Probabilistic Risk Analysis and Bayesian Decision Theory

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```r
knitr::opts_chunk$set( collapse=TRUE, echo=F, comment=">" )
library( geodata )
library( terra )
```

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Linkages between PRA and BDT

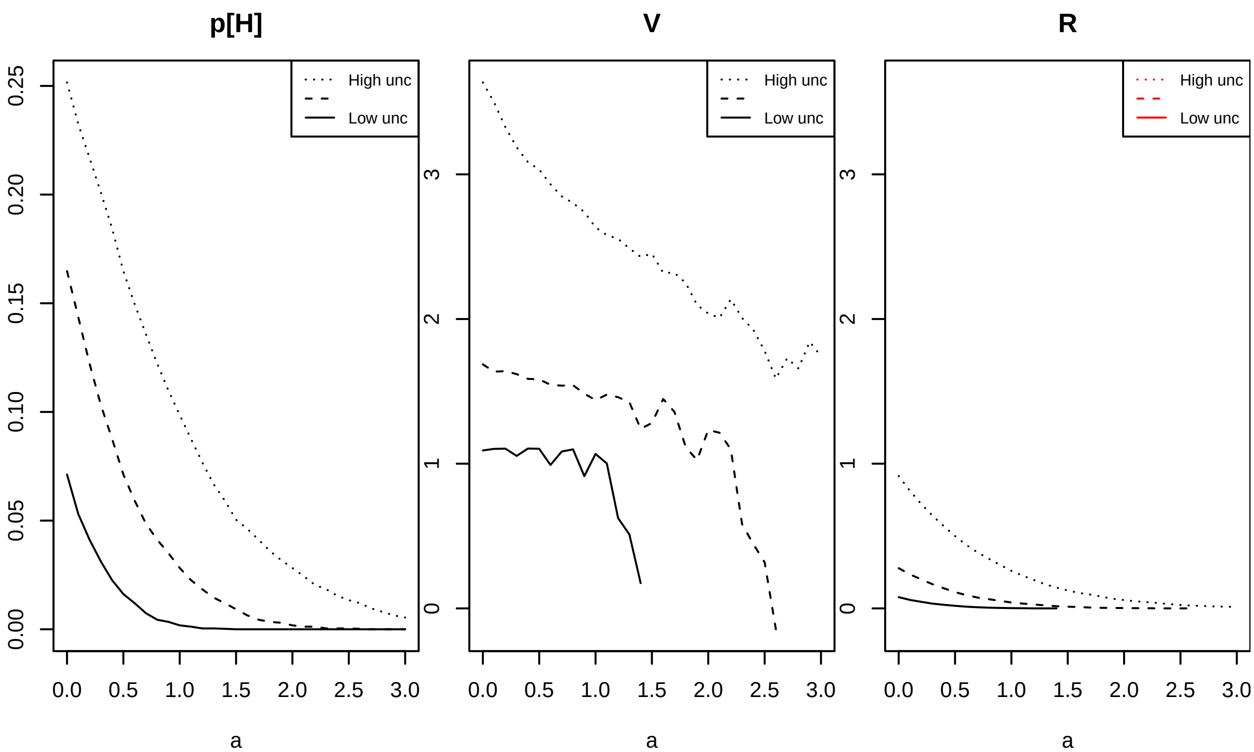


Figure 1: PRAs on data generated for BDT.

Risk management

The relationship between utility maximisation in BDT and risk assessment in PRA: R_c

$$R = E[u|\neg H] - E[u]. \tag{1}$$

$$\begin{aligned} R_c &= R - E[u|\neg H] \\ &= R + E[ka|\neg H] \times a - E[ky \times y|\neg H].(\#eq:Rc) \end{aligned} \tag{2}$$

Simplified accounting for both benefits and costs of the action: R_b

$$R_b = R + E[ka] \times a - E[ky] \times E[y].(\#eq:Rb) \tag{3}$$

Only correcting for costs: R_a

$$R_a = R + E[ka] \times a. \tag{4}$$

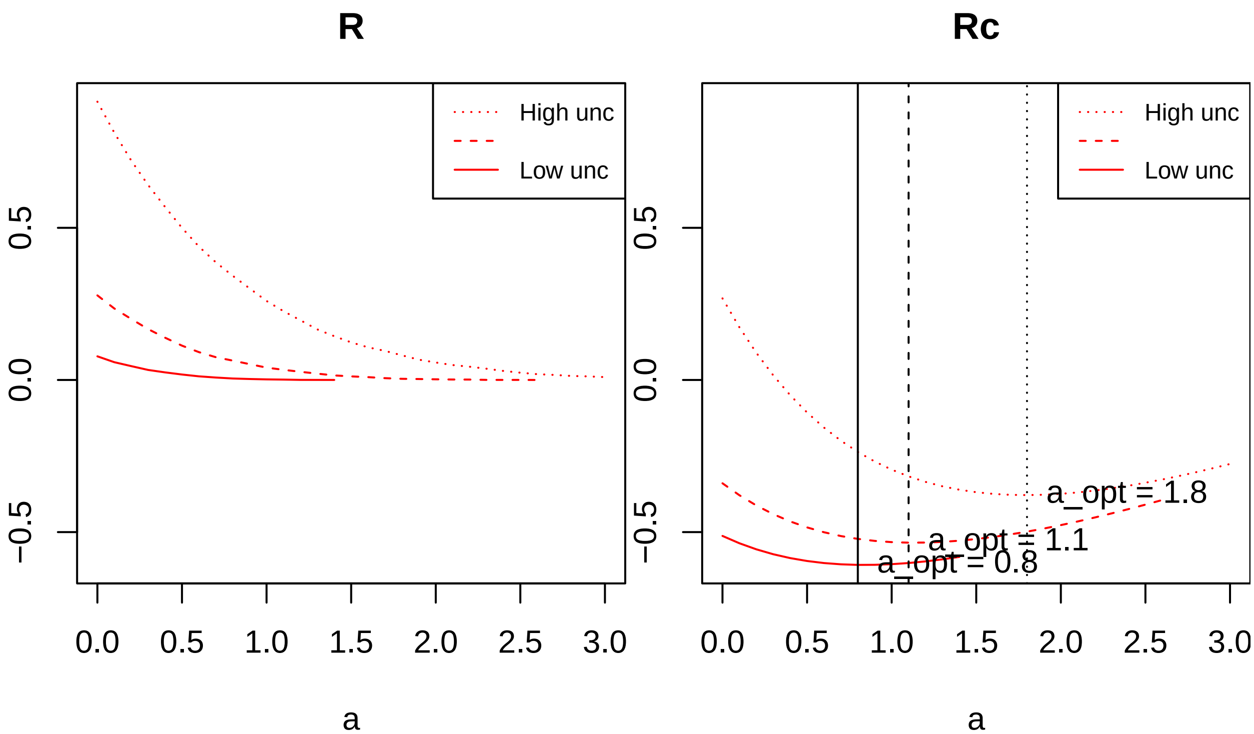


Figure 2: Impact of action a on risk calculated from data generated for BDT. Left: uncorrected risk R, always decreasing with increasing a. Right: corrected risk R_c, reaching an uncertainty-dependent minimum at finite a.

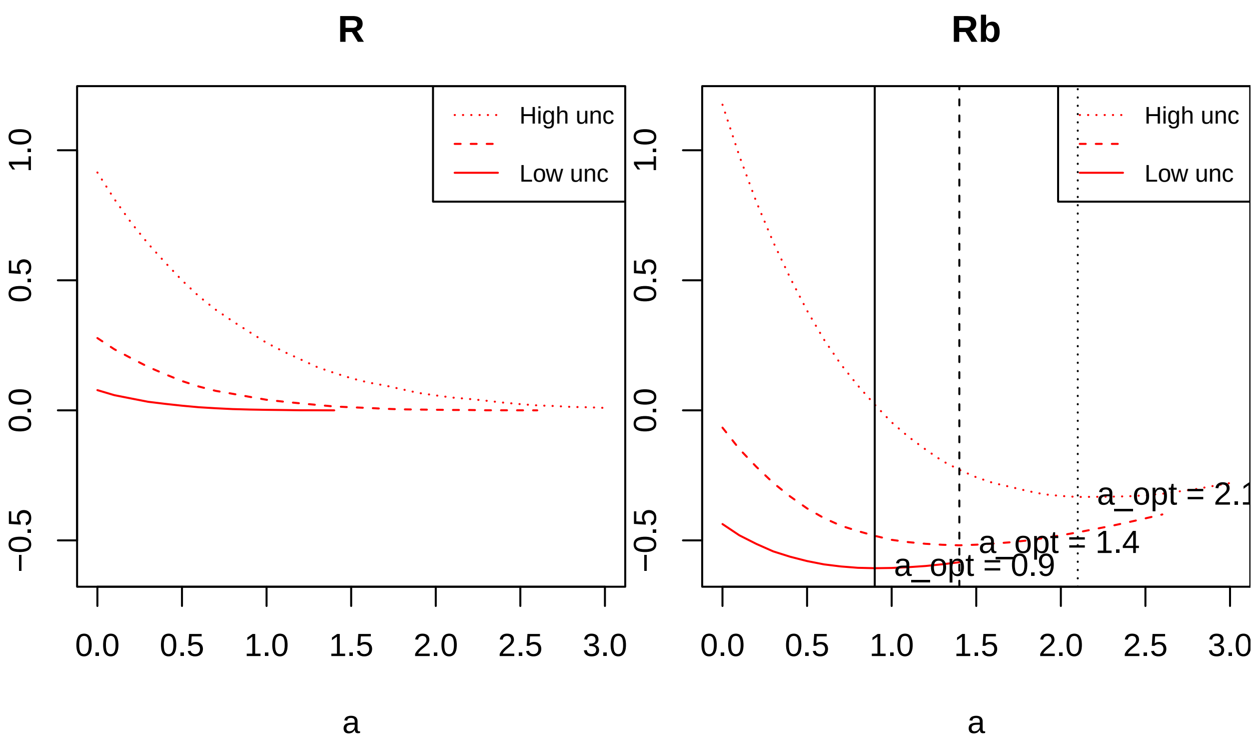


Figure 3: Cost- and benefit-adjusted risk R_b using data generated for BDT.

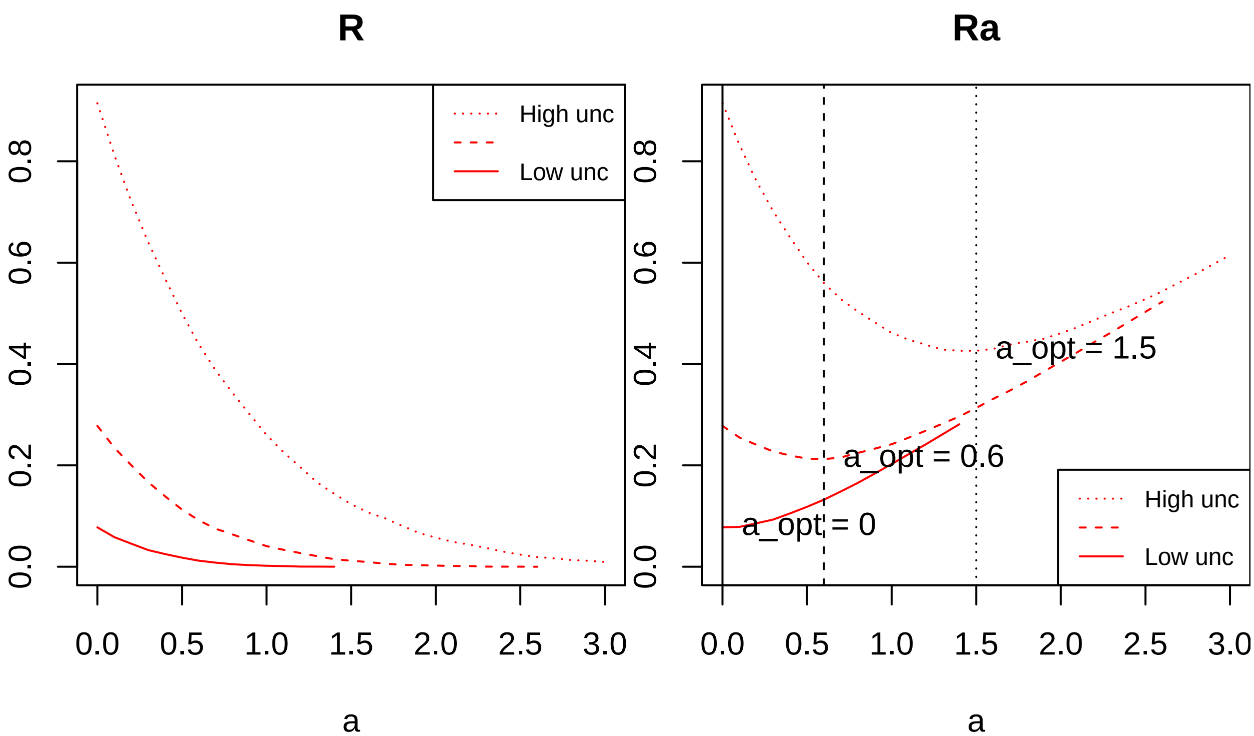


Figure 4: Cost-adjusted risk R_a using data generated for BDT.

PRA vs. BDT in the spatial example

```
IRRIG <- 500

s_YC       <- rast( sapply(1:19, function(i){
  xapp( r_alt, s_prec[[i]]      , fun=YC )}) )
s_YC.IRRIG <- rast( sapply(1:19, function(i){
  xapp( r_alt, s_prec[[i]]+IRRIG, fun=YC )}) )
```

```
ky         <- 30 ; ka <- 0.1

s_U        <- s_YC       * ky
s_U.IRRIG <- s_YC.IRRIG * ky - IRRIG * ka
```

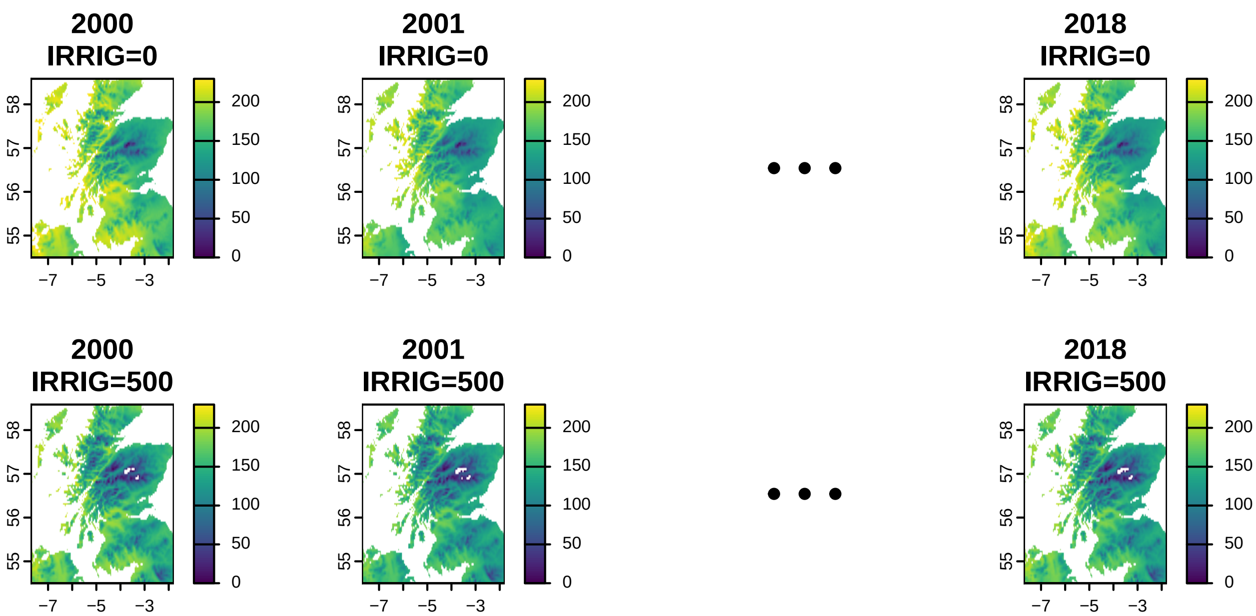


Figure 5: Utility in 2000, 2001 and 2018. Top row: no irrigation. Bottom row: irrigation at 500 $mm\,y^{-1}$.

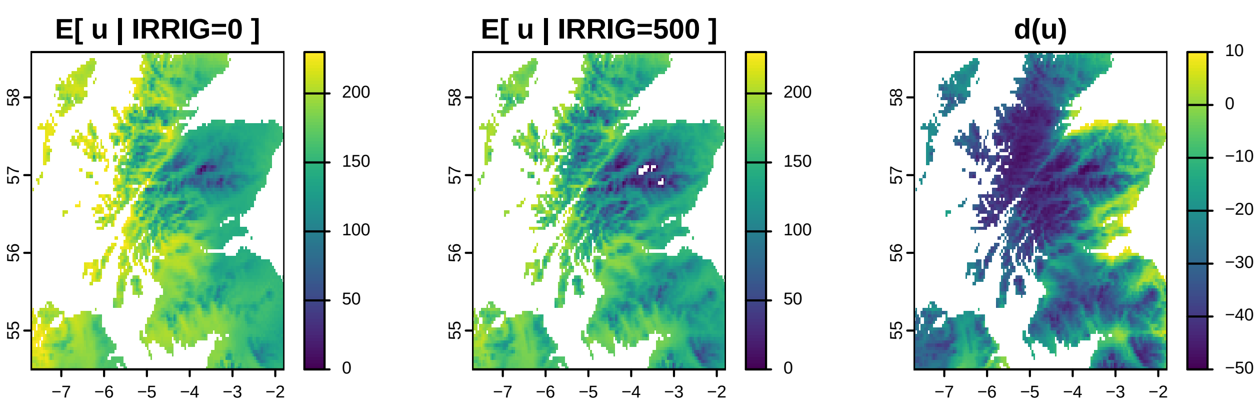


Figure 6: Mean utility. Left: no irrigation. Middle: irrigation = 500 $mm\,y^{-1}$. Right: utility-gain from irrigation.

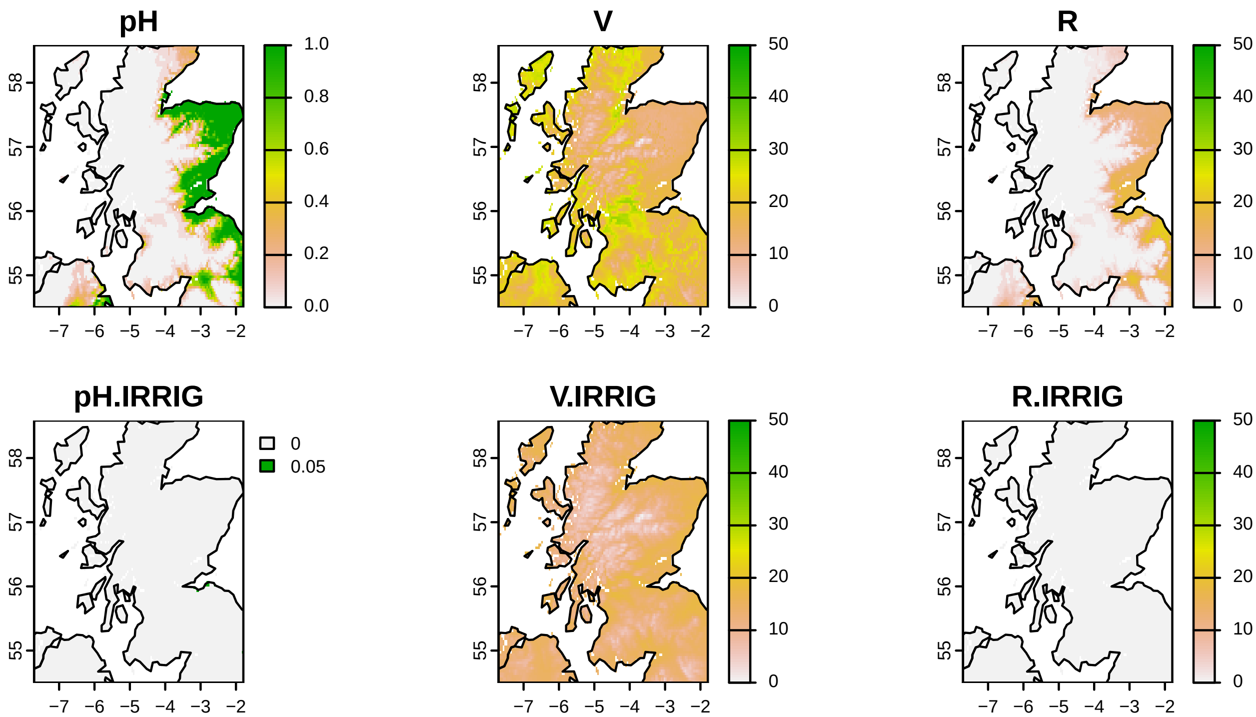


Figure 7: PRA based on data for 2000-2018. Top row: no irrigation. Bottom row: irrigation = 500 $mm\,y^{-1}$.

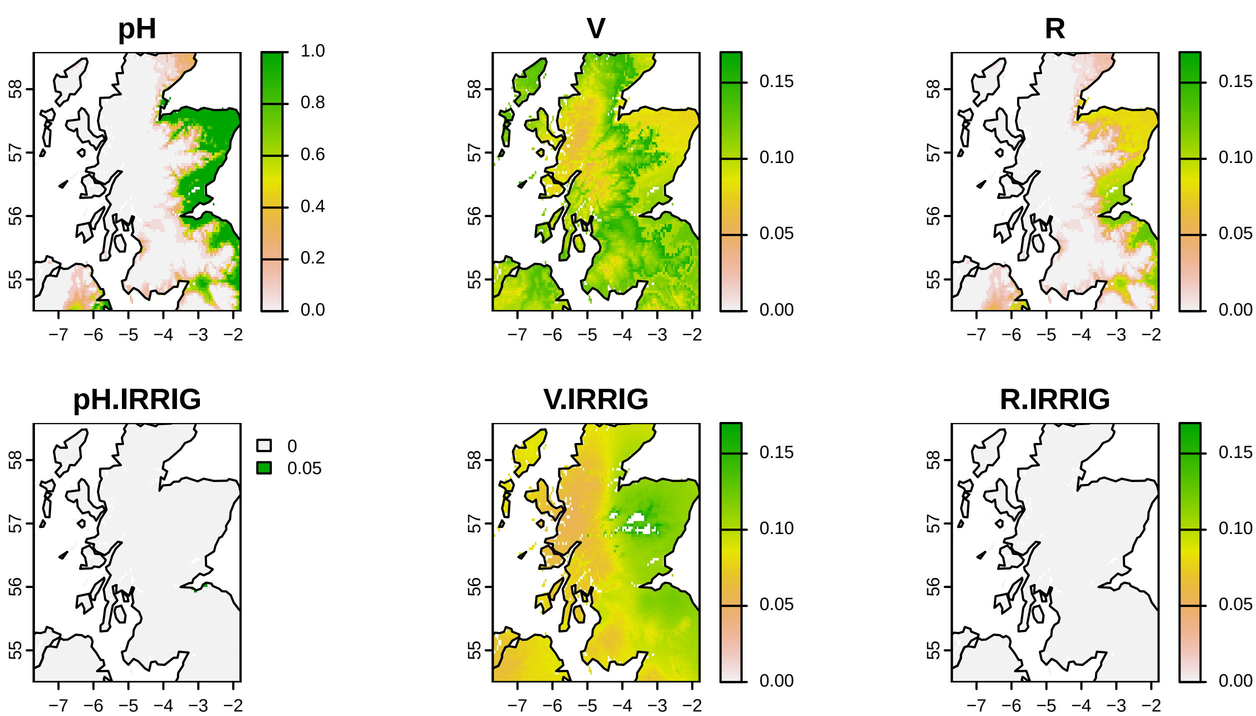


Figure 8: Relative PRA based on data for 2000-2018. Top row: no irrigation. Bottom row: irrigation = 500 $mm\,y^{-1}$.

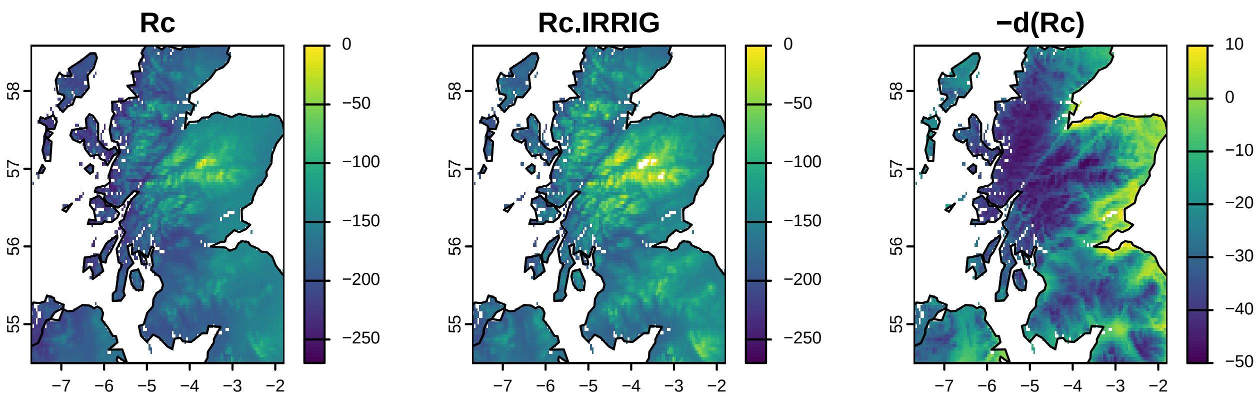
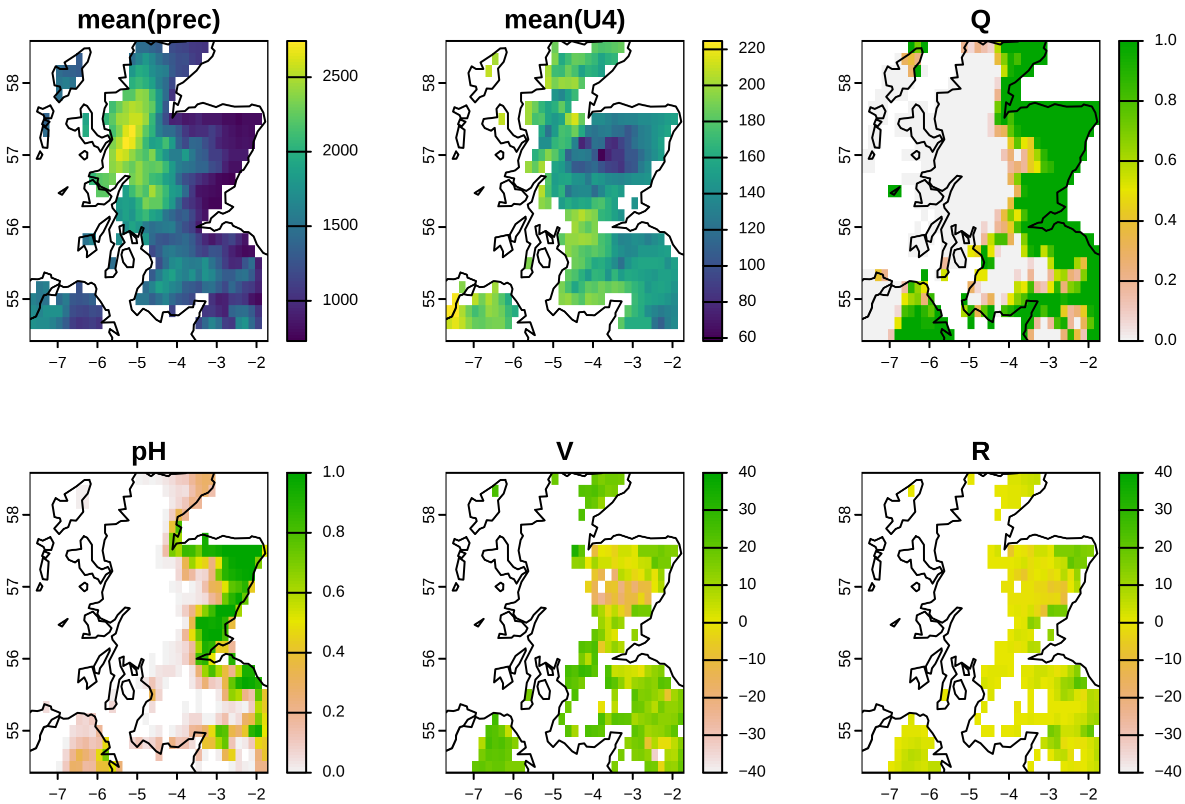


Figure 9: Corrected risk for utility. Left: no irrigation. Middle: irrigation as above. Right: decrease in corrected risk due to irrigation.

Three-component PRA in the spatial example

```
exposure <- function( pH, ... ){
  pH <- pH[!is.na(pH)]         ; n <- length(pH)
  nE <- length( pH[pH>1/21] ) ; Q <- nE/n
  return( Q ) }
```



Discussion

PRA and its application

Data and computational demand of PRA

BDT

Computational demand of BDT

PRA as a tool for simplifying and elucidating BDT

Parameter and model uncertainties

Modelling and decision-support for forest response to hazards

Spatial statistics

References