Coupling ForestGALES with an airflow model and a yield model in QGIS

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Contents:

- The setting
- How we coupled ForestGALES with WAsP and a growth model in QGIS
- Challenges
- Further opportunities with FG-TMC

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- Typhoons, complex terrain, and complex ownership patterns make it difficult to have concerted efforts to manage plantations to reduce risk of wind damage.
- Customer looking for tailored tools to calculate risk and inform management practices to reduce risk

Model coupling demonstration:

- Wind risk and roughness: ForestGALES

ForestGALES
A wind risk decision support tool for forest management in Britain

- Growth of *Eucalyptus globulus* stands: GLOBULUS 3.0 (Tomé et al., 2006)
- Airflow model: WAsP
- Mapped using QGIS

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Model coupling – Process:

- Digitise forest map
- Simulate growth of *E. globulus* plots
- Calculate roughness of *E. globulus* plots with ForestGALES
- Digitise WAsP contour and roughness map
- Run WAsP to calculate Weibull A + k
- Use values of Weibull parameters to calculate risk of wind damage with ForestGALES

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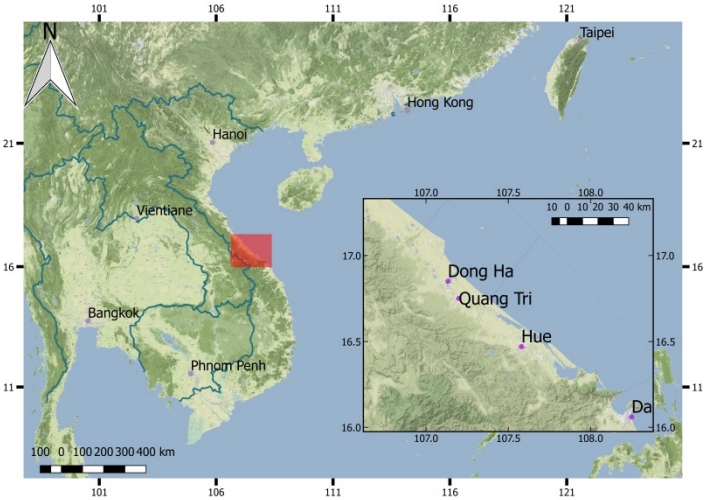
Model coupling – Process:

- Digitise forest map



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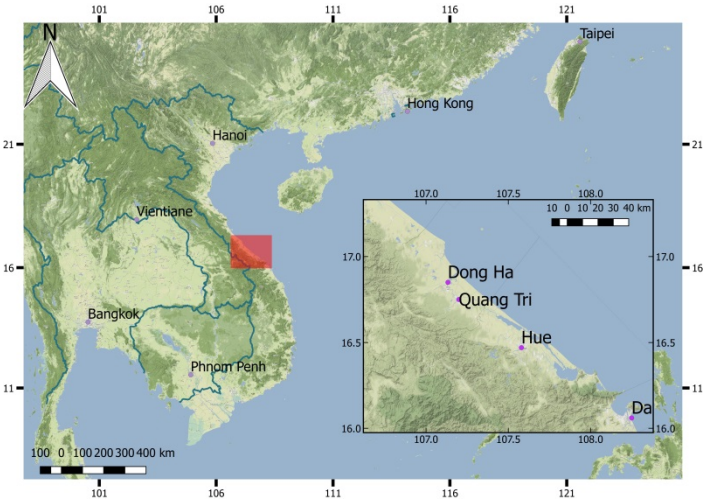

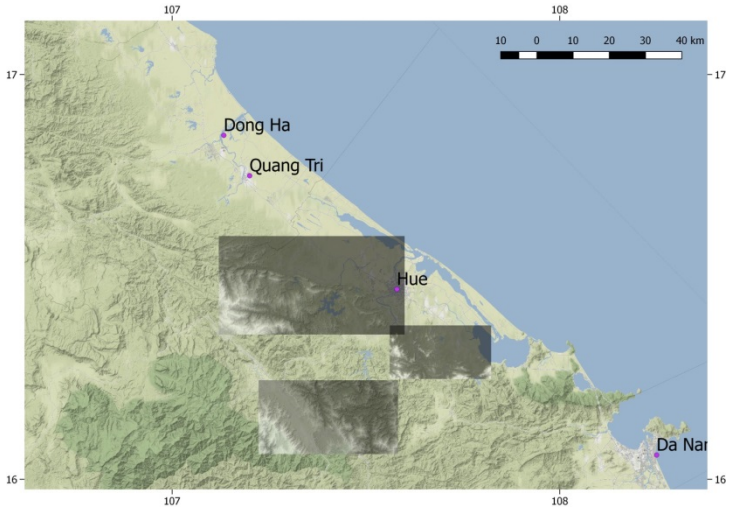

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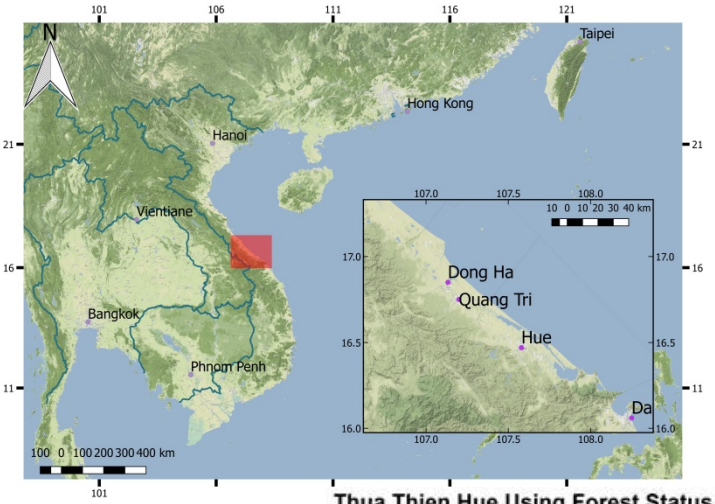

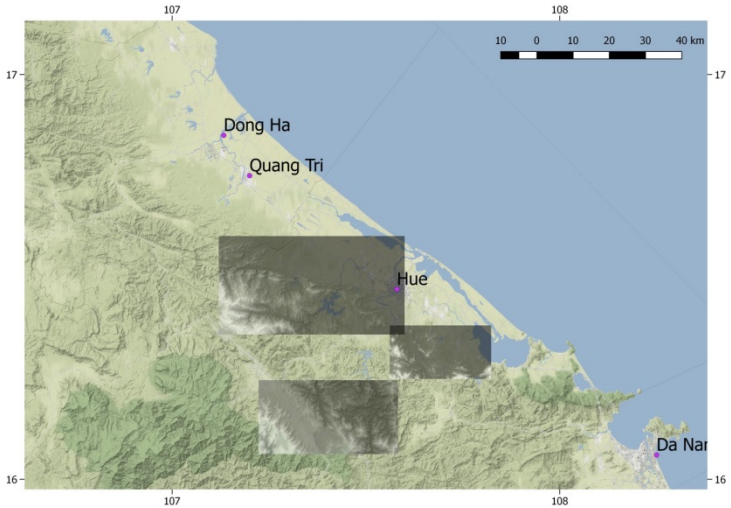

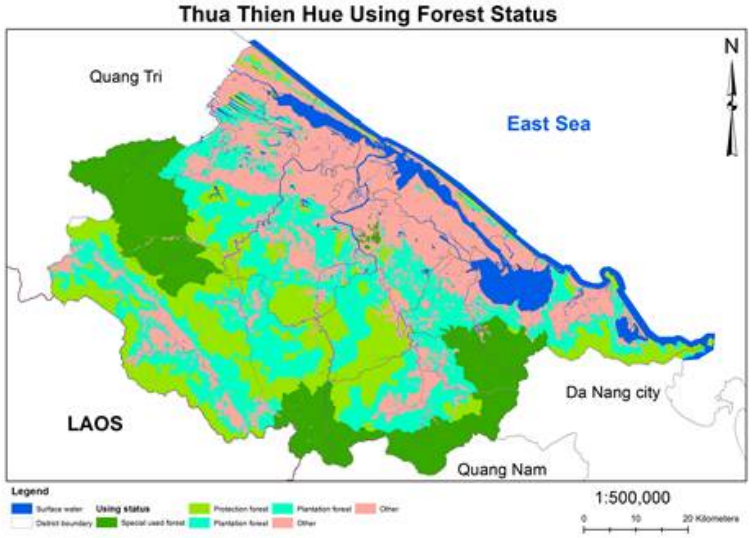

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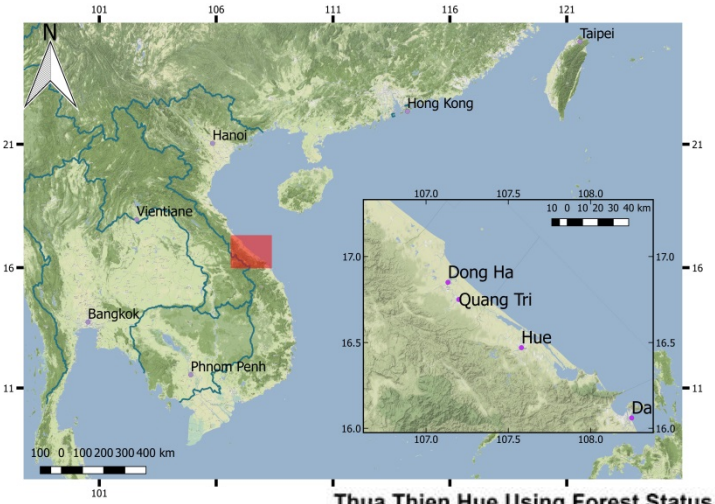

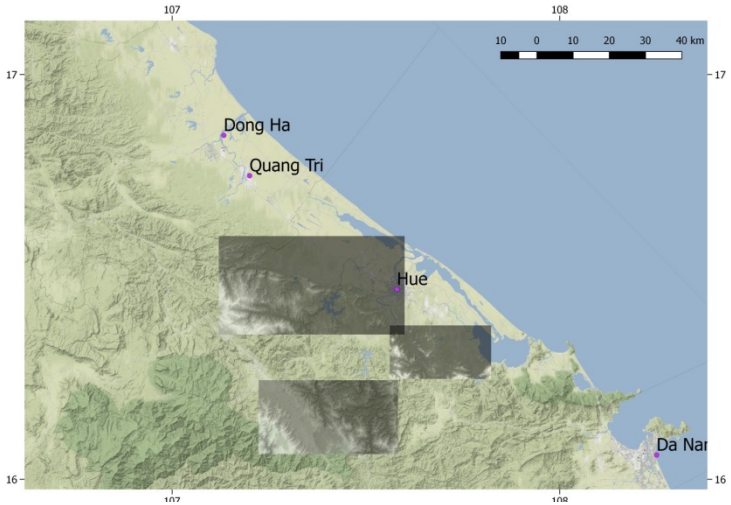

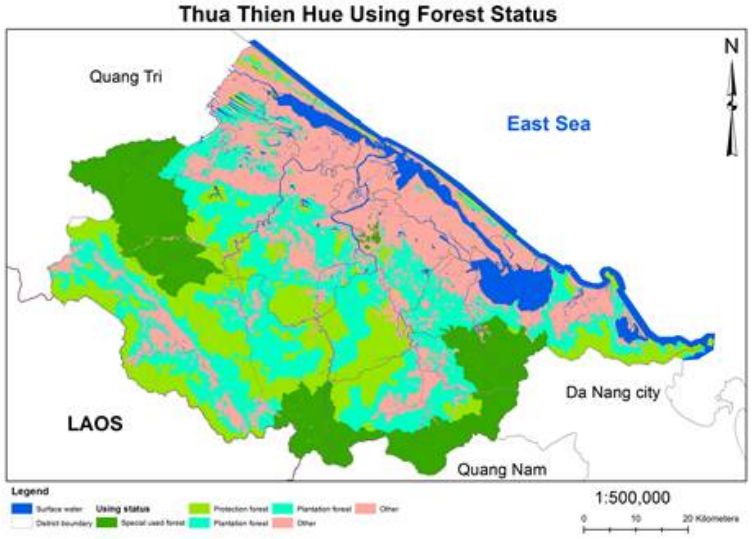

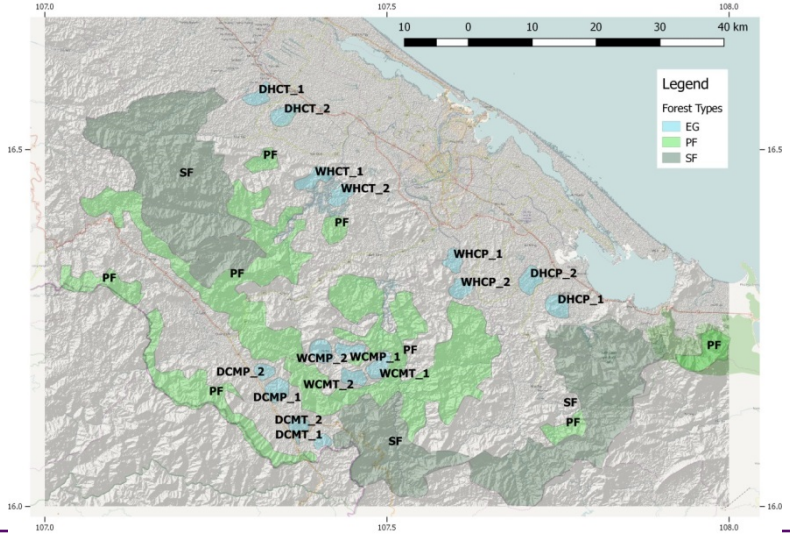

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Model coupling – Process:

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Model coupling – Process:

- Simulate growth of *E. globulus* plots

Inputs:
- Nº of days with rain
- Mean elevation
- SI_{10}
- Sph at planting

Outputs:
- Tree height
- Dbh
- Sph

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Model coupling – Process:

- Calculate roughness of *E. globulus* plots with ForestGALES

```
z0F <- function(crownBreadth, crownDepth, spacing, uguess, N, C, height) {
    z0 <- (height - zpd(crownBreadth, crownDepth, spacing, uguess, N, C, height)) *
    exp((-k * gammaSolvedF(crownBreadth, crownDepth, spacing, uguess, N, C)) + (log(cw) -1 + cw^(-1)))
  return(z0)
}

zpd <- function(crownBreadth, crownDepth, spacing, uguess, N, C, height) {
  d <- (1 - ((1 - exp( - sqrt(cd1 * lambdaCapitalF(crownBreadth, crownDepth, spacing, uguess, N, C)))) /
              sqrt(cd1 * lambdaCapitalF(crownBreadth, crownDepth, spacing, uguess, N, C))))*height
  return(d)
}

gammaSolvedF <- function(crownBreadth, crownDepth, spacing, uguess, N, C) {
  gammaSolved <- ifelse(lambdaCapitalF(crownBreadth, crownDepth, spacing, uguess, N, C) > 0.6,
                        (1/sqrt(Cs + Cr * 0.3)), 1/(sqrt(Cs + Cr + lambdaCapitalF(crownBreadth, crownDepth, spacing, uguess, N, C)/2)))

  return(gammaSolved)
}

lambdaCapitalF <- function(crownBreadth, crownDepth, spacing, uguess, N, C) {
  lambdaCapital <- 2 * (canopybreadthF(crownBreadth, uguess, N, C) * crownDepth / spacing^2)
  return(lambdaCapital)
}

canopybreadthF <- function(crownBreadth, uguess, N, C) {
  canopybreadth <- crownBreadth * porosity_fun(uguess, N, C)/2
  return(canopybreadth)
}

porosity_fun <- function(uguess, N, C) {
  porosity <- ifelse (uguess<10, C*10^(-N), ifelse(uguess>25, C*25^(-N), C * uguess^(-N)))
  return(porosity)
}
```


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Model coupling – Process:

- Calculate roughness of *E. globulus* plots with ForestGALES

```
z0F <- function(crownBreadth, crownDepth, spacing, uguess, N, C, height) {
    z0 <- (height - zpd(crownBreadth, crownDepth, spacing, uguess, N, C, height)) *
    exp((-k * gammaSolvedF(crownBreadth, crownDepth, spacing, uguess, N, C)) + (log(cw) -1 + cw^(-1)))
  return(z0)
}
```


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Model coupling – Process:

- Calculate roughness of *E. globulus* plots with ForestGALES

Stand data

Species-specific

```
z0F <- function(crownBreadth, crownDepth, spacing, uguess, N, C, height) {
    z0 <- (height - zpd(crownBreadth, crownDepth, spacing, uguess, N, C, height)) *
    exp((-k * gammaSolvedF(crownBreadth, crownDepth, spacing, uguess, N, C)) + (log(cw) -1 + cw^(-1)))
  return(z0)
}
```

Tree data
Species-specific parameters

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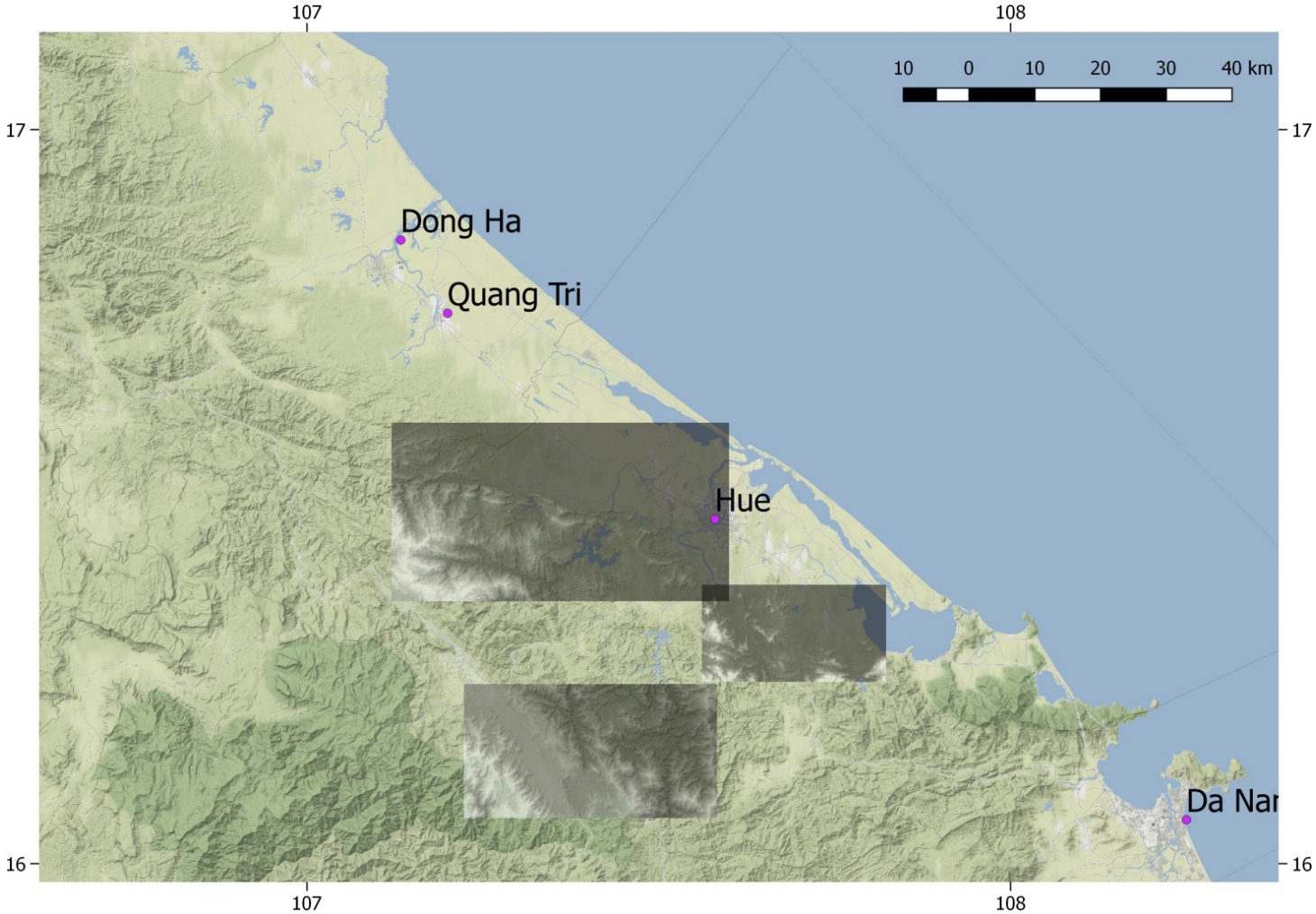
Model coupling – Process:

- Digitise WAsP contour and roughness map



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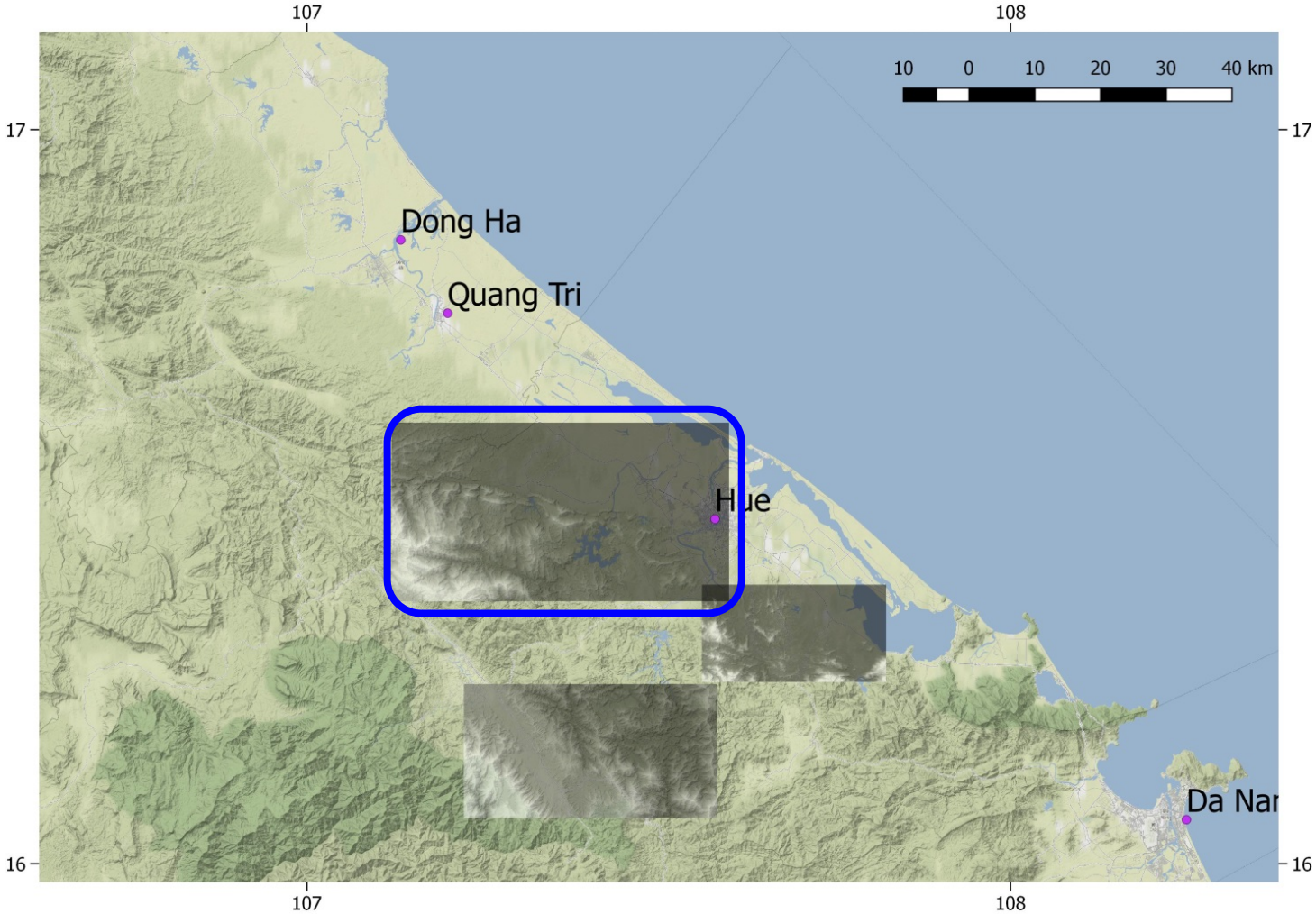
Model coupling – Process:

- Digitise WAsP: contour and roughness map



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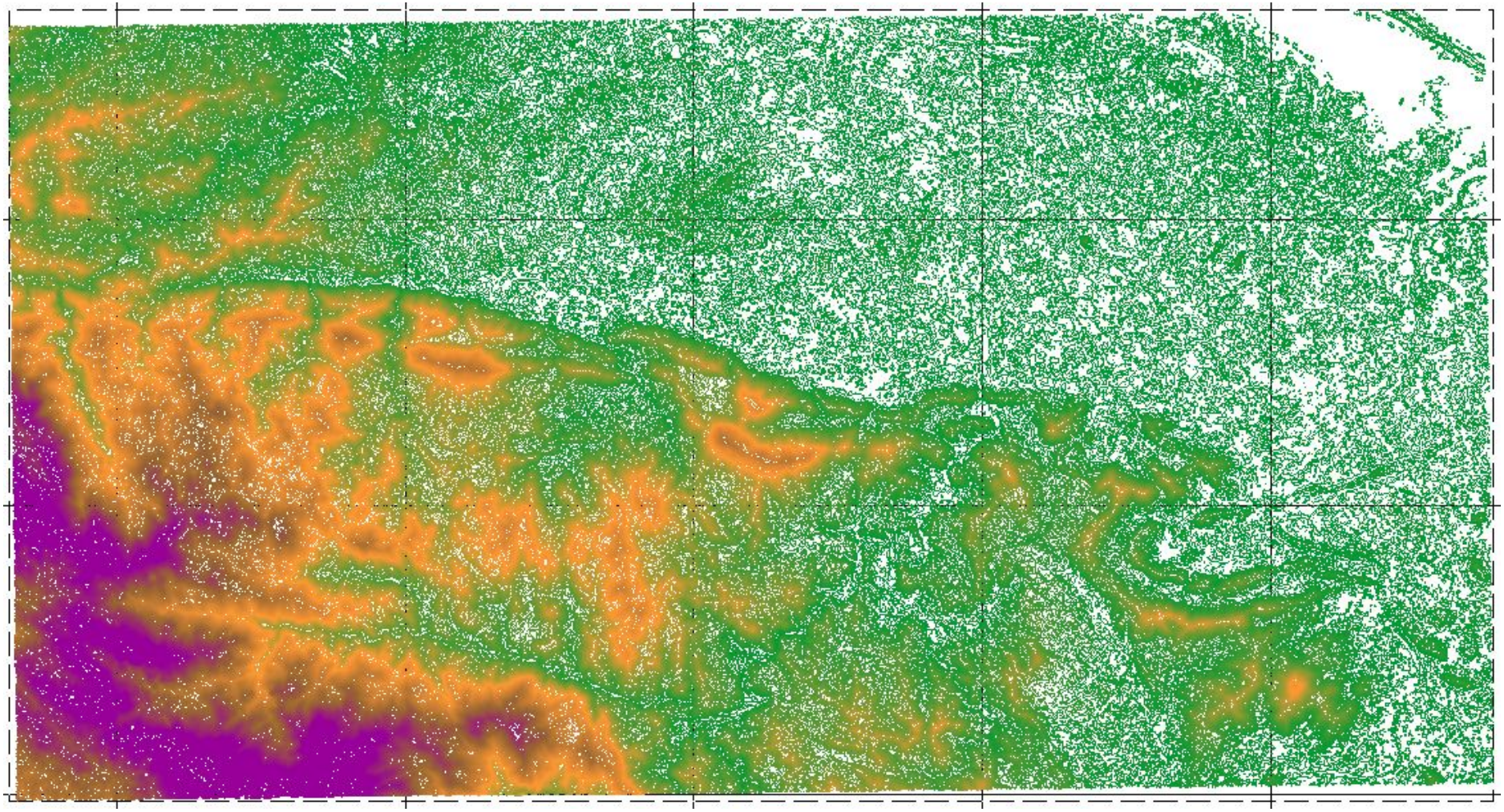
Model coupling – Process:

- Digitise WAsP: **contour** and roughness **map**



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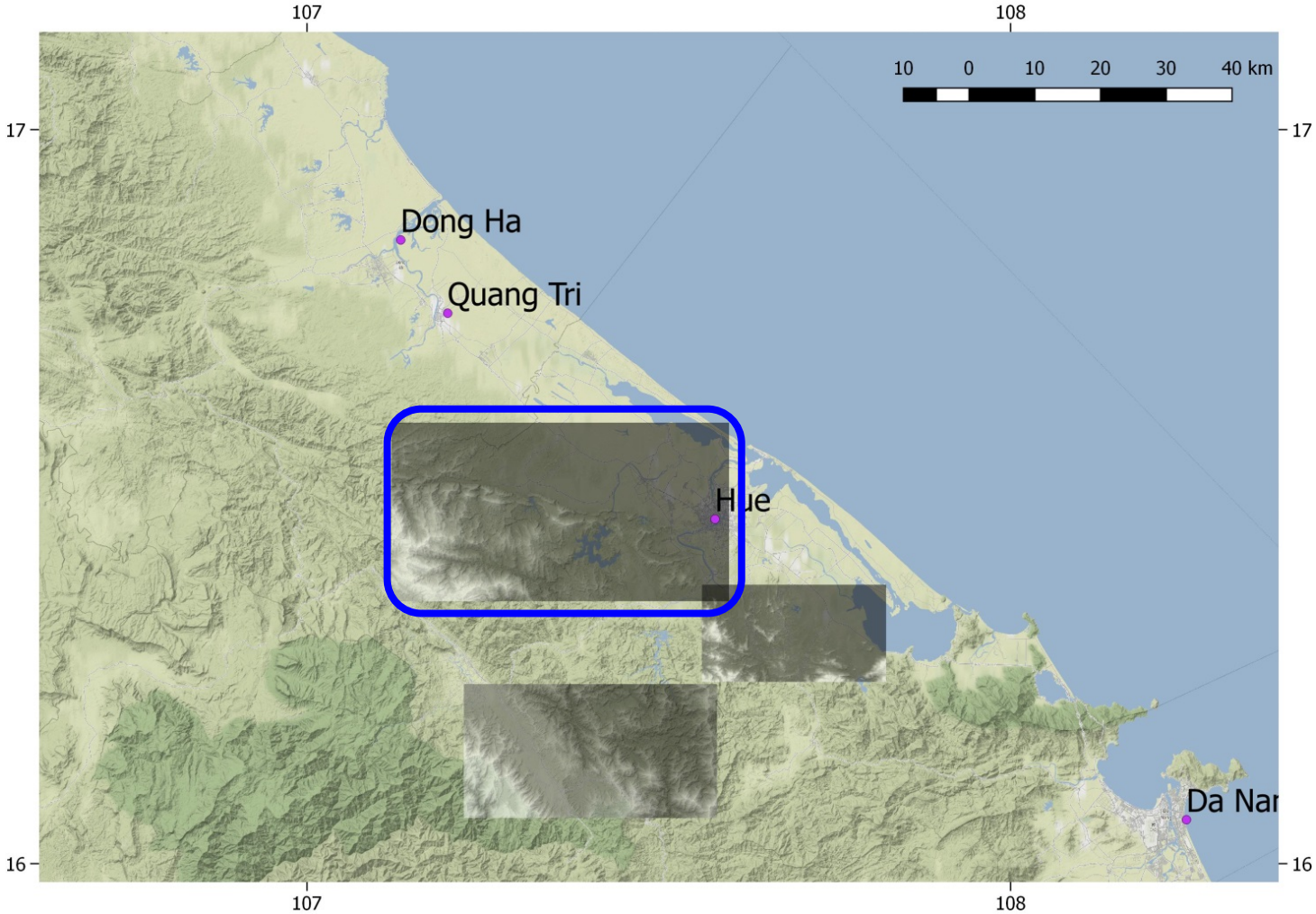

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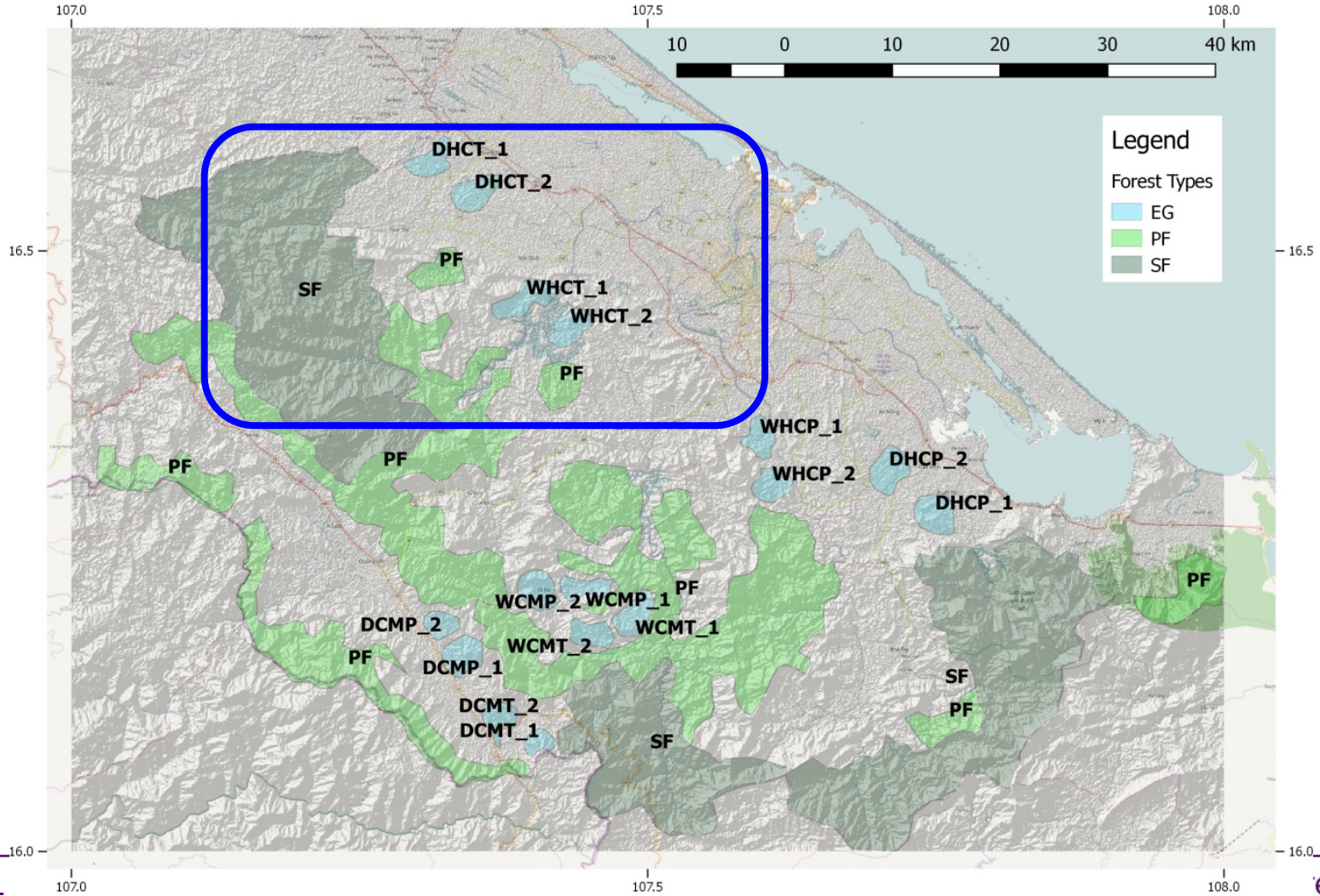
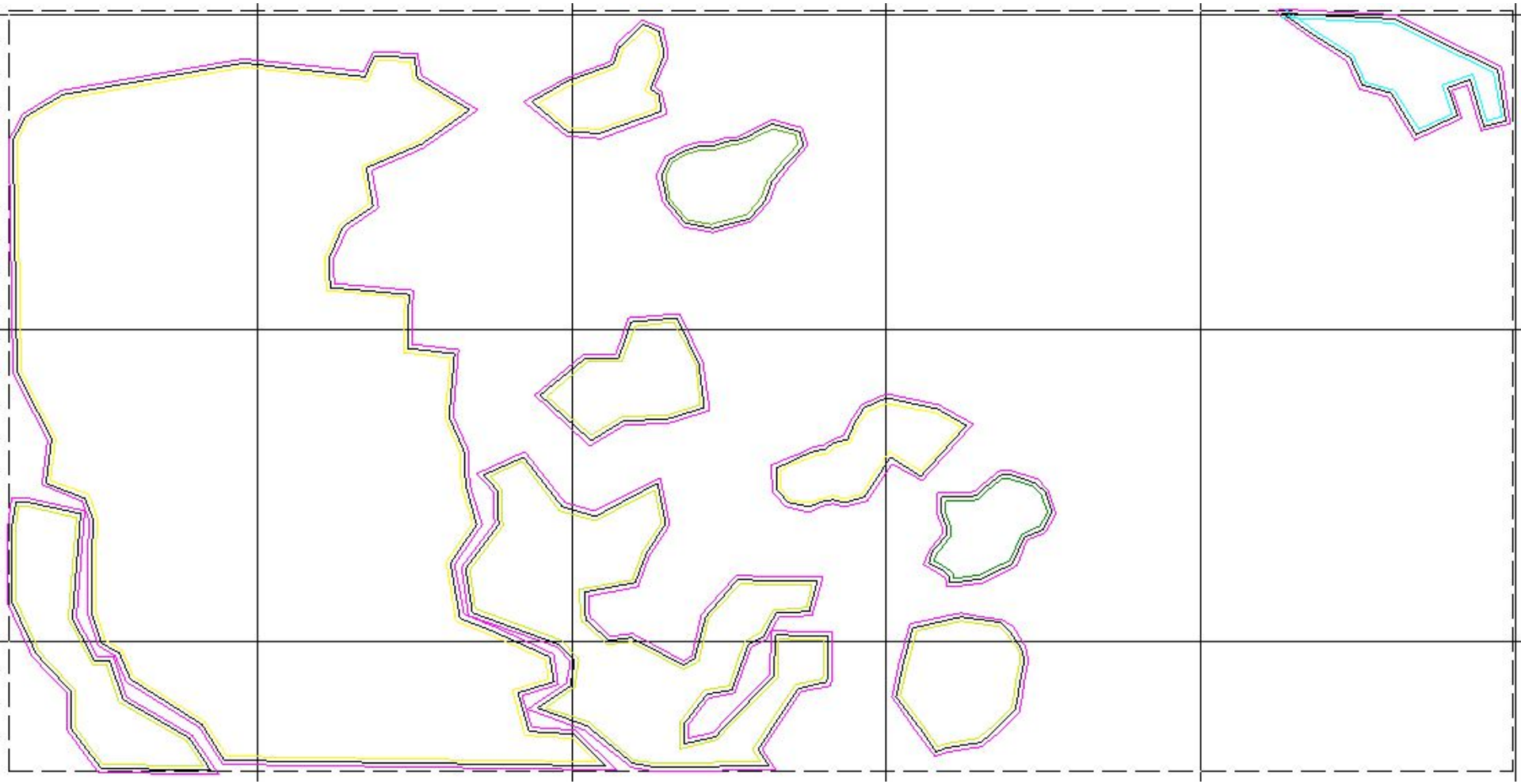


Model coupling – Process:

- Digitise WAsP: contour and **roughness map**



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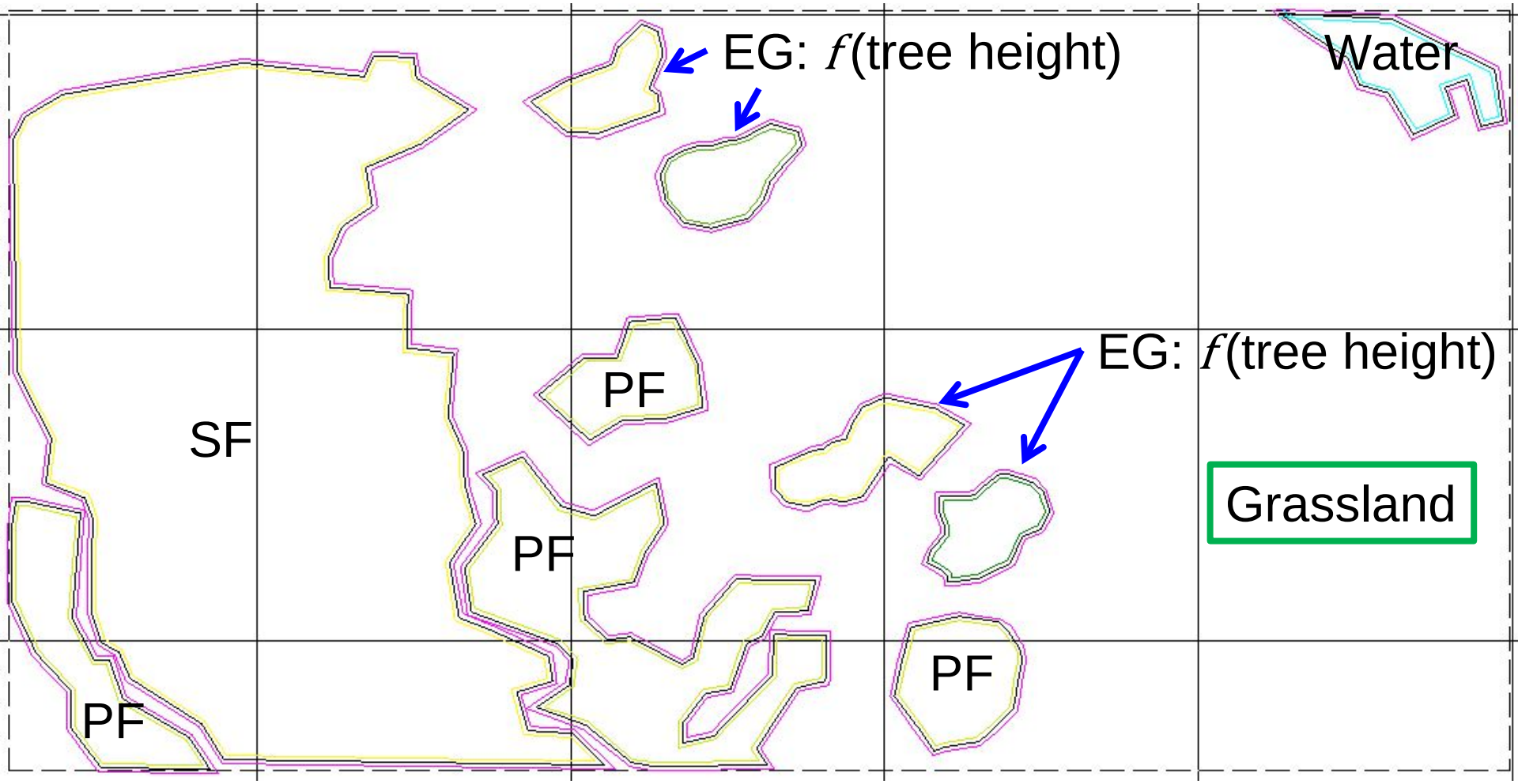

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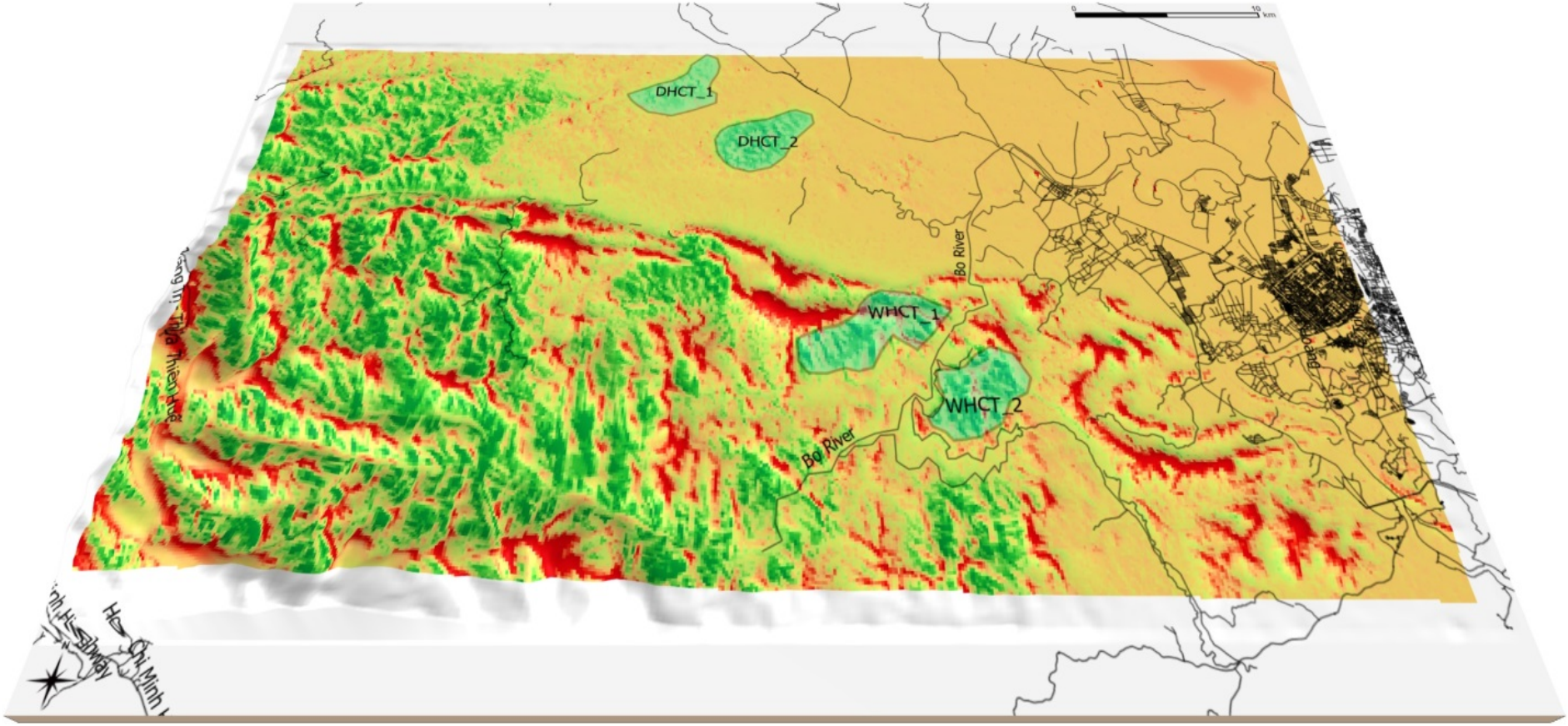

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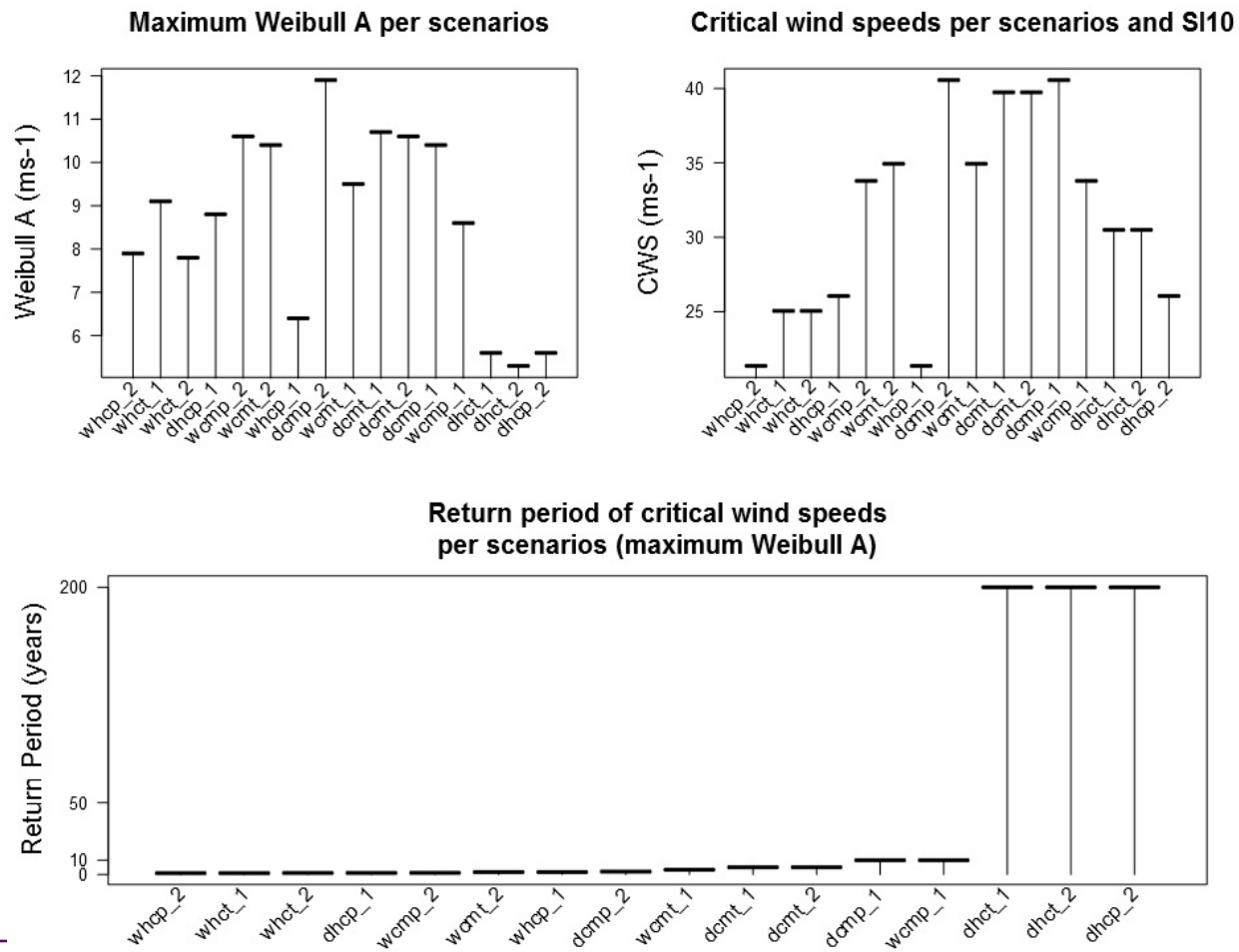

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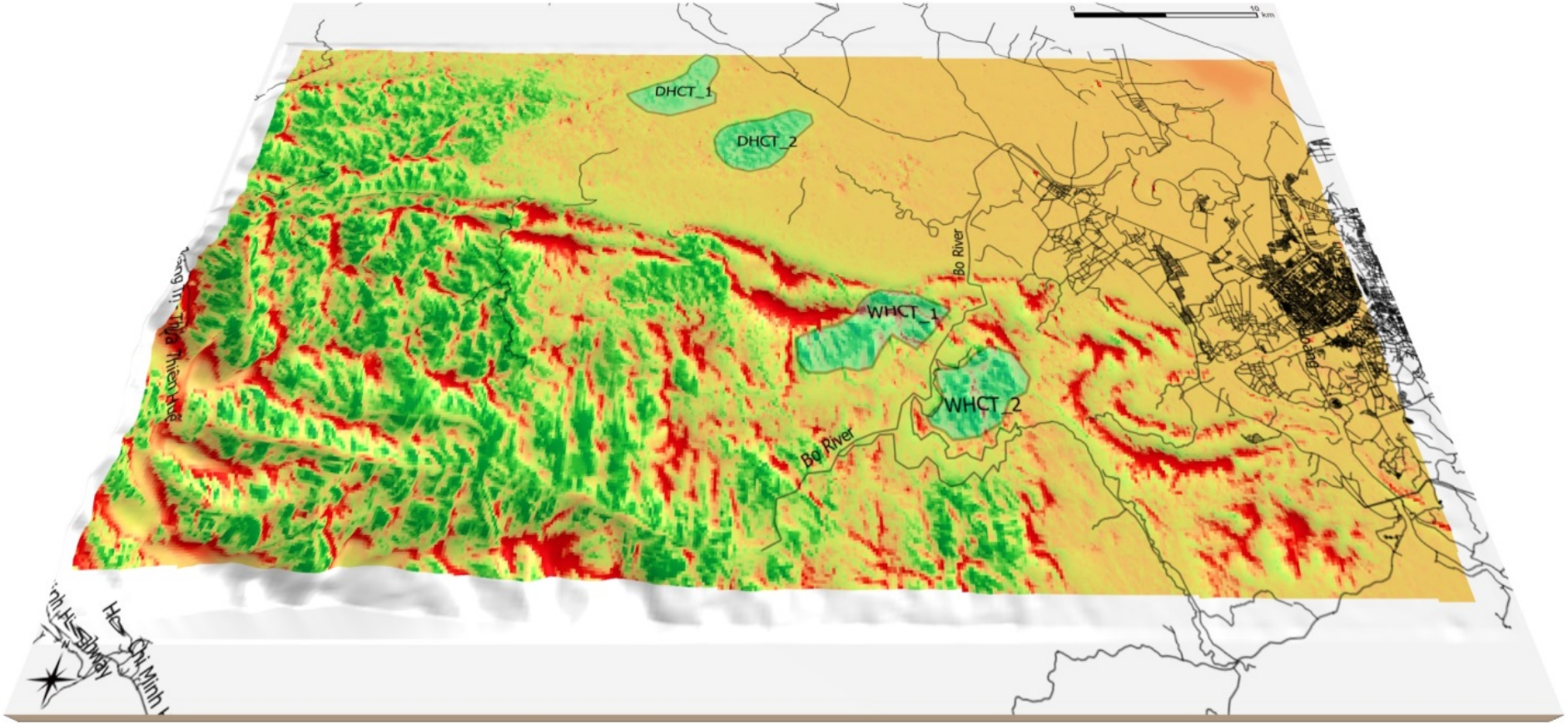

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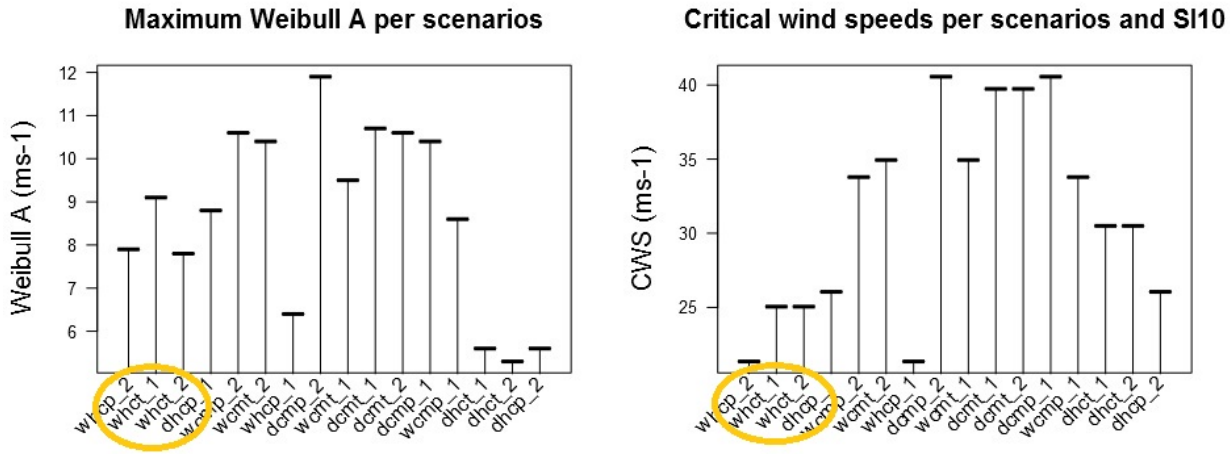

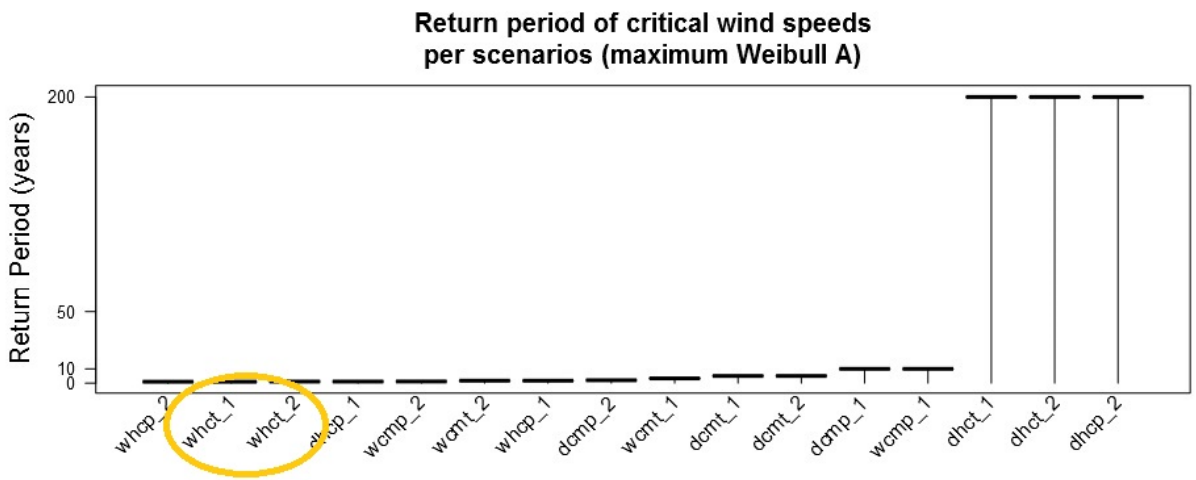

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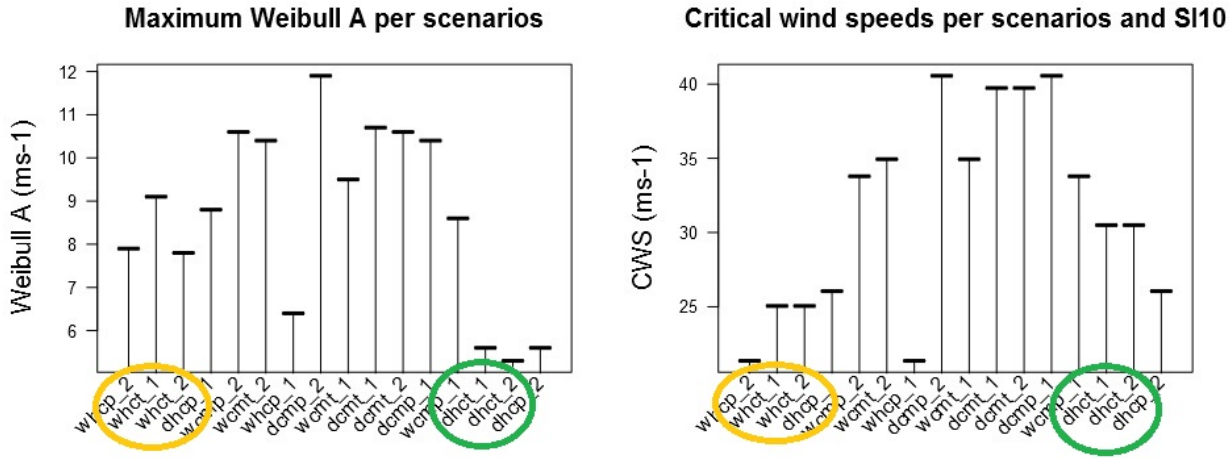

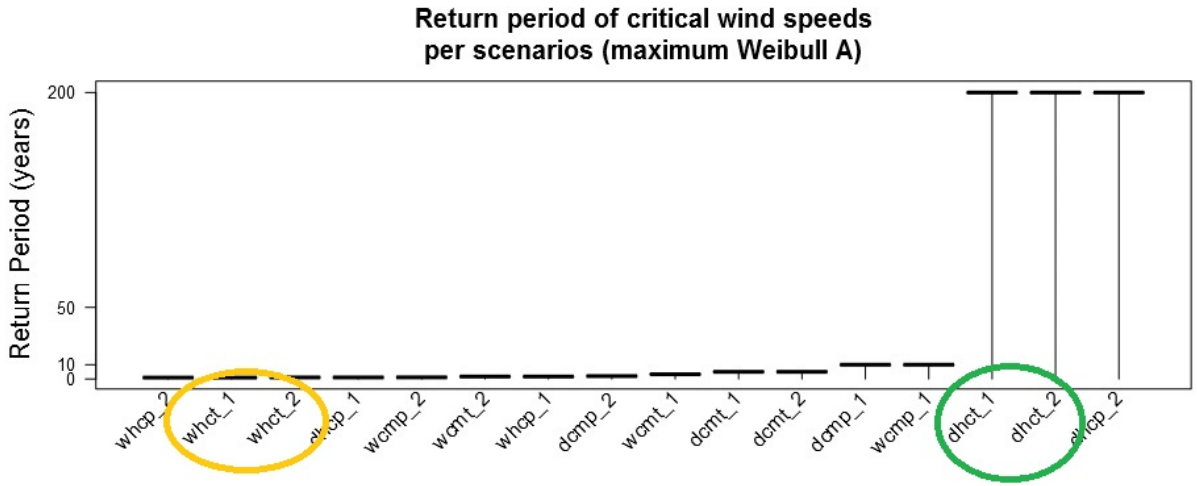

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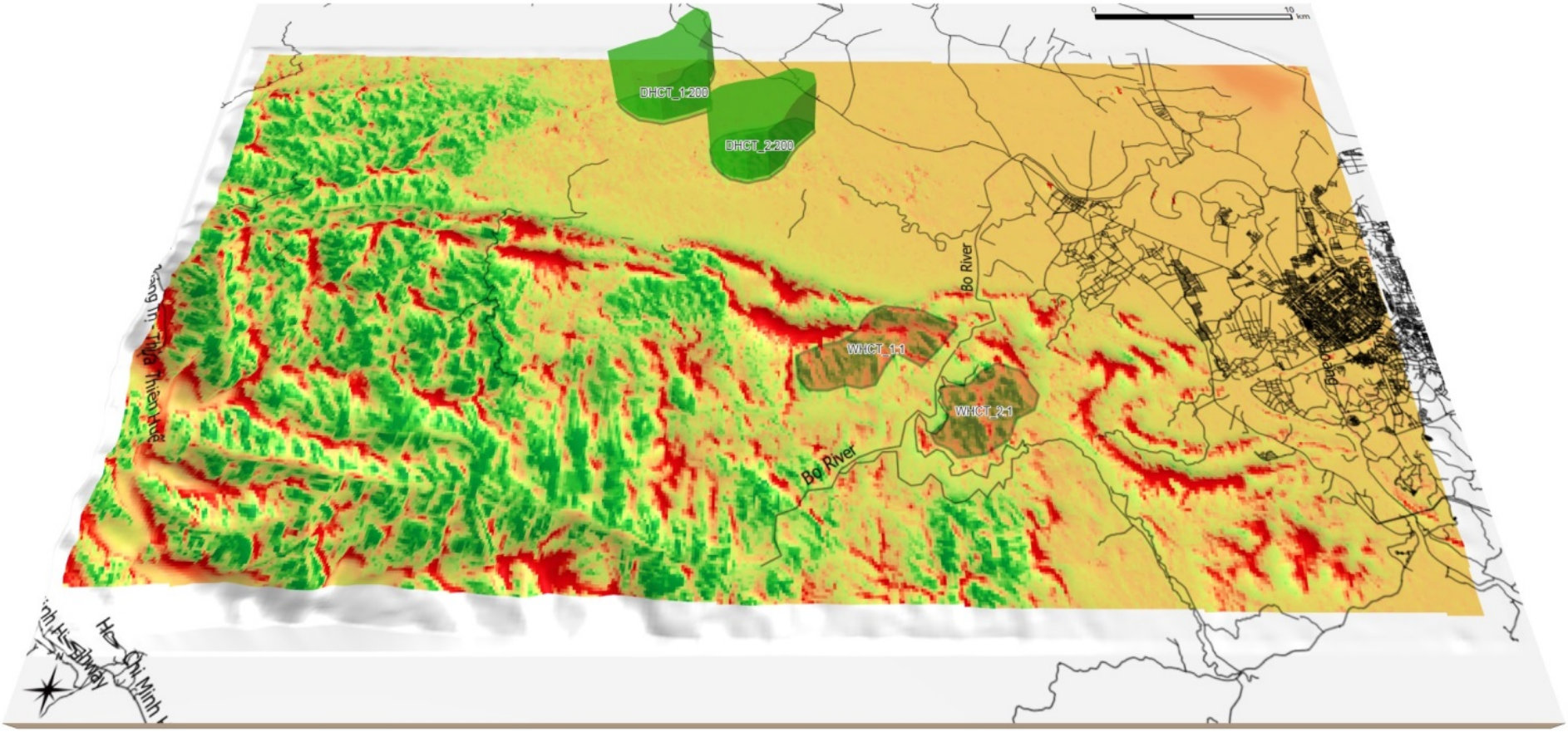

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Let us move on to ForestGALES - TMC

ForestGALES

A wind risk decision support tool for forest management in Britain

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