(roi.cd) <- cd696[, "number"]

> roi01.50year <- new.env()
> for(i in 1:696) {
+   print(paste(i, "/ 696"))
+   assign(as.character(row.names(roi.cd)[i]), roi.st.year(roi.cd[i,], as.data.frame(roi.cd),
```

```

+       row.names(roi.cd),am696[, "am"],am696[, "number"],test="HW",station.year=250,Nsim=100),
+       env=roi01.50year)
+ }
> roi01.50year <- as.list(roi01.50year)

> estrai.region <- function (x) {x$region}
> estrai.test <- function (x) {x$test}

> regioni.50year <- sapply(roi01.50year, estrai.region)
> test.50year <- sapply(roi01.50year, estrai.test)
> mL.50year <- mean(sapply(regioni.50year,length)) # 11.2
> mH2.50year <- mean(test.50year["H2",]) # 1.53
> gH2gr2.50year <- sum(test.50year["H2",]>2)/696 # 0.34
> gH2gr4.50year <- sum(test.50year["H2",]>4)/696 # 0.07

> roi01.100year <- new.env()
> for(i in 1:696) {
+   print(paste(i,"/ 696"))
+   assign(as.character(row.names(roi.cd)[i]), roi.st.year(roi.cd[i,],as.data.frame(roi.cd),
+       row.names(roi.cd),am696[, "am"],am696[, "number"],test="HW",station.year=500,Nsim=100),
+       env=roi01.100year)
+ }
> roi01.100year <- as.list(roi01.100year)

> regioni.100year <- sapply(roi01.100year, estrai.region)
> test.100year <- sapply(roi01.100year, estrai.test)
> mL.100year <- mean(sapply(regioni.100year,length)) # 21.8
> mH2.100year <- mean(test.100year["H2",]) # 2.19
> gH2gr2.100year <- sum(test.100year["H2",]>2)/696 # 0.52
> gH2gr4.100year <- sum(test.100year["H2",]>4)/696 # 0.15

> table16.2 <- data.frame(signif(rbind(c(mL.50year,mH2.50year,
+                                       gH2gr2.50year*100,gH2gr4.50year*100),
+                                       c(mL.100year,mH2.100year,gH2gr2.100year*100,gH2gr4.100year*100)),3),
+   row.names=c("50-year","100-year"))
> names(table16.2) <- c("Avg. n sites","m(H2)","% H2>2","% H2>4")
> print(table16.2)

```

	Avg. n sites	m(H2)	% H2>2	% H2>4
50-year	11.2	1.53	34	7
100-year	21.8	2.19	52	15

Example 16.3 pag.164, FEH Vol.3:

```

> prova54088 <- roi.st.year(roi.cd["54088",],roi.cd,row.names(roi.cd),am696[, "am"],
+   am696[, "number"],test="HW",station.year=250,Nsim=500)
> prova28018 <- roi.st.year(roi.cd["28018",],roi.cd,row.names(roi.cd),am696[, "am"],
+   am696[, "number"],test="HW",station.year=250,Nsim=500)

> Lmomenti696 <- as.data.frame(Lmomenti696)
> par(mfrow=c(1,2))
> plot(Lmomenti696[c("lca","lcv")], xlab="L-CA", ylab="L-CV",

```

```

+       pch=".", cex=2, main="54088"); grid()
> points(Lmomenti696[c("54088"), c("lca","lcv")],
+       pch=19, col="red", cex=1)
> points(Lmomenti696[prova54088$region[-1], c("lca","lcv")],
+       pch=19, cex=1)
> plot(Lmomenti696[,c("lca","lkur")], xlab="L-CA", ylab="L-kur",
+       pch=".", cex=2, main="28018"); grid()
> points(Lmomenti696[c("28018"), c("lca","lcv")],
+       pch=19, col="red", cex=1)
> points(Lmomenti696[prova28018$region[-1], c("lca","lcv")],
+       pch=19, cex=1)
> par(mfrow=c(1,1))

```

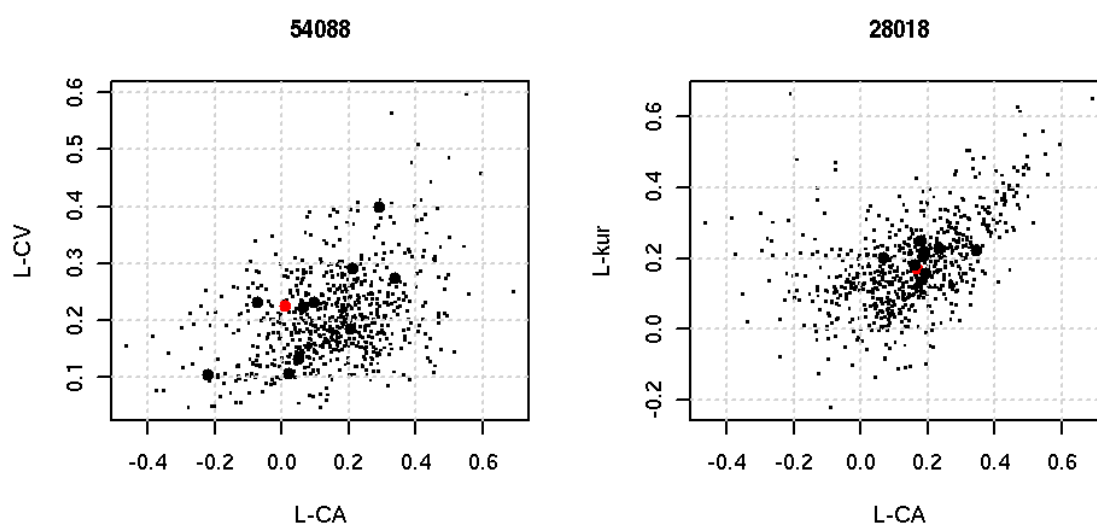


Figure 16.9 pag.174 (1st part), FEH Vol.3:

```

> figure16.9a <- function (x,r,cd) {
+   # x = station of interest (e.g. "28018")
+   # r = output of roi.st.year()
+
+   if(!r$region[1]==x) r$region <- c(x,r$region)
+   row.names(cd) <- cd[, "number"]
+   n <- length(cd[, "number"])
+   cd.r <- cd[r$region,]
+   par(mfrow=c(2,3))
+   hist(log(cd[, "dtm_area"]), col="lightgray", border="lightgray",
+        main="", xlab="AREA", axes=FALSE)
+   axis(1, at=c(log(1), log(10), log(100), log(1000), log(10000)),
+        label=c("1", "10", "100", "1000", "10000"))
+   axis(2, at=seq(0, 1, by=.05)*n, label=seq(0, 1, by=.05))
+   box()
+   points(cbind(log(cd.r[-1, "dtm_area"]), 0), pch=19, cex=.7)
+   points(cbind(log(cd.r[1, "dtm_area"]), 0), pch=4, cex=2, lwd=2)
+
+   hist(cd[, "saar"], col="lightgray", border="lightgray",

```

```

+       main="",xlab="SAAR",axes=FALSE)
+   axis(1)
+   axis(2,at=seq(0,1,by=.05)*n,label=seq(0,1,by=.05))
+   box()
+   points(cbind(cd.r[-1,"saar"],0),pch=19,cex=.7)
+   points(cbind(cd.r[1,"saar"],0),pch=4,cex=2,lwd=2)
+
+   hist(cd[, "bfihost"],col="lightgray",border="lightgray",
+        main="",xlab="BFIHOST",axes=FALSE)
+   axis(1)
+   axis(2,at=seq(0,1,by=.05)*n,label=seq(0,1,by=.05))
+   box()
+   points(cbind(cd.r[-1,"bfihost"],0),pch=19,cex=.7)
+   points(cbind(cd.r[1,"bfihost"],0),pch=4,cex=2,lwd=2)
+
+   hist(cd[, "farl"],col="lightgray",border="lightgray",
+        main="",xlab="FARL",axes=FALSE)
+   axis(1)
+   axis(2,at=seq(0,1,by=.05)*n,label=seq(0,1,by=.05))
+   box()
+   points(cbind(cd.r[-1,"farl"],0),pch=19,cex=.7)
+   points(cbind(cd.r[1,"farl"],0),pch=4,cex=2,lwd=2)
+
+   hist(cd[, "propwet"],col="lightgray",border="lightgray",
+        main="",xlab="PROPWET",axes=FALSE)
+   axis(1)
+   axis(2,at=seq(0,1,by=.05)*n,label=seq(0,1,by=.05))
+   box()
+   points(cbind(cd.r[-1,"propwet"],0),pch=19,cex=.7)
+   points(cbind(cd.r[1,"propwet"],0),pch=4,cex=2,lwd=2)
+
+   hist(cd[, "urbext1990"],col="lightgray",border="lightgray",
+        main="",xlab="URBEXT",axes=FALSE)
+   axis(1)
+   axis(2,at=seq(0,1,by=.05)*n,label=seq(0,1,by=.05))
+   box()
+   points(cbind(cd.r[-1,"urbext1990"],0),pch=19,cex=.7)
+   points(cbind(cd.r[1,"urbext1990"],0),pch=4,cex=2,lwd=2)
+   par(mfrow=c(1,1))
+   title(main=x,cex.main=1,font.main=1)
+ }

> prova40009 <- roi.st.year(roi.cd["40009",],roi.cd,row.names(roi.cd),am696[, "am"],
+                           am696[, "number"],test="HW",station.year=500,Nsim=500)

> figure16.9a("40009",prova40009,cd696)

```

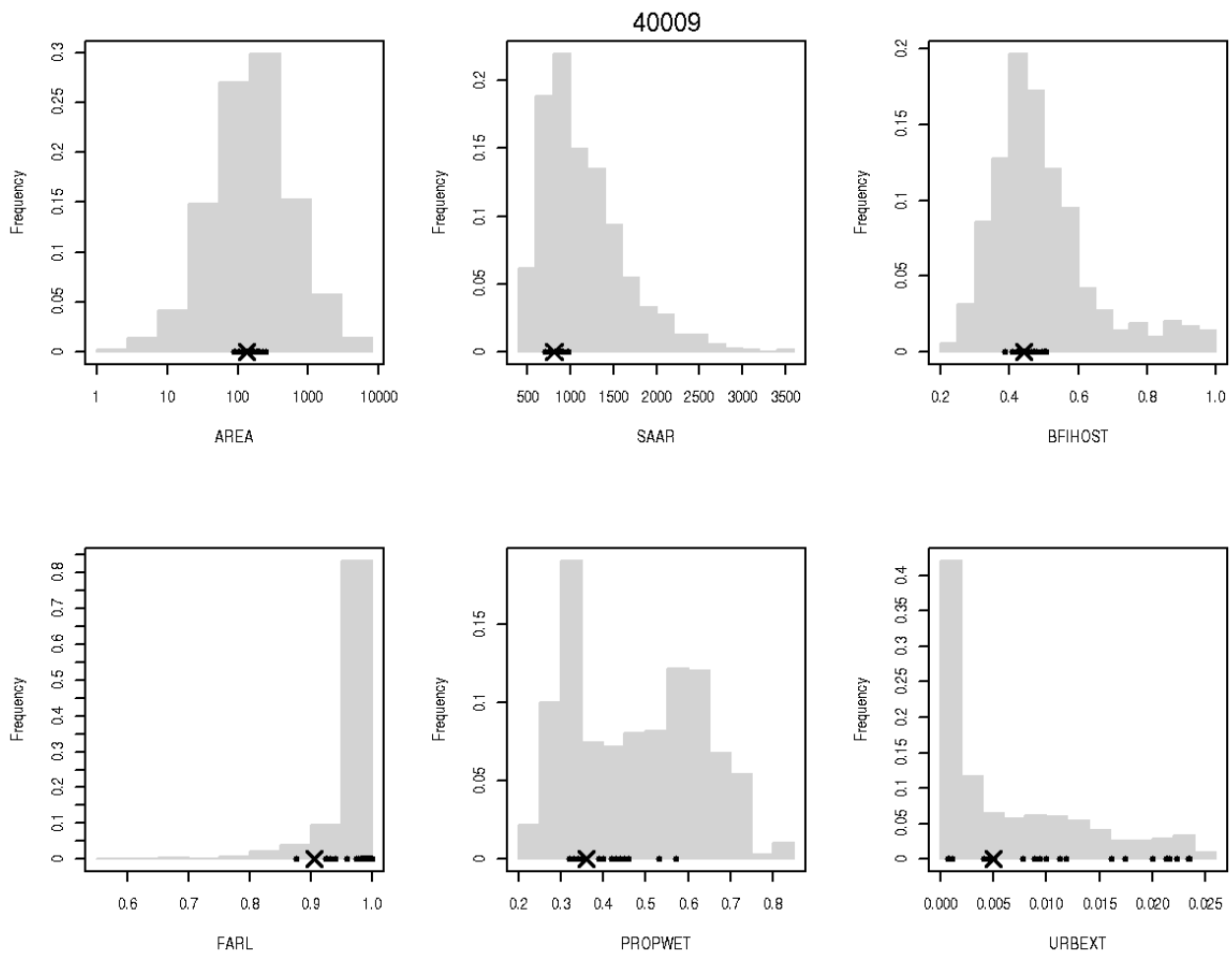


Figure 16.9 pag.174 (2nd part), FEH Vol.3:

```
> figure16.9b <- function (x,r,am,cd) {
+ # x = station of interest (e.g. "28018")
+ # r = output of roi.st.year()
+
+ row.names(cd) <- cd[, "number"]
+ n <- length(cd[, "number"])
+ cd.r <- cd[r$region,]
+ cd.x <- cd[x,]
+ fac <- factor(am[, "number"], levels=cd.r[, "number"])
+ am.r <- am[!is.na(fac),]
+ fac <- factor(am[, "number"], levels=x)
+ am.x <- am[!is.na(fac),]
+ am.xr <- rbind(am.x, am.r)
+ QMED.r <- tapply(am.r[, 4], am.r[, 1], median)
+ QMED.x <- median(am.x[, 4])
+ am.r.adim <- am.r; am.r.adim[, 4] <- am.r[, 4]/unsplit(QMED.r, am.r[, 1])
+ am.x.adim <- am.x; am.x.adim[, 4] <- am.x[, 4]/QMED.x
+ lcv <- tapply(am[, 4], am[, 1], LCV)
+ lca <- tapply(am[, 4], am[, 1], LCA)
```

```

+ lkur <- tapply(am[,4],am[,1],Lkur)
+ lcv.r <- tapply(am.r[,4],am.r[,1],LCV)
+ lca.r <- tapply(am.r[,4],am.r[,1],LCA)
+ lkur.r <- tapply(am.r[,4],am.r[,1],Lkur)
+ lcv.x <- LCV(am.x[,4])
+ lca.x <- LCA(am.x[,4])
+ lkur.x <- Lkur(am.x[,4])
+ days <- as.numeric(format(as.Date(am[,2]),"%j"))
+ days.r <- as.numeric(format(as.Date(am.r[,2]),"%j"))
+ days.x <- as.numeric(format(as.Date(am.x[,2]),"%j"))
+
+ par(mfrow=c(2,3))
+ lognormplot(am.r.adim[,4],line=FALSE,xlab="Q/QMED",type="n")
+ for(i in r$region) {
+   xxx <- am.r.adim[am.r.adim[,1]==i,4]
+   normpoints(xxx,type="l",col="gray")
+ }
+ normpoints(am.r.adim[,4],type="l",lwd=2)
+ normpoints(am.x.adim[,4],type="l",col=2,lwd=2)
+
+ plot(lca,lcv,pch=".",cex=2)
+ points(lca.r,lcv.r,pch=19)
+ points(lca.x,lcv.x,pch=4,cex=2,lwd=2)
+
+ plot(lca,lkur,pch=".",cex=2)
+ points(lca.r,lkur.r,pch=19)
+ points(lca.x,lkur.x,pch=4,cex=2,lwd=2)
+
+ plot(cd[c("ihdtm_ngr_x","ihdtm_ngr_y")],pch=".",cex=2,xlab="",ylab="",axes=FALSE)
+ points(cd.r[c("ihdtm_ngr_x","ihdtm_ngr_y")],pch=19)
+ points(cd.x[c("ihdtm_ngr_x","ihdtm_ngr_y")],pch=4,cex=2,lwd=2)
+
+ consistencyplot (am.r[,3],am.r[,1])
+
+ dummy <- seq(0,2*pi,length=100)
+ plot(cos(dummy),sin(dummy),type="l",xlab="",ylab="",axes=FALSE)
+ abline(h=0,lty=3); abline(v=0,lty=3)
+ radd <- days*pi/180
+ XFLOOD <- tapply(cos(radd),am[,1],mean)
+ YFLOOD <- tapply(sin(radd),am[,1],mean)
+ points(XFLOOD,YFLOOD,pch=".",cex=2)
+ radd <- days.r*pi/180
+ XFLOOD <- tapply(cos(radd),am.r[,1],mean)
+ YFLOOD <- tapply(sin(radd),am.r[,1],mean)
+ points(XFLOOD,YFLOOD,pch=19,cex=1)
+ radd <- days.x*pi/180
+ XFLOOD <- tapply(cos(radd),am.x[,1],mean)
+ YFLOOD <- tapply(sin(radd),am.x[,1],mean)
+ points(XFLOOD,YFLOOD,pch=4,cex=2,lwd=2)
+ axis(1,at=0,label="Oct 1")

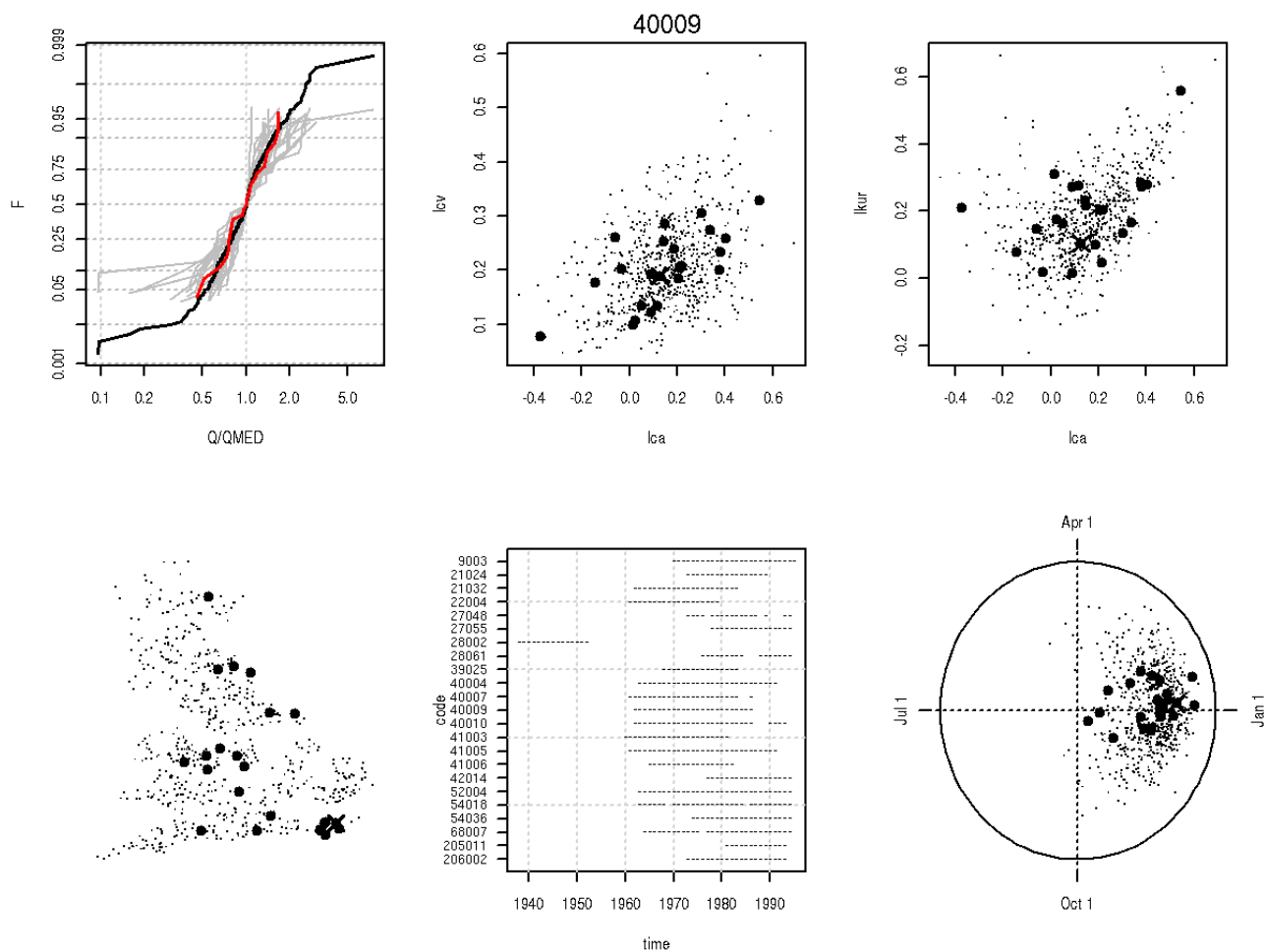
```

```

+ axis(2,at=0,label="Jul 1")
+ axis(3,at=0,label="Apr 1")
+ axis(4,at=0,label="Jan 1")
+ par(mfrow=c(1,1))
+ title(main=x,cex.main=1,font.main=1)
+ }

> figure16.9b("40009",prova40009,am696,cd696)

```



There are differences because: I plot the empirical growth curves; site 40009 in FEH book has 14 data, while I have 25; book uses POT for the polar plot, I only use annual maximum.

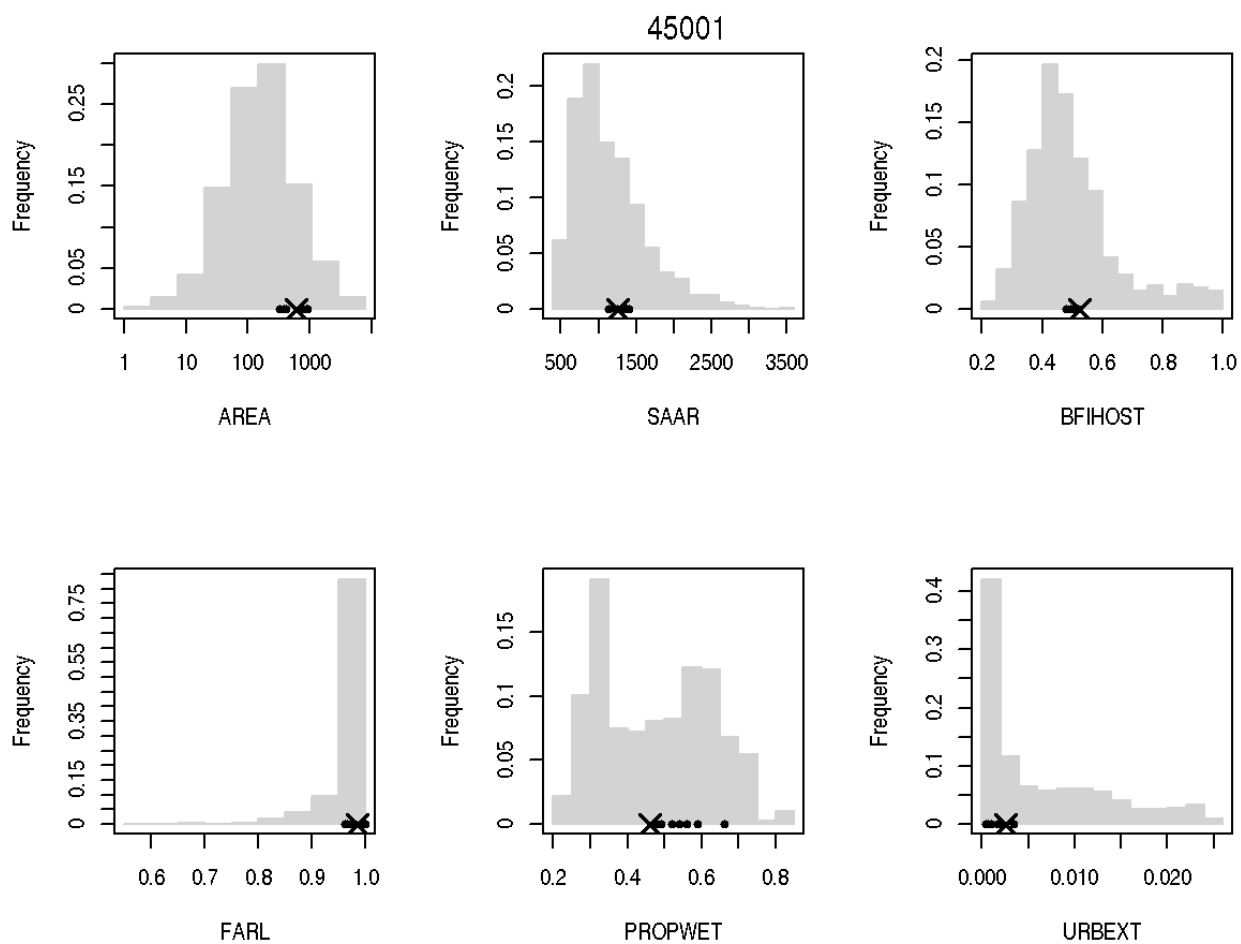
Figure 6.2 pag. 30, FEH Vol.3:

```

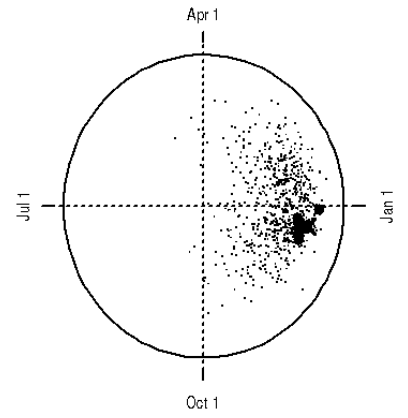
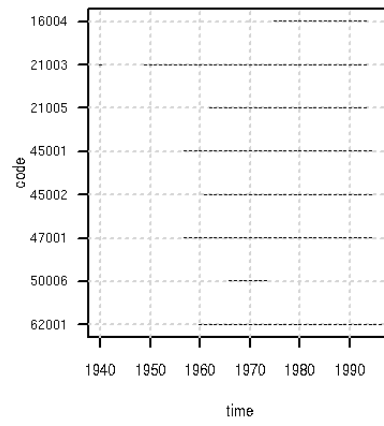
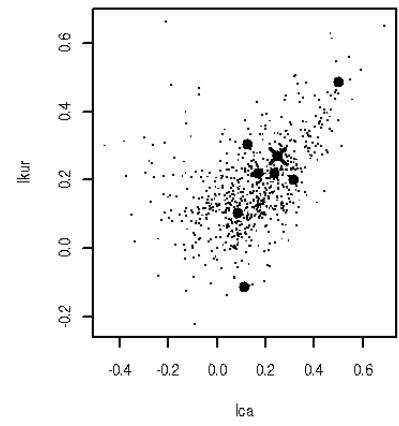
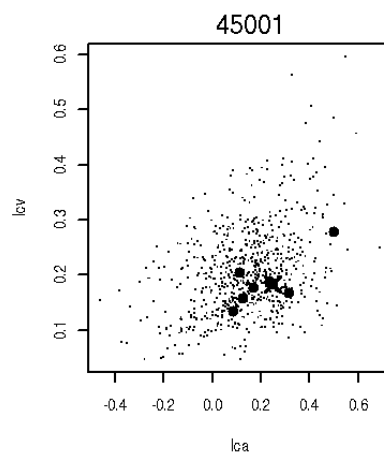
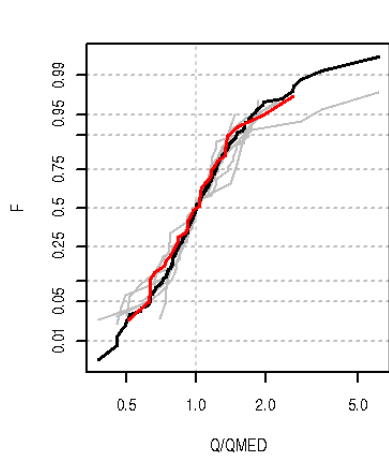
> prova45001 <- roi.st.year(roi.cd["45001",],roi.cd,row.names(roi.cd),am696[, "am"],
+                           am696[, "number"],test="HW",station.year=250,Nsim=500)

> figure16.9a("45001",prova45001,cd696)

```

```
> figure16.9b("45001",prova45001,am696,cd696)
```



References

Robson, A. and Reed, D. (1999). Statistical procedures for flood frequency estimation. In *Flood Estimation HandBook*, volume 3. Institute of Hydrology Crowmarsh Gifford, Wallingford, Oxfordshire.