

# Uncertainty Analysis of the Water Scarcity Footprint Based on the AWARE Model Considering Temporal Variations

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## R code for block bootstrap

R scripts for determining confidence interval of water scarcity footprint with the sample output using the block bootstrap method: example of the water scarcity footprint of paddy rice cultivation in the Geum river basin.

```
# Finding 1000 water scarcity footprint ( $z^*$ s) and confidence interval
zbarstar<-vector()
i<-1
repeat{
  q<-rep(1:45,times=1)
  block<-sample(q)
  b.data<-cbind(RCFGeumAW,block)
  b<-sort(unique(b.data$block))
  block.group<-function(b){b.data[b.data$block==b,]}
  block.list<-lapply(b,block.group)
  b.sample<-sample(b,replace=T)
  block.sample<-block.list[b.sample]
  block.size<-1
  block.bind<-function(b){matrix(unlist(b),nrow=block.size)}
  b.boot<-do.call(rbind,lapply(block.sample,block.bind))
  b.boot<-b.boot[,-c(13)]
  b.boot
  g<-matrix(CaseGeum$rice,ncol=12)
  gt<-t(g)
  zbar<-colMeans(RCFGeumAW)%*%CaseGeum$rice
  x1col<-colMeans(b.boot)
  x1bar<-matrix(x1col,ncol=12)
  zbar1<-x1bar%*%gt
  zbarstar[i]<- zbar1
  if(i==1000){
    break
  }
  i<-i+1
}
deltastar=zbarstar-zbar
sorteddeltastar=sort(deltastar)
d975=sorteddeltastar[25]
d25=sorteddeltastar[975]
CI=zbar-c(d25,d975)
```

**Table S1.** The monthly CF data in the Geum River Basin (unit:  $\text{m}^3_{\text{world-eq}}/\text{m}^3_{\text{Geum}}$ )

|      | Jan  | Feb  | Mar  | Apr  | May  | June | July | Aug  | Sep  | Oct | Nov  | Dec  |
|------|------|------|------|------|------|------|------|------|------|-----|------|------|
| 1970 | 6.7  | 1.0  | 3.0  | 0.7  | 1.5  | 16.9 | 0.6  | 0.8  | 0.3  | 0.9 | 1.6  | 2.3  |
| 1971 | 1.1  | 1.0  | 1.2  | 4.1  | 1.0  | 1.1  | 0.4  | 0.9  | 0.9  | 1.9 | 4.3  | 9.0  |
| 1972 | 1.4  | 1.4  | 0.3  | 0.5  | 0.5  | 39.9 | 1.2  | 0.5  | 1.1  | 1.7 | 0.5  | 1.0  |
| 1973 | 0.4  | 1.6  | 5.0  | 0.6  | 0.6  | 6.7  | 5.4  | 1.1  | 6.0  | 2.7 | 4.0  | 11.6 |
| 1974 | 100  | 2.2  | 0.9  | 0.3  | 0.2  | 6.5  | 0.4  | 1.8  | 1.5  | 1.5 | 5.9  | 6.8  |
| 1975 | 100  | 100  | 1.1  | 0.5  | 0.4  | 8.4  | 0.5  | 1.3  | 0.6  | 1.7 | 1.7  | 2.5  |
| 1976 | 4.3  | 0.5  | 1.9  | 1.7  | 1.6  | 4.7  | 100  | 0.6  | 2.9  | 4.7 | 10.8 | 2.6  |
| 1977 | 37   | 100  | 7.5  | 0.3  | 0.9  | 43.8 | 1.7  | 1.5  | 17.3 | 100 | 7.4  | 4.1  |
| 1978 | 3.2  | 3.5  | 1.2  | 12.3 | 100  | 0.7  | 0.5  | 0.5  | 4.2  | 2.5 | 4.0  | 5.8  |
| 1979 | 73   | 0.9  | 1.3  | 0.5  | 0.7  | 0.5  | 1.8  | 0.5  | 0.6  | 1.8 | 3.5  | 4.1  |
| 1980 | 3.0  | 19.1 | 3.8  | 0.2  | 0.3  | 0.5  | 0.4  | 0.6  | 2.0  | 1.5 | 2.7  | 2.9  |
| 1981 | 13   | 3.7  | 2.1  | 2.5  | 13.2 | 4.0  | 0.5  | 0.6  | 0.6  | 1.5 | 2.3  | 5.7  |
| 1982 | 5.8  | 34.1 | 1.8  | 1.2  | 1.6  | 100  | 100  | 0.8  | 13.8 | 7.2 | 0.8  | 0.6  |
| 1983 | 2.6  | 2.4  | 0.6  | 0.5  | 0.7  | 1.4  | 0.7  | 1.6  | 0.9  | 2.1 | 3.6  | 17.4 |
| 1984 | 100  | 100  | 100  | 0.6  | 1.0  | 4.8  | 0.5  | 2.8  | 0.4  | 1.8 | 1.1  | 4.8  |
| 1985 | 30   | 2.5  | 1.0  | 1.1  | 0.4  | 8.6  | 0.4  | 0.5  | 0.3  | 0.4 | 0.6  | 0.7  |
| 1986 | 1.3  | 2.5  | 0.9  | 3.8  | 0.6  | 1.0  | 0.8  | 1.0  | 1.1  | 1.0 | 2.2  | 1.1  |
| 1987 | 0.5  | 0.6  | 1.5  | 2.7  | 3.3  | 1.4  | 0.2  | 0.2  | 0.9  | 1.3 | 0.9  | 2.3  |
| 1988 | 4.9  | 100  | 4.7  | 4.5  | 10.8 | 100  | 0.3  | 18.1 | 100  | 100 | 100  | 100  |
| 1989 | 1.2  | 1.5  | 0.6  | 3.8  | 9.4  | 1.6  | 0.5  | 1.6  | 0.4  | 2.2 | 1.4  | 5.7  |
| 1990 | 1.9  | 0.4  | 0.9  | 1.0  | 0.9  | 0.6  | 0.5  | 1.8  | 0.6  | 2.3 | 2.8  | 7.5  |
| 1991 | 4.8  | 2.3  | 0.6  | 0.7  | 1.9  | 2.1  | 0.6  | 1.0  | 0.7  | 1.7 | 3.8  | 3.5  |
| 1992 | 4.5  | 12.9 | 3.7  | 0.7  | 1.3  | 100  | 1.5  | 0.9  | 0.9  | 1.4 | 2.0  | 1.3  |
| 1993 | 3.2  | 0.7  | 2.0  | 4.3  | 0.6  | 1.0  | 0.5  | 0.4  | 1.2  | 1.9 | 0.9  | 0.9  |
| 1994 | 2.1  | 4.5  | 1.3  | 5.9  | 1.0  | 10.7 | 1.8  | 2.0  | 16.8 | 0.8 | 3.3  | 7.4  |
| 1995 | 15   | 18.0 | 3.4  | 1.2  | 4.3  | 100  | 8.7  | 0.1  | 1.0  | 2.2 | 4.1  | 19.0 |
| 1996 | 12   | 100  | 0.6  | 2.6  | 3.2  | 0.3  | 1.0  | 6.3  | 100  | 4.4 | 1.9  | 1.8  |
| 1997 | 3.2  | 1.5  | 0.8  | 0.9  | 0.4  | 1.0  | 0.3  | 0.6  | 12.3 | 9.0 | 0.5  | 0.5  |
| 1998 | 1.7  | 1.1  | 1.9  | 0.3  | 0.6  | 0.6  | 0.7  | 0.2  | 0.7  | 0.3 | 1.6  | 3.6  |
| 1999 | 2.1  | 100  | 1.5  | 0.5  | 0.7  | 0.9  | 4.7  | 1.1  | 0.3  | 0.3 | 1.2  | 2.7  |
| 2000 | 2.2  | 21.8 | 46.4 | 5.3  | 100  | 1.0  | 0.6  | 0.3  | 0.3  | 1.3 | 1.8  | 4.2  |
| 2001 | 1.1  | 1.0  | 0.8  | 7.2  | 100  | 1.6  | 1.7  | 3.8  | 100  | 3.1 | 39.9 | 25.3 |
| 2002 | 0.9  | 52.6 | 6.1  | 0.5  | 0.2  | 100  | 3.9  | 0.1  | 1.0  | 1.9 | 3.3  | 1.4  |
| 2003 | 2.7  | 0.7  | 1.2  | 0.2  | 0.3  | 1.2  | 0.2  | 0.5  | 0.4  | 1.5 | 2.2  | 4.0  |
| 2004 | 14.0 | 3.0  | 3.2  | 3.6  | 0.8  | 0.3  | 0.4  | 0.6  | 0.8  | 2.0 | 2.5  | 1.9  |
| 2005 | 12.2 | 3.5  | 2.1  | 2.4  | 4.1  | 2.3  | 0.3  | 0.3  | 0.7  | 1.1 | 2.5  | 6.6  |
| 2006 | 5.1  | 2.9  | 100  | 1.1  | 1.0  | 9.6  | 0.1  | 2.0  | 9.0  | 5.4 | 3.4  | 5.0  |
| 2007 | 24.9 | 2.0  | 0.7  | 1.7  | 1.0  | 1.7  | 0.8  | 0.3  | 0.2  | 1.1 | 1.9  | 3.7  |
| 2008 | 3.5  | 100  | 4.2  | 27.1 | 7.7  | 1.9  | 0.8  | 1.1  | 7.9  | 8.7 | 100  | 100  |
| 2009 | 100  | 100  | 9.3  | 100  | 0.7  | 100  | 0.2  | 2.1  | 10.6 | 8.0 | 9.8  | 7.6  |
| 2010 | 2.6  | 0.6  | 0.6  | 0.8  | 0.6  | 100  | 1.7  | 0.3  | 0.4  | 1.5 | 2.9  | 6.0  |
| 2011 | 100  | 3.1  | 1.9  | 1.7  | 0.3  | 0.4  | 0.2  | 0.3  | 1.6  | 1.7 | 1.1  | 1.0  |
| 2012 | 5.3  | 100  | 1.4  | 0.6  | 3.3  | 100  | 0.6  | 0.3  | 0.3  | 1.0 | 0.7  | 1.8  |
| 2013 | 0.7  | 0.7  | 0.6  | 0.7  | 0.7  | 1.9  | 1.1  | 1.0  | 1.3  | 1.8 | 3.1  | 1.7  |
| 2014 | 5.5  | 24.0 | 1.1  | 1.6  | 2.0  | 100  | 100  | 0.5  | 1.9  | 0.5 | 0.6  | 1.3  |