Section 5.5.2 - River Water Level

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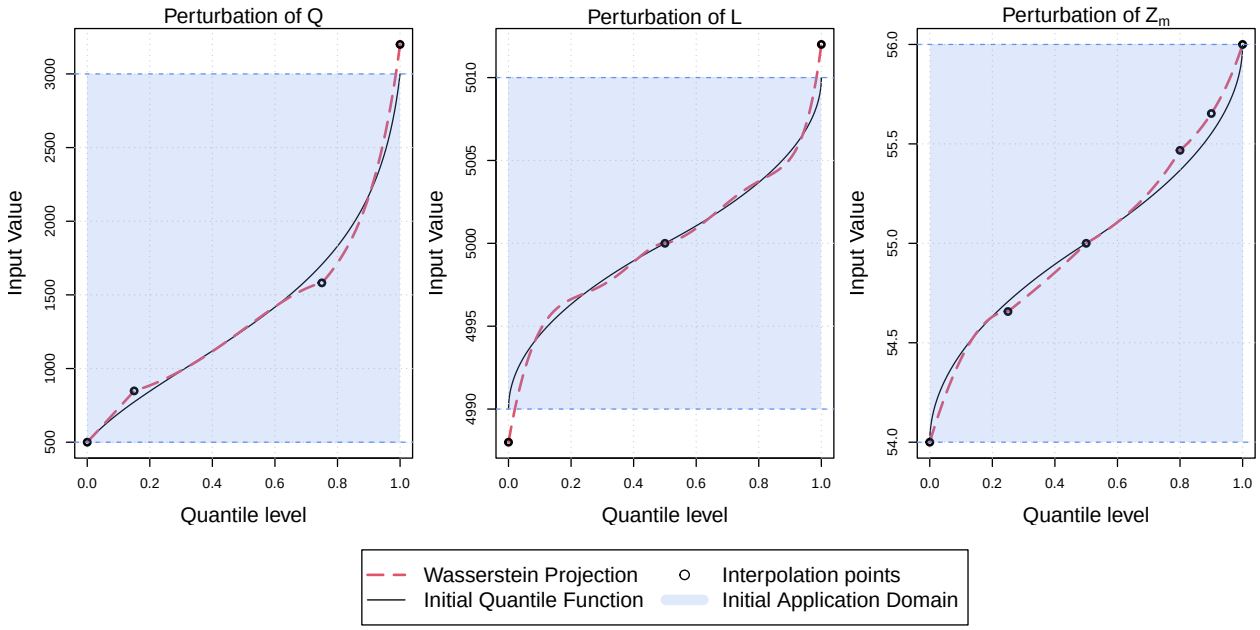
```
load(file="results/pertRes_RWL.RData")
load(file="surrogate/pertSurrogate_RWL.RData")
```

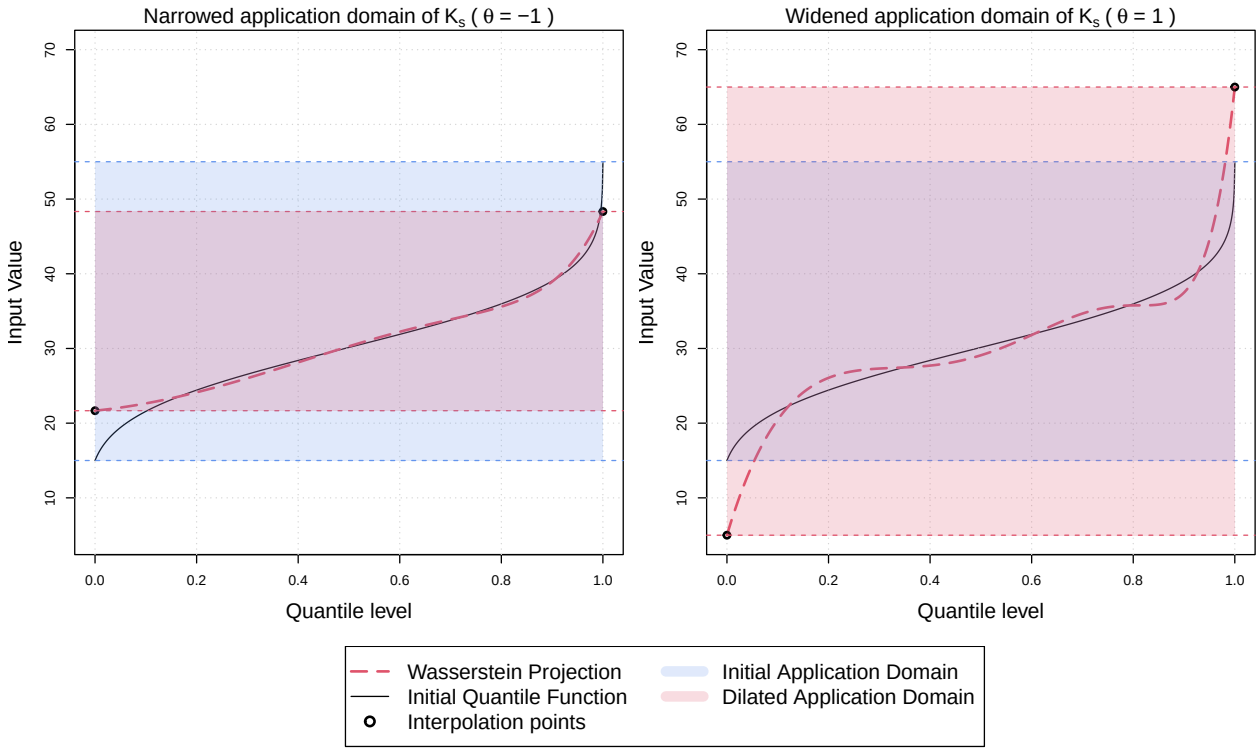
```
par(mar=c(4,4,1.5,1))

layout(matrix(c(1,1,2,2,3,3,
                1,1,2,2,3,3,
                1,1,2,2,3,3,
                4,4,4,4,4,4), nrow=4, ncol=6, byrow=T))

plot(Q.pert,
     main=expression("Perturbation of"~Q),
     cex.main=1.5,
     cex.lab=1.5)
abline(h=c(500,3000),
       lty=2,
       col="cornflowerblue")
polygon(x=c(0,1,1,0),
        y=c(500,500,3000,3000),
        col=rgb(0.3921569,0.5843137,0.9294118,0.2),
        border=F)

plot(L.pert,
     main=expression("Perturbation of"~L),
     cex.main=1.5,
     cex.lab=1.5)
abline(h=c(4990,5010),
       lty=2,
       col="cornflowerblue")
polygon(x=c(0,1,1,0),
        y=c(4990,4990,5010,5010),
        col=rgb(0.3921569,0.5843137,0.9294118,0.2),
        border=F)

plot(Zm.pert,
     main=expression("Perturbation of"~Z[m]),
     cex.main=1.5,
     cex.lab=1.5)
abline(h=c(54,56),
       lty=2,
       col="cornflowerblue")
polygon(x=c(0,1,1,0),
```

```
        y=c(54,54,56,56),
        col=rgb(0.3921569,0.5843137,0.9294118,0.2),
        border=F)

plot.new()
legend("top",
           legend=c("Wasserstein Projection", "Initial Quantile Function", "Interpolation points", "Ini
           lty=c(5,1, NA, 1),
           col=c(2,1,1,rgb(0.3921569,0.5843137,0.9294118,0.2)),
           pch=c(NA, NA, 1,NA),
           lwd=c(2,1,1, 8),
       bg="white",
       ncol=2,
       cex=1.5)
```




```
par(mar=c(4,4,1.5,1))
layout(matrix(c(1,1,1,2,2,2,
                1,1,1,2,2,2,
                1,1,1,2,2,2,
                3,3,3,3,3,3), nrow=4, ncol=6, byrow=T))

plot(res.pert.Ks[[1]], ylim=c(5,70),
     main=expression("Narrowed application domain of"~K[s]~"("~theta~ "= -1 )"),
     cex.main=1.5,
     cex.lab=1.5)

abline(h=c(15,55),
       col="cornflowerblue",
       lty=2)
abline(h=c(21+2*1/3,48+1/3),
       col=2,
       lty=2)

polygon(x=c(0,1,1,0),
```

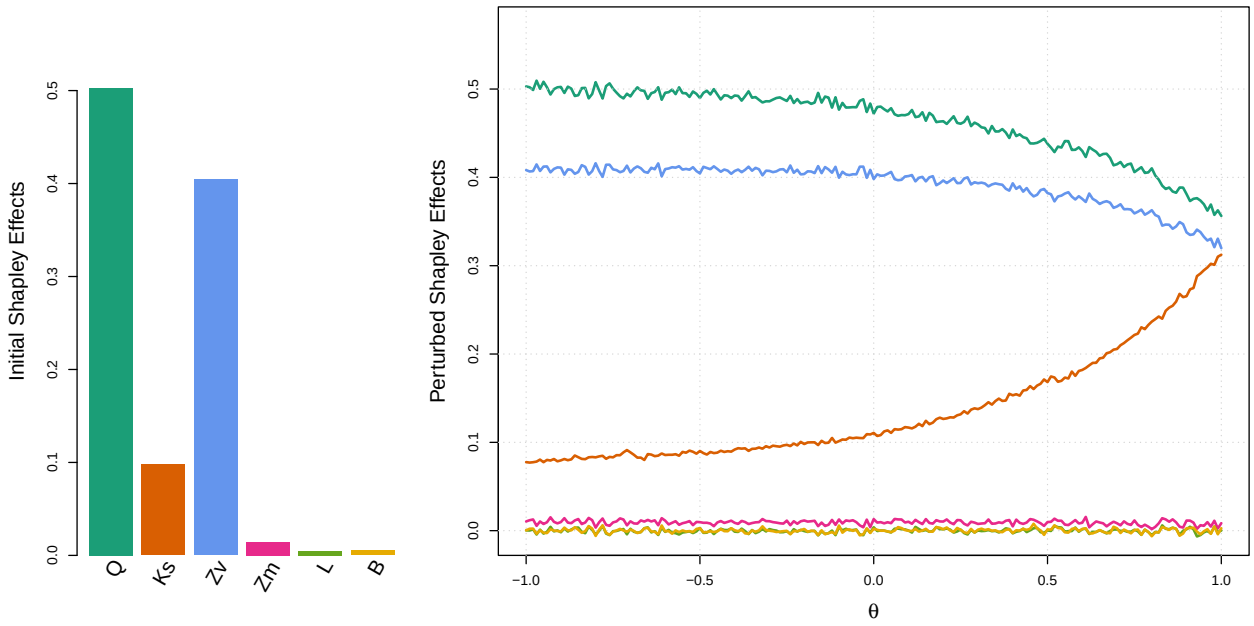
```
        y=c(15,15,55,55),
        col=rgb(0.3921569,0.5843137,0.9294118,0.2),
        border=F)
polygon(x=c(0,1,1,0),
        y=c(21+2*1/3,21+2*1/3,48+1/3,48+1/3),
        col=rgb(0.8745098,0.3254902,0.4196078,0.2),
        border=F)

plot(res.pert.Ks[[201]], ylim=c(5,70),
     main=expression("Widened application domain of"~K[s]~"("~theta~ "= 1 )"),
     cex.main=1.5,
     cex.lab=1.5)

abline(h=c(15,55),
       col="cornflowerblue",
       lty=2)
abline(h=c(5,65),
       col=2,
       lty=2)
polygon(x=c(0,1,1,0),
        y=c(15,15,55,55),
        col=rgb(0.3921569,0.5843137,0.9294118,0.2),
        border=F)
polygon(x=c(0,1,1,0),
        y=c(5,5,65,65),
        col=rgb(0.8745098,0.3254902,0.4196078,0.2),
        border=F)

plot.new()
legend("top",
           legend=c("Wasserstein Projection", "Initial Quantile Function", "Interpolation points", "Ini
           lty=c(5,1, NA, 1,1),
           col=c(2,1,1,rgb(0.3921569,0.5843137,0.9294118,0.2), rgb(0.8745098,0.3254902,0.4196078,0.2)),
           pch=c(NA, NA, 1,NA,NA),
           lwd=c(2,1,2,8,8),
       bg="white",
       ncol=2,
       cex=1.5)
```




```
#Set-up
#Baseline Shap
load(file="../../Chapter3/RWL/results/allocations_RWL.RData")
baseline.shap=colMeans(Shaps.RWL)

#Non-perturbed stats
source(file="../../useCases/riverWaterLevel/RWL_model.R")
set.seed(12345)
init.Y<-model.RWL(sim.RWL(1e6))
init.stats<-c(mean(init.Y), var(init.Y), quantile(init.Y,c(0,0.025, 0.05, 0.95,0.975,1), type=1))
```

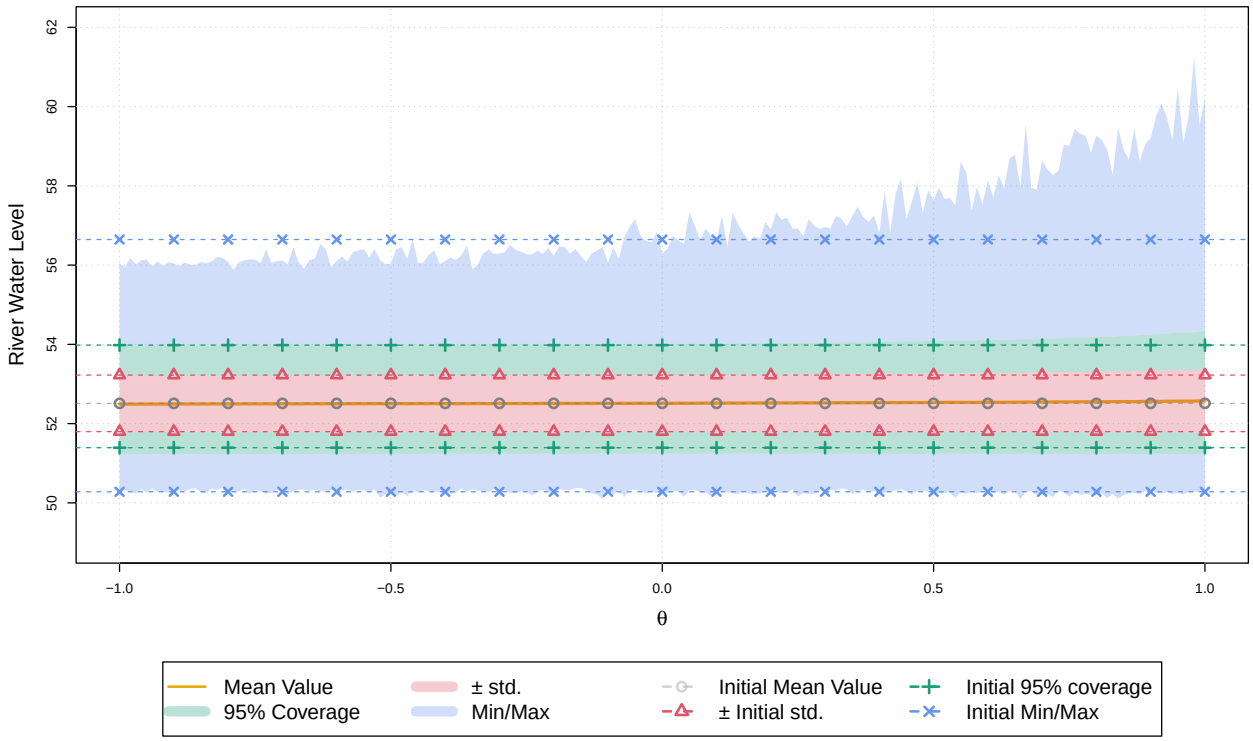
```
par(mar=c(4,4.5,1,1))

layout(matrix(c(1,1,2,2,2,2,
                1,1,2,2,2,2,
                1,1,2,2,2,2), nrow=3, ncol=6, byrow=T))

a=barplot(height=c(baseline.shap)+0.005,
        names=rownames(baseline.shap),
        col=coul,
        ylim=c(0,0.59),
        ylab="Initial Shapley Effects",
        cex.names=1.5,
        cex.lab=1.5,
        xaxt="n",
        border=F)
 text(a, par("usr")[3], labels = c("Q","Ks","Zv","Zm","L","B"), srt = 60, adj = c(1.1,1.1), xpd = TRUE,


plot(res.shap[,1], res.shap[,2], type='l', col=coul[1], ylim=c(-0.005,0.57), lwd=2,
```

```
     ylab="Perturbed Shapley Effects",
     xlab=expression(theta),
     cex.lab=1.5)
grid()
lines(res.shap[,1], res.shap[,3], col=coul[2], lwd=2)
lines(res.shap[,1], res.shap[,4], col=coul[3], lwd=2)
lines(res.shap[,1], res.shap[,5], col=coul[4], lwd=2)
lines(res.shap[,1], res.shap[,6], col=coul[5], lwd=2)
lines(res.shap[,1], res.shap[,7], col=coul[6], lwd=2)
```



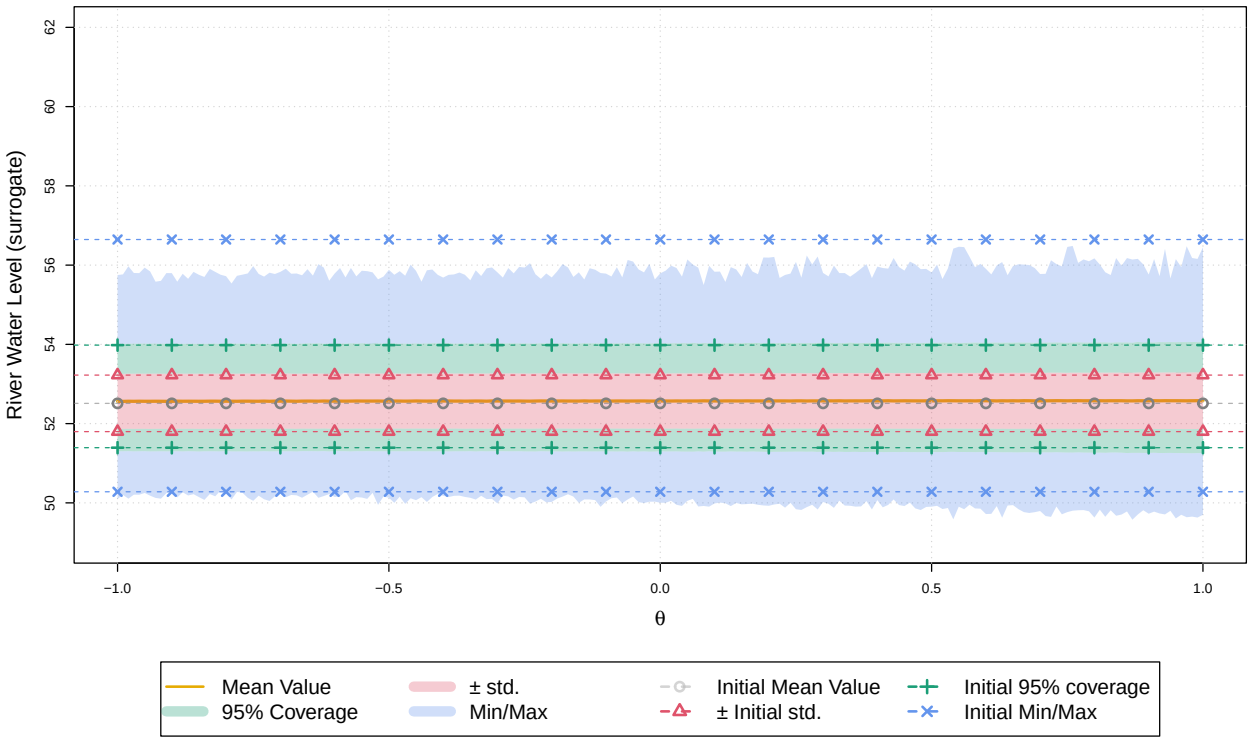

```
par(mar=c(4,4.5,2,0.1))
layout(matrix(c(1,1,1,
                1,1,1,
                1,1,1,
                2,2,2), nrow=4, ncol=3, byrow=T))
plot(res.stats[,1], res.stats[,2], type='l',
     ylim=c(49,62),
     xlab=expression(theta),
     ylab="River Water Level",
     lwd=2.5,
     col=coul[6],
     main="",
     cex.lab=1.5)
grid()

polygon(x=c(res.stats[,1], rev(res.stats[,1])),
        y=c(res.stats[,2]+sqrt(res.stats[,3]),rev(res.stats[,2]-sqrt(res.stats[,3]))),
        col=rgb(0.8745098,0.3254902,0.4196078,0.3),
        border=NA)
polygon(x=c(res.stats[,1], rev(res.stats[,1])),
        y=c(res.stats[,2]-sqrt(res.stats[,3]),rev(res.stats[,5])),
        col=rgb(0.1058824,0.6196078, 0.4666667,0.3),
        border=NA)
polygon(x=c(res.stats[,1], rev(res.stats[,1])),
```

```
        y=c(res.stats[,8], rev(res.stats[,2]+sqrt(res.stats[,3]))),
        col=rgb(0.1058824,0.6196078, 0.4666667,0.3),
        border=NA)
polygon(x=c(res.stats[,1], rev(res.stats[,1])),
        y=c(res.stats[,5], rev(res.stats[,4])),
        col=rgb(0.3921569,0.5843137,0.9294118,0.3),
        border=NA)
polygon(x=c(res.stats[,1], rev(res.stats[,1])),
        y=c(res.stats[,9], rev(res.stats[,8])),
        col=rgb(0.3921569,0.5843137,0.9294118,0.3),
        border=NA)

seq_dots=seq(-1.1,1.1,0.1)
n_dots=length(seq_dots)
abline(h=init.stats[1], col=rgb(0.5,0.5,0.5,0.6), lty=2, lwd=1)
points(seq_dots, rep(init.stats[1], n_dots), col=rgb(0.5,0.5,0.5,1), pch=1, cex=1.5, lwd=2)

abline(h=init.stats[1]+sqrt(init.stats[2]), col=2, lty=2, lwd=1)
points(seq_dots, rep(init.stats[1]+sqrt(init.stats[2]), n_dots), col=2, pch=2, cex=1.3, lwd=2)

abline(h=init.stats[1]-sqrt(init.stats[2]), col=2, lty=2, lwd=1)
points(seq_dots, rep(init.stats[1]-sqrt(init.stats[2]), n_dots), col=2, pch=2, cex=1.3, lwd=2)

abline(h=init.stats[5], col=coul[1], lty=2, lwd=1)
points(seq_dots, rep(init.stats[5], n_dots), col=coul[1], pch=3, cex=1.3, lwd=2)

abline(h=init.stats[7], col=coul[1], lty=2, lwd=1)
points(seq_dots, rep(init.stats[7], n_dots), col=coul[1], pch=3, cex=1.3, lwd=2)

abline(h=init.stats[3], col="cornflowerblue", lty=2, lwd=1)
points(seq_dots, rep(init.stats[3], n_dots), col="cornflowerblue", pch=4, cex=1.3, lwd=2)

abline(h=init.stats[8], col="cornflowerblue", lty=2, lwd=1)
points(seq_dots, rep(init.stats[8], n_dots), col="cornflowerblue", pch=4, cex=1.3, lwd=2)

plot.new()


legend("top",
       legend=c("Mean Value", "95% Coverage", "± std.", "Min/Max","Initial Mean Value", "± Initial std.
       lwd=c(2,8,8,8,2,2,2,2),
       lty=c(1,1,1,1,2,2,2,2),
       pch=c(NA,NA,NA,NA,1,2,3,4),
       col=c(coul[6],rgb(0.1058824,0.6196078, 0.4666667,0.3),rgb(0.8745098,0.3254902,0.4196078,0.3),rgb
       ncol=4,
       cex=1.5)
```




```
par(mar=c(4,4.5,2,0.1))
layout(matrix(c(1,1,1,
                1,1,1,
                1,1,1,
                2,2,2), nrow=4, ncol=3, byrow=T))
plot(res.stats.nn[,1], res.stats.nn[,2], type='l',
     ylim=c(49,62),
     xlab=expression(theta),
     ylab="River Water Level (surrogate)",
     lwd=2.5,
     col=coul[6],
     main="",
     cex.lab=1.5)
grid()

polygon(x=c(res.stats.nn[,1], rev(res.stats.nn[,1])),
        y=c(res.stats.nn[,2]+sqrt(res.stats.nn[,3]),rev(res.stats.nn[,2]-sqrt(res.stats.nn[,3]))),
        col=rgb(0.8745098,0.3254902,0.4196078,0.3),
        border=NA)
polygon(x=c(res.stats.nn[,1], rev(res.stats.nn[,1])),
        y=c(res.stats.nn[,2]-sqrt(res.stats.nn[,3]),rev(res.stats.nn[,5])),
        col=rgb(0.1058824,0.6196078, 0.4666667,0.3),
        border=NA)
polygon(x=c(res.stats.nn[,1], rev(res.stats.nn[,1])),
        y=c(res.stats.nn[,8], rev(res.stats.nn[,2]+sqrt(res.stats.nn[,3]))),
        col=rgb(0.1058824,0.6196078, 0.4666667,0.3),
        border=NA)
polygon(x=c(res.stats.nn[,1], rev(res.stats.nn[,1])),
        y=c(res.stats.nn[,5], rev(res.stats.nn[,4])),
        col=rgb(0.3921569,0.5843137,0.9294118,0.3),
```

```
        border=NA)
polygon(x=c(res.stats.nn[,1], rev(res.stats.nn[,1])),
        y=c(res.stats.nn[,9], rev(res.stats.nn[,8])),
        col=rgb(0.3921569,0.5843137,0.9294118,0.3),
        border=NA)

seq_dots=seq(-1.1,1.1,0.1)
n_dots=length(seq_dots)
abline(h=init.stats[1], col=rgb(0.5,0.5,0.5,0.6), lty=2, lwd=1)
points(seq_dots, rep(init.stats[1], n_dots), col=rgb(0.5,0.5,0.5,1), pch=1, cex=1.5, lwd=2)

abline(h=init.stats[1]+sqrt(init.stats[2]), col=2, lty=2, lwd=1)
points(seq_dots, rep(init.stats[1]+sqrt(init.stats[2]), n_dots), col=2, pch=2, cex=1.3, lwd=2)

abline(h=init.stats[1]-sqrt(init.stats[2]), col=2, lty=2, lwd=1)
points(seq_dots, rep(init.stats[1]-sqrt(init.stats[2]), n_dots), col=2, pch=2, cex=1.3, lwd=2)

abline(h=init.stats[5], col=coul[1], lty=2, lwd=1)
points(seq_dots, rep(init.stats[5], n_dots), col=coul[1], pch=3, cex=1.3, lwd=2)

abline(h=init.stats[7], col=coul[1], lty=2, lwd=1)
points(seq_dots, rep(init.stats[7], n_dots), col=coul[1], pch=3, cex=1.3, lwd=2)

abline(h=init.stats[3], col="cornflowerblue", lty=2, lwd=1)
points(seq_dots, rep(init.stats[3], n_dots), col="cornflowerblue", pch=4, cex=1.3, lwd=2)

abline(h=init.stats[8], col="cornflowerblue", lty=2, lwd=1)
points(seq_dots, rep(init.stats[8], n_dots), col="cornflowerblue", pch=4, cex=1.3, lwd=2)

plot.new()


legend("top",
       legend=c("Mean Value", "95% Coverage", "± std.", "Min/Max","Initial Mean Value", "± Initial std.
       lwd=c(2,8,8,8,2,2,2,2),
       lty=c(1,1,1,1,2,2,2,2),
       pch=c(NA,NA,NA,NA,1,2,3,4),
       col=c(coul[6],rgb(0.1058824,0.6196078, 0.4666667,0.3),rgb(0.8745098,0.3254902,0.4196078,0.3),rgb
       ncol=4,
       cex=1.5)
```


River Water Level (surrogate)
62
60
58
56
54
52
50
−1.0
−0.5
0.0
0.5
1.0
θ
Mean Value
95% Coverage
± std.
Min/Max
Initial Mean Value
± Initial std.
Initial 95% coverage
Initial Min/Max