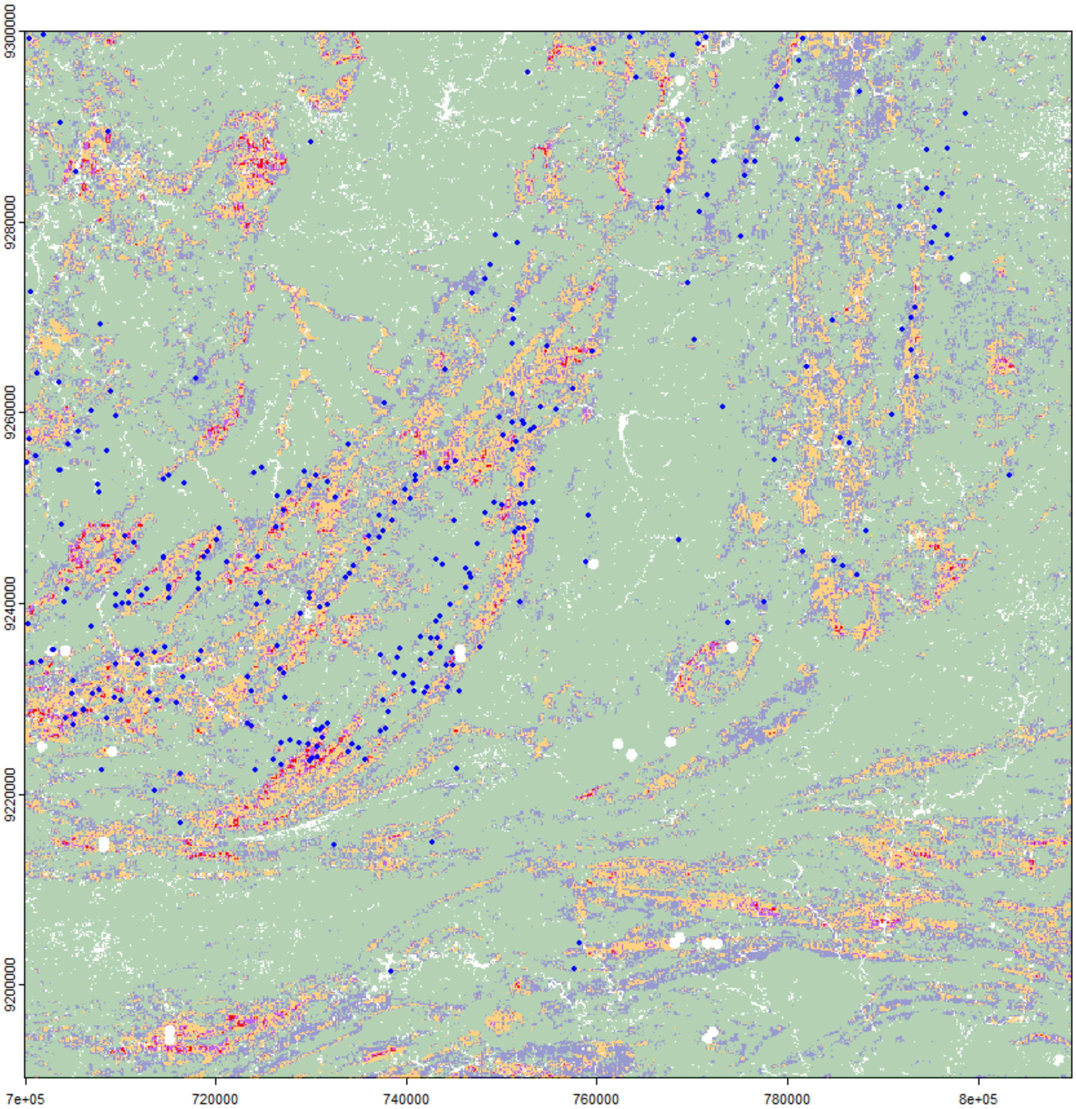
Mineral Exploration Targeting

PART 4 – Final Result Evaluation and Ranking



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PART 4

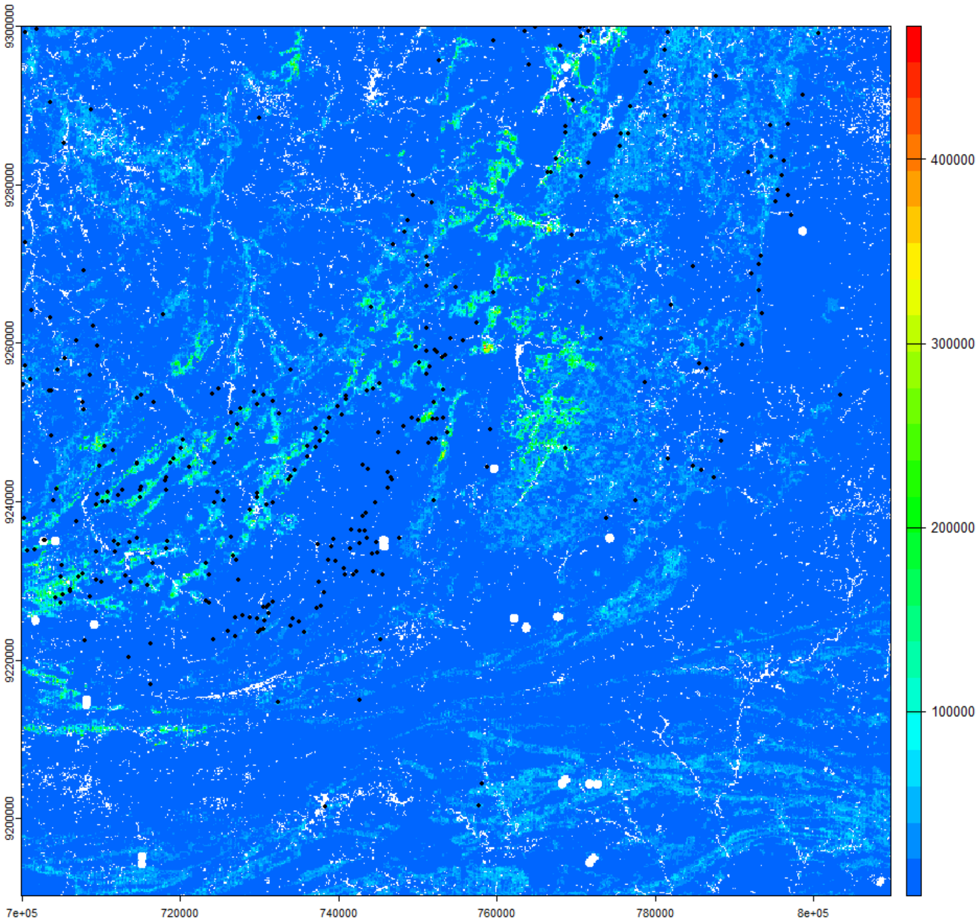
Result Evaluation

By completing a preliminary targeting result for Tungsten (W) it is possible now to have a deeper analysis of the result achieved.

Evaluation of results is most of the time a neglected step. Quite often, in targeting, wrong or hidden results can occur due to different population of a mineral good and/or ineffective layer/layers selection that will obfuscate the resulting ranking by giving weight where it doesn't exist. The careful evaluation of will, most of the time, improves the result.

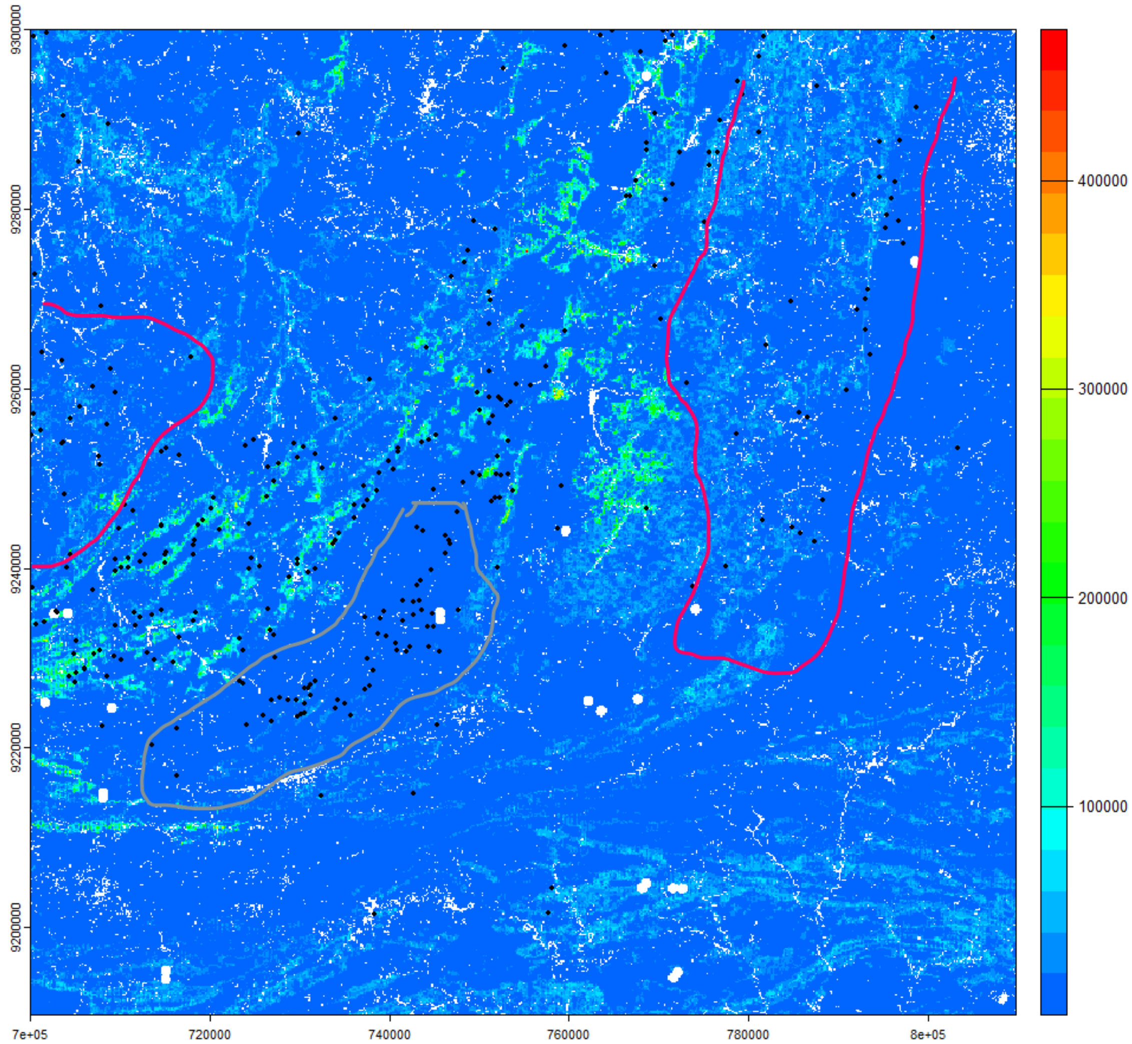
Load again all the layer with the weights defined in the last part using the weight of evidence stack and occurrence location as the starting point.

```
library(terra)
wd<-'C:/Users/User/Desktop/R algo/WDIR_P3'
setwd(wd)
train<-vect('tungst_occu.shp')
tgst<-rast(c('geoclass.tif','demclass.tif','crestclass.tif','kclass.tif',
             'uclass.tif','thclass.tif','tcclass.tif','uthclass.tif','ukclass.tif',
             'thkclass.tif','ffclass.tif','tmfclass.tif','asaclass.tif'))
multip<-tgst[[1]]*tgst[[2]]*tgst[[3]]*tgst[[4]]*tgst[[5]]*tgst[[6]]*tgst[[7]]*
        tgst[[8]]*tgst[[9]]*tgst[[10]]*tgst[[11]]*tgst[[2]]*tgst[[13]]
plot(multip,col=rainbow(24, start = 0.0, end = 0.6,rev=T))
plot(train,add=T,col='black',cex=0.5)
```



Different Population

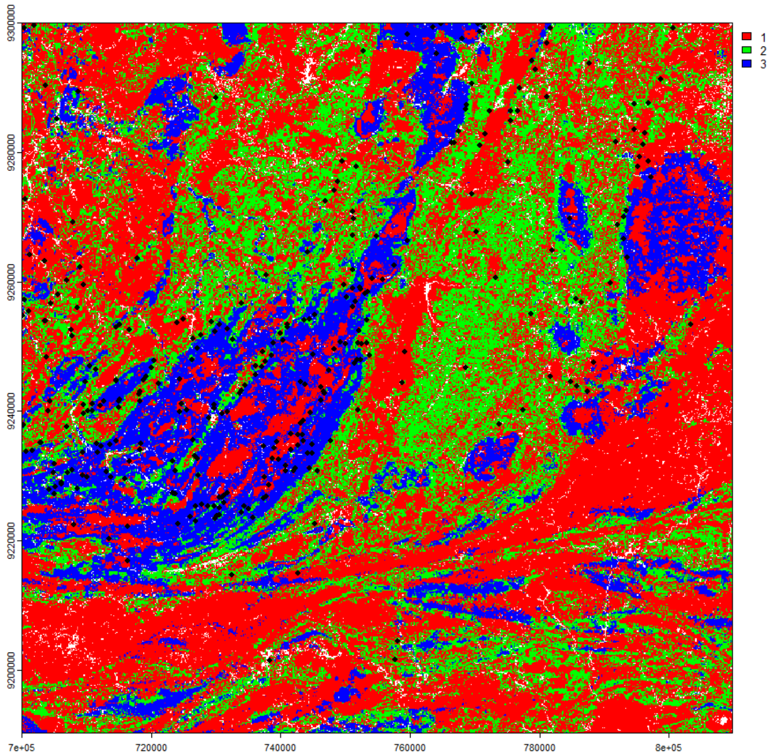
A reasonable number of the occurrences in the plot below lies on low potential zones (circled in gray) and quite a few on intermediary potential zones (circled in orange). The ideal scenario would be having most of the occurrences over or near high potential zones. The main cause of this distinctive behavior would be the presence of distinct populations of this type of occurrence, if all the data used is correct.



To better visualize the distinct populations of occurrences the series below using isolated ranking layers will be evaluated.

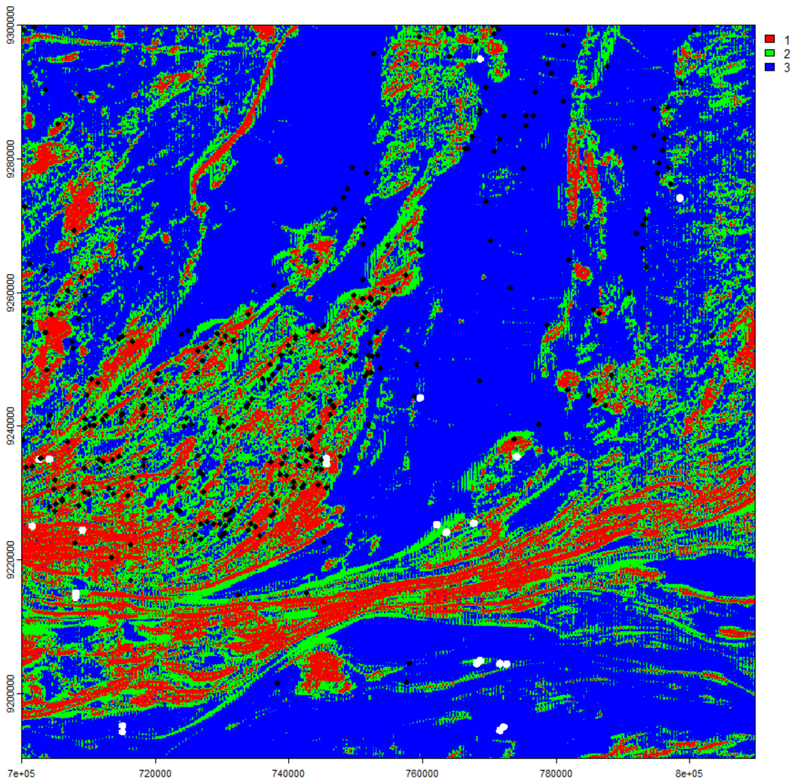
Geology

```
plot(tgst[[1]],col=rainbow(3))
plot(train,add=T,col='black',cex=0.9)
```



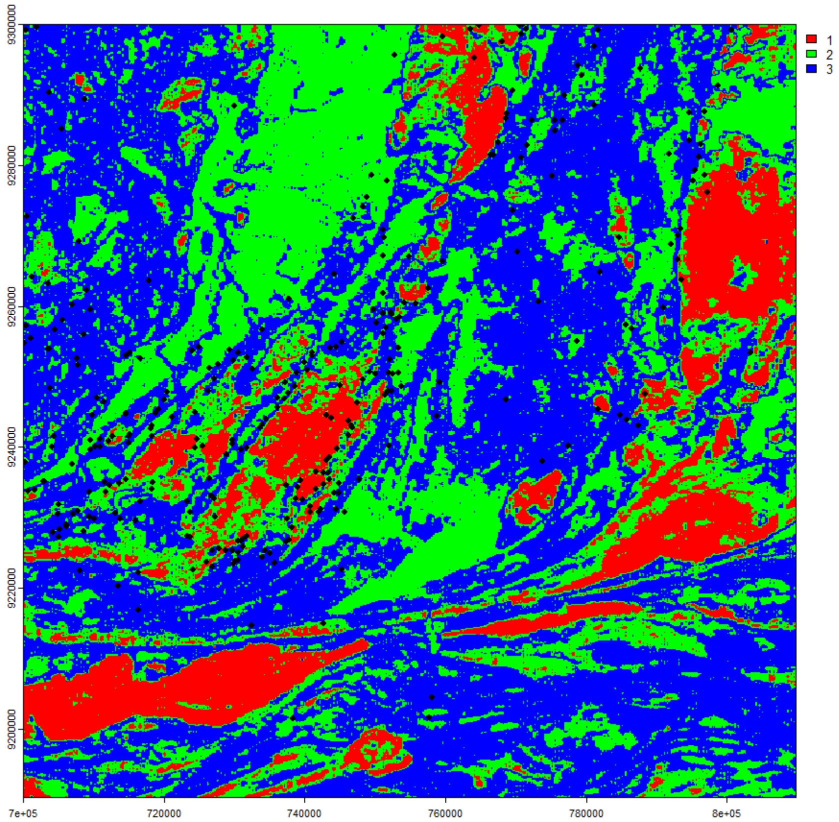
Analytical Signal

```
plot(tgst[[13]],col=rainbow(3))
plot(train,add=T,col='black',cex=0.9)
```

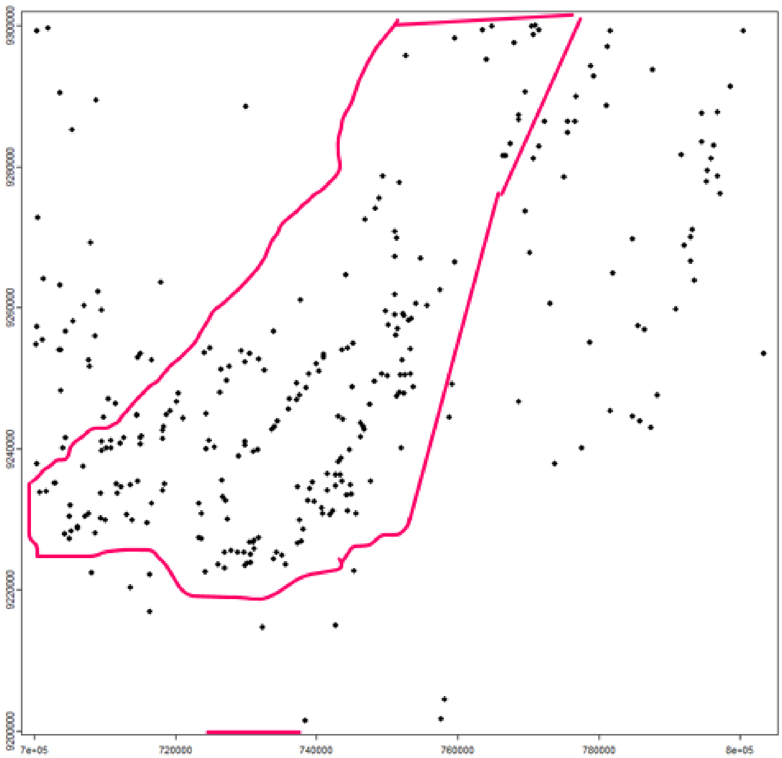


K

```
plot(tgst[[4]],col=rainbow(3))
plot(train,add=T,col='black',cex=0.9)
```



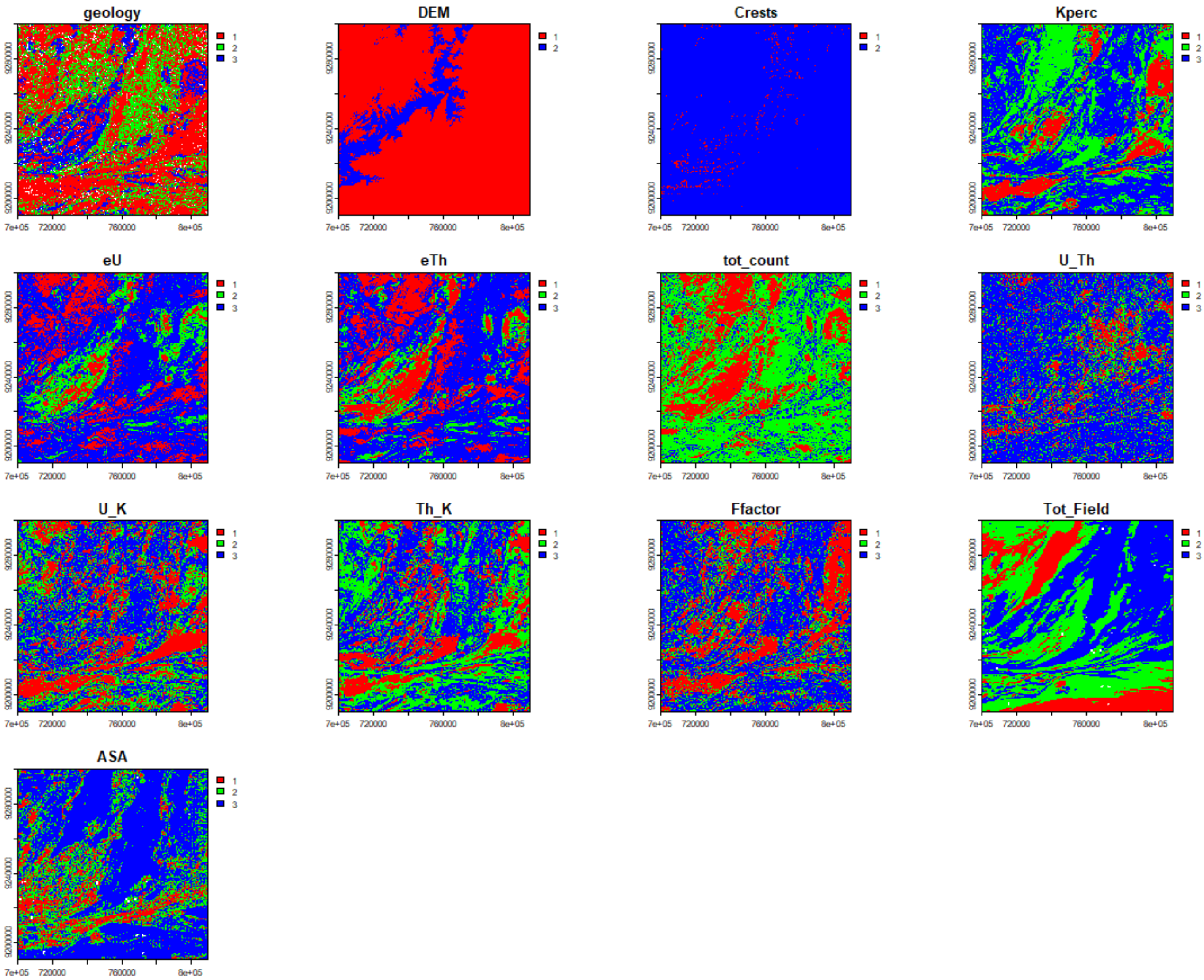
It becomes clear that we have a distinct population and it will be used to create a new preliminary target layer (using only the occurrence data circled in red).



Relevant Layer

After selecting the population to be used it is time to select the relevant layer for the final targeting on this population.

```
plot(tgst,col=rainbow(3))
```

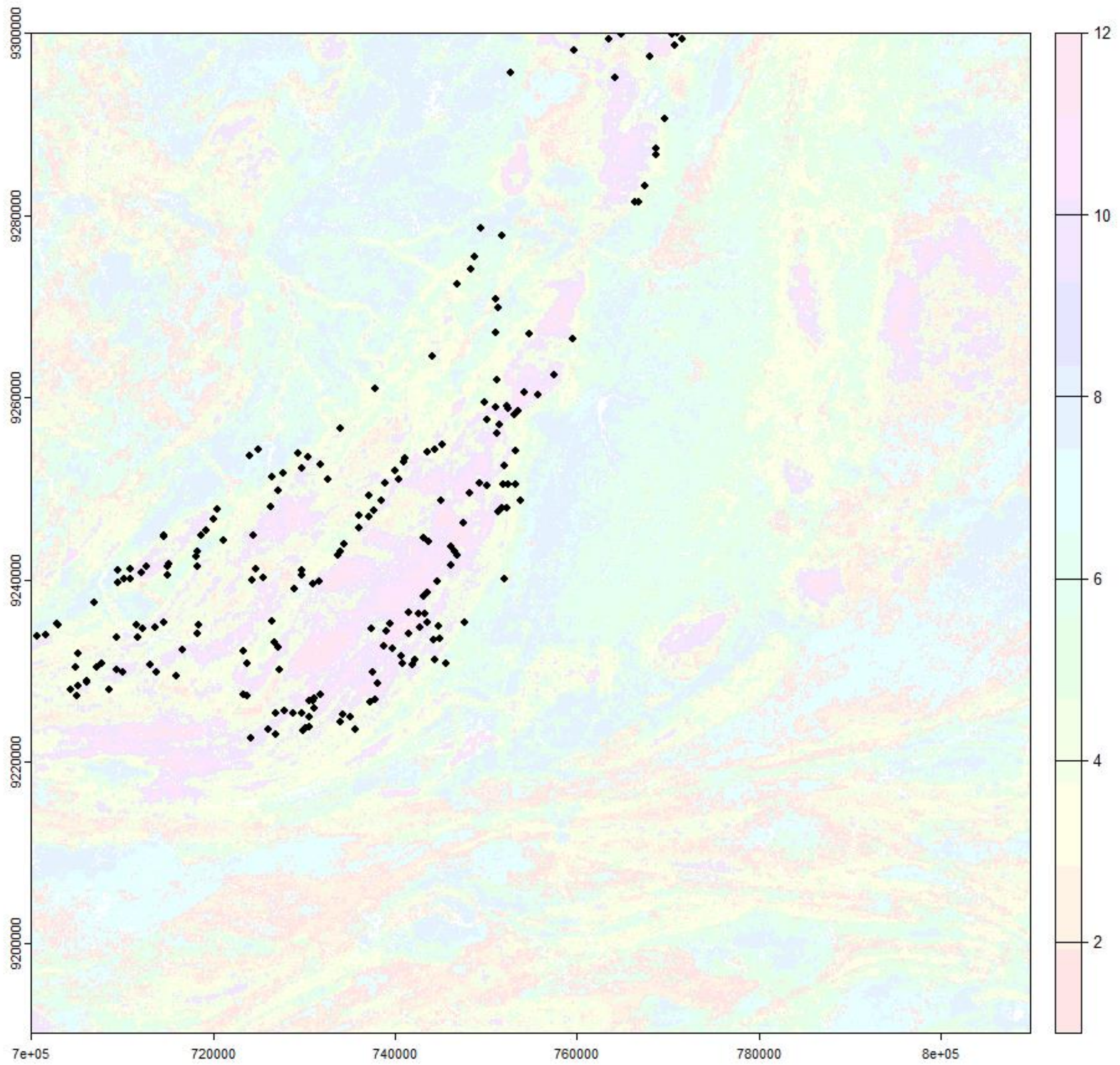


The best fit for this W population targeting is to use the layers Geology, Kperc, eU, eTh, Ffactor and ASA.

Ranking

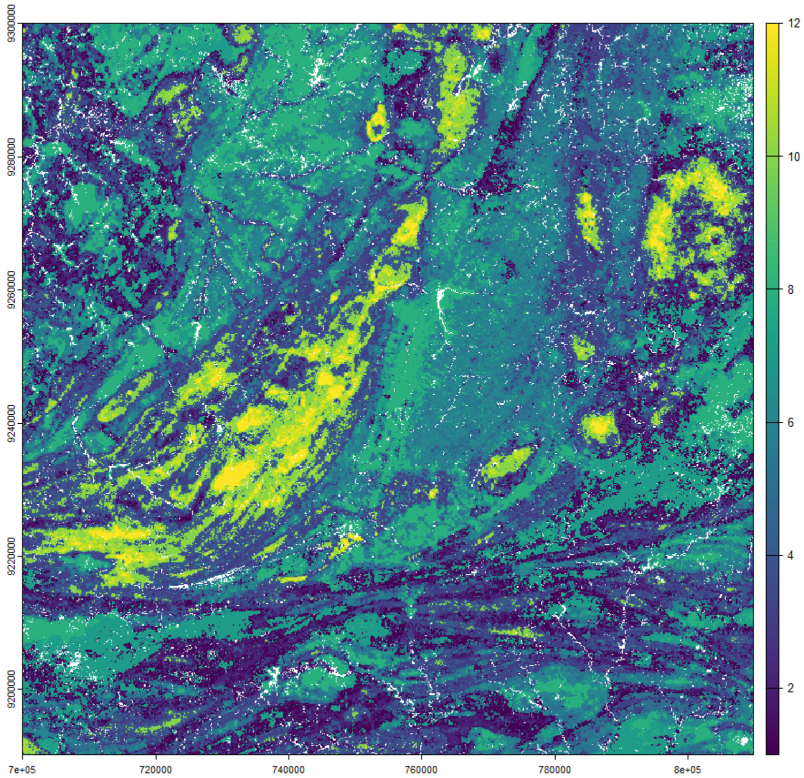
Executing the final targeting and ranking for the selected W occurrence population.

```
library(terra)
#Working directory where the images and data are located
wd<-'C:/Users/User/Desktop/R algo/WDIR_P3'
setwd(wd)
train<-vect('tungst_Pop1.shp')
targ<-rast('targ_stack.tif')
plot(targ[[1]],alpha=0.1,col=rainbow(12))
plot(train,col='black',cex=0.9,add=T)
```

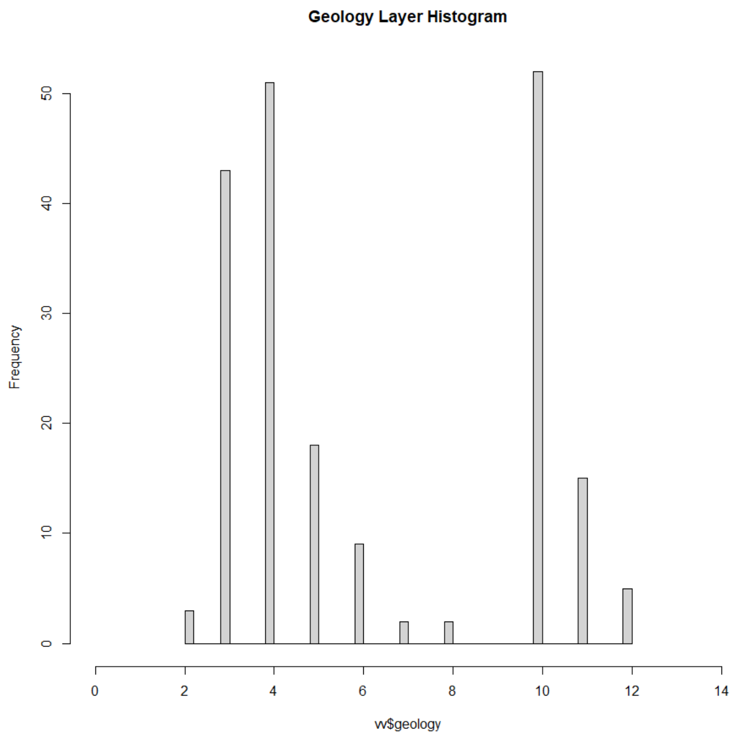


Geology

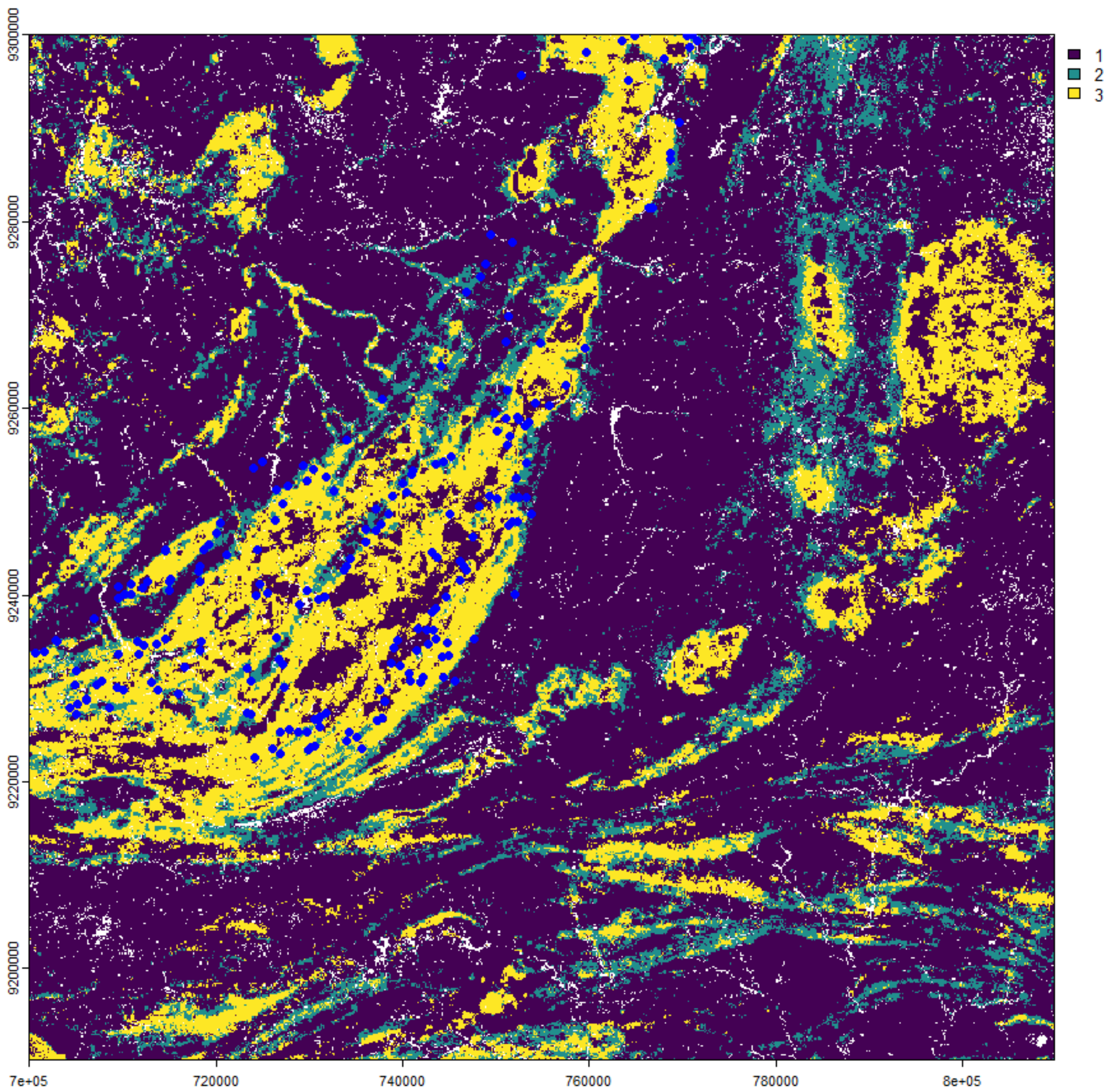
```
geo1<-targ[[1]]
v <- na.omit(terra::extract(geo1, train,xy=T, method = "simple", ID=F))
vv<-vect(v,geom=c('x','y'))
plot(geo1)
```




```
hist(vv$geology,xlim=c(0,14),n=70,main= 'Geology Layer Histogram')
```



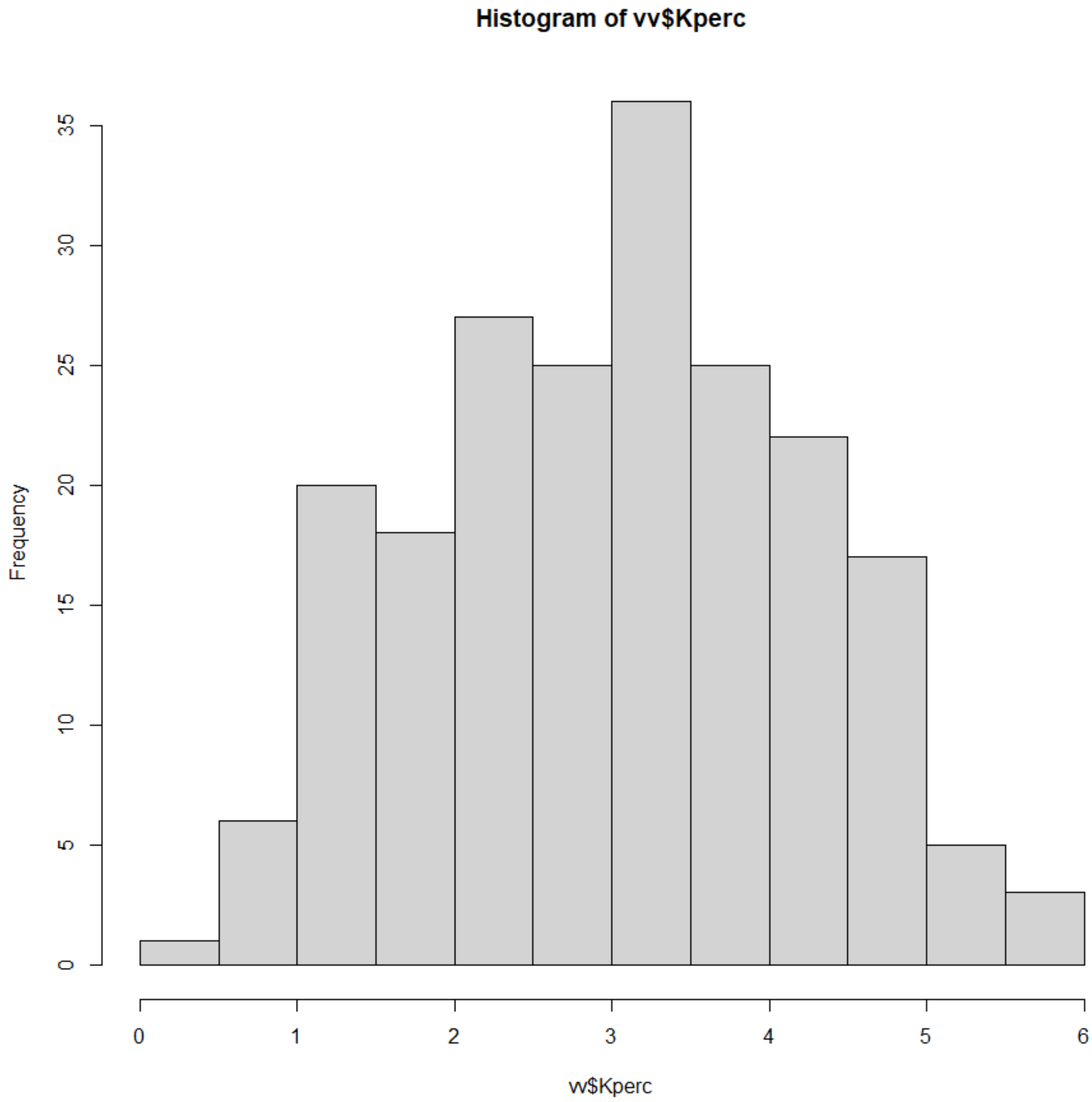
```
geoClass<-geo1
geoClass[geoClass==1 | geoClass ==2 | geoClass ==5 | geoClass ==7 | geoClass ==8 |
geoClass ==11 | geoClass ==12 | geoClass ==6]<-1
geoClass[geoClass==3]<-2
geoClass[geoClass ==4 | geoClass ==10]<-3
plot(geoClass)
plot(vv,add=T,col='blue')
```



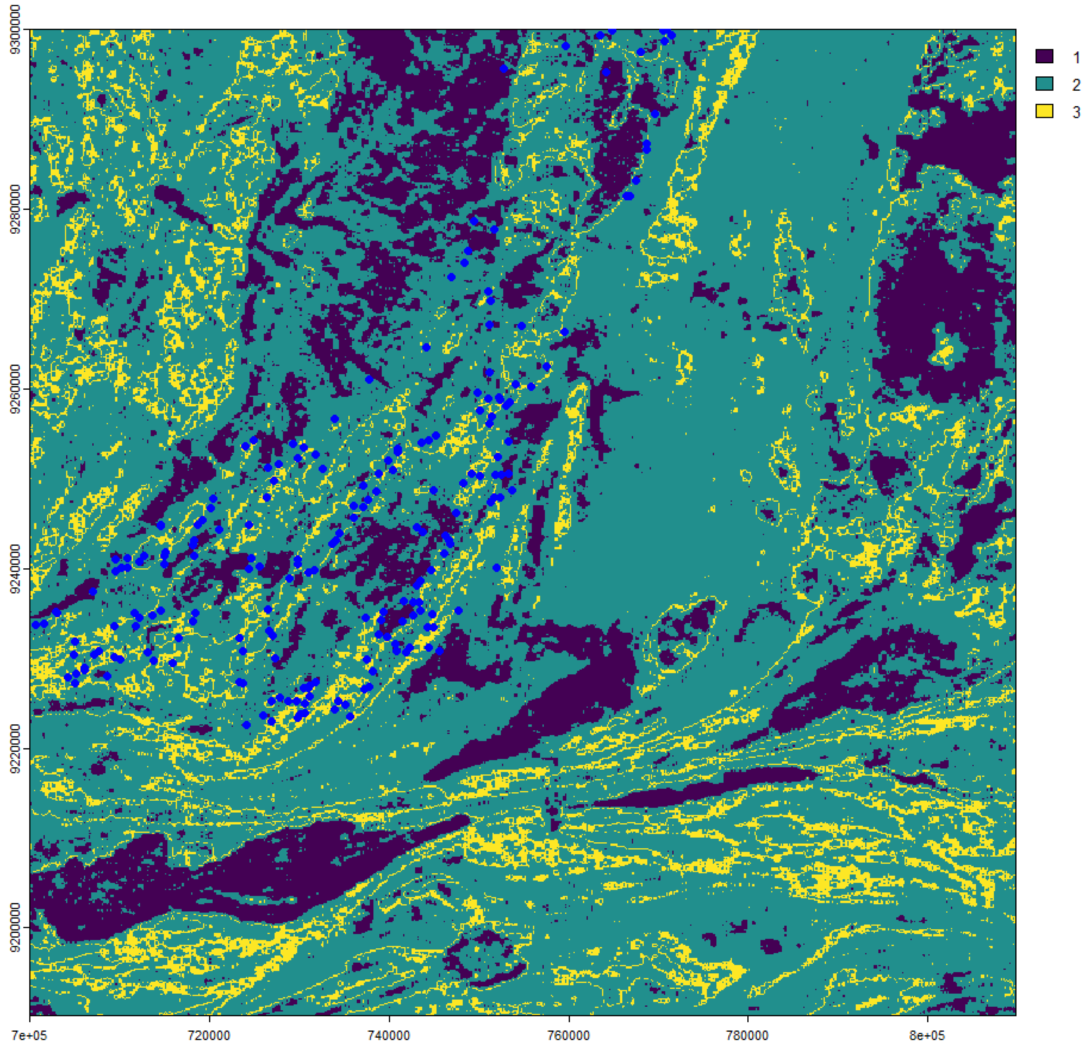

```
writeRaster(geoClass,'geoPop1.tif', overwrite=TRUE)
```

K

```
k<-targ[[6]]
v <- na.omit(terra::extract(k, train,xy=T, method = "simple", ID=F))
vv<-vect(v,geom=c('x','y'))
hist(vv$Kperc,n=10)# 3 to 3.5 good, 1 to 3 and 3.5 to 4.5 moderate
```



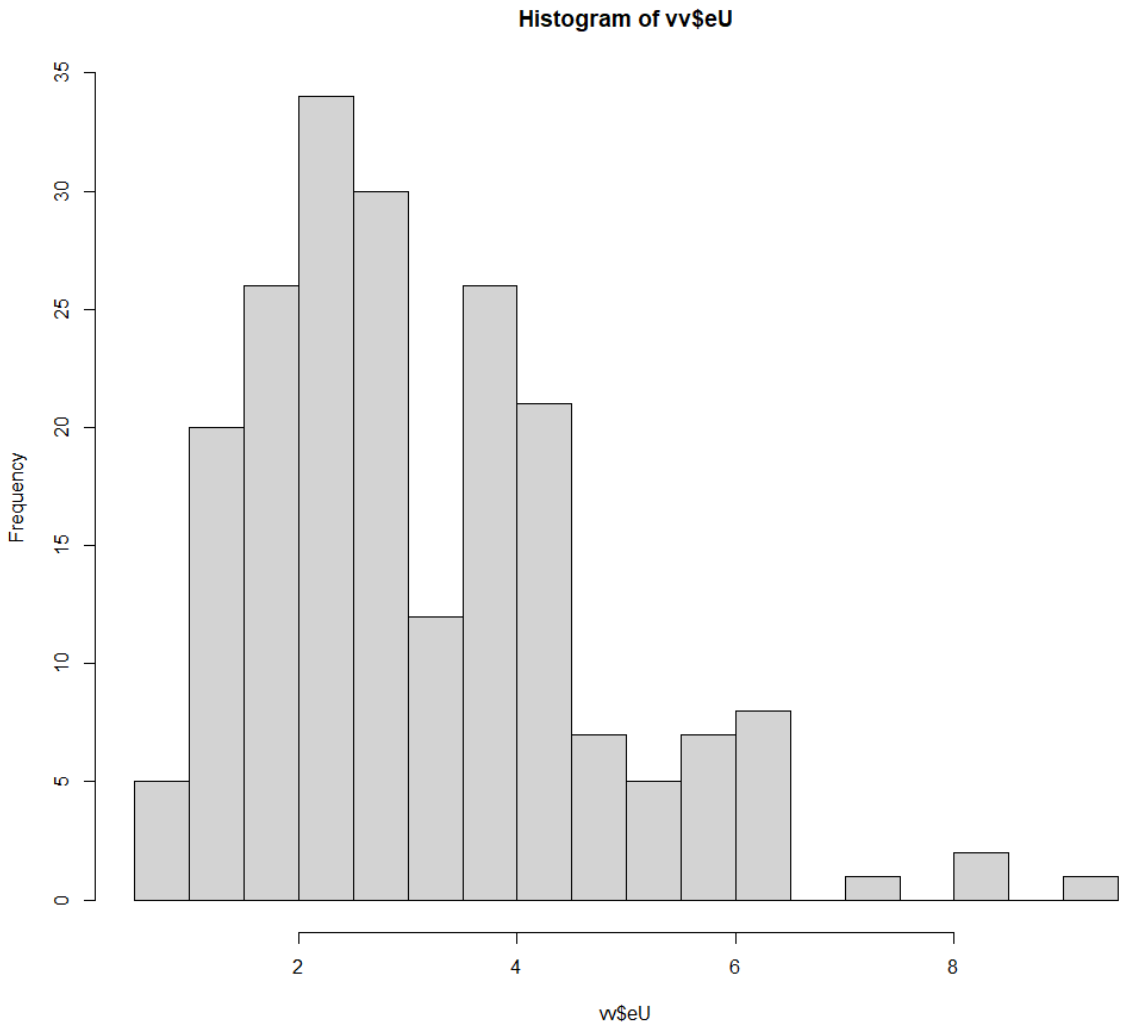

```
kClass <-k
kClass[kClass$Kperc >=3 & kClass$Kperc < 3.5]<-3000
kClass[kClass$Kperc >=1 & kClass$Kperc < 3]<-2000
kClass[kClass$Kperc >=3.5 & kClass$Kperc < 5]<-2000
kClass[kClass$Kperc < 1]<-1000
kClass[kClass$Kperc >= 5 & kClass$Kperc<2000]<-1000
kClass[kClass$Kperc == 1000]<-1
kClass[kClass$Kperc == 2000]<-2
kClass[kClass$Kperc == 3000]<-3
plot(kClass)
plot(vv,add=T,col='blue')
```



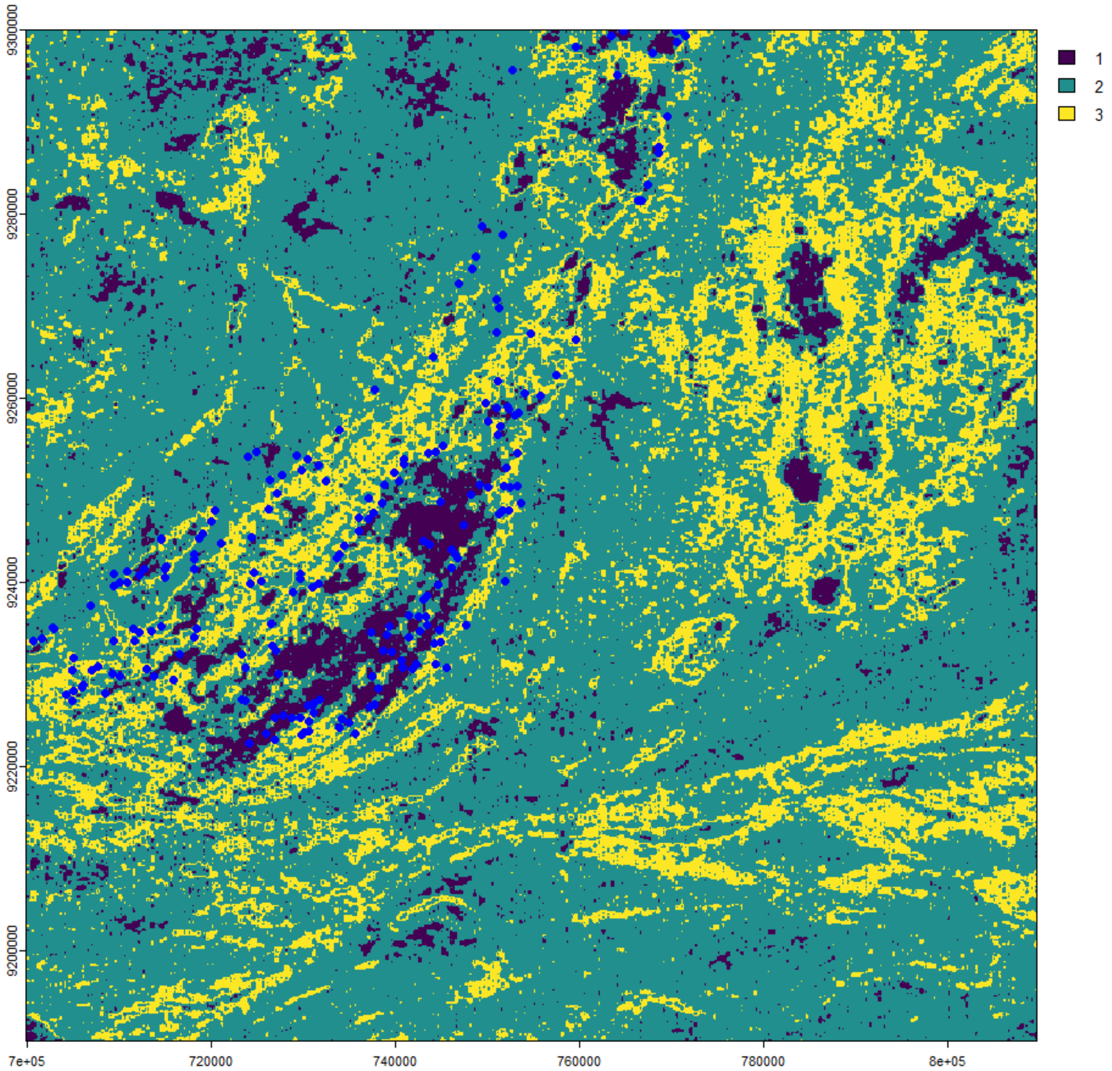

```
writeRaster(kClass,'kPop1.tif', overwrite=TRUE)
```

U

```
u<-targ[[7]]
v <- na.omit(terra::extract(u, train,xy=T, method = "simple", ID=F))
vv<-vect(v,geom=c('x','y'))
hist(vv$eU,n=15)# 2 to 3 good, 0.5 to 2 and 3 to 4.5 moderate
```



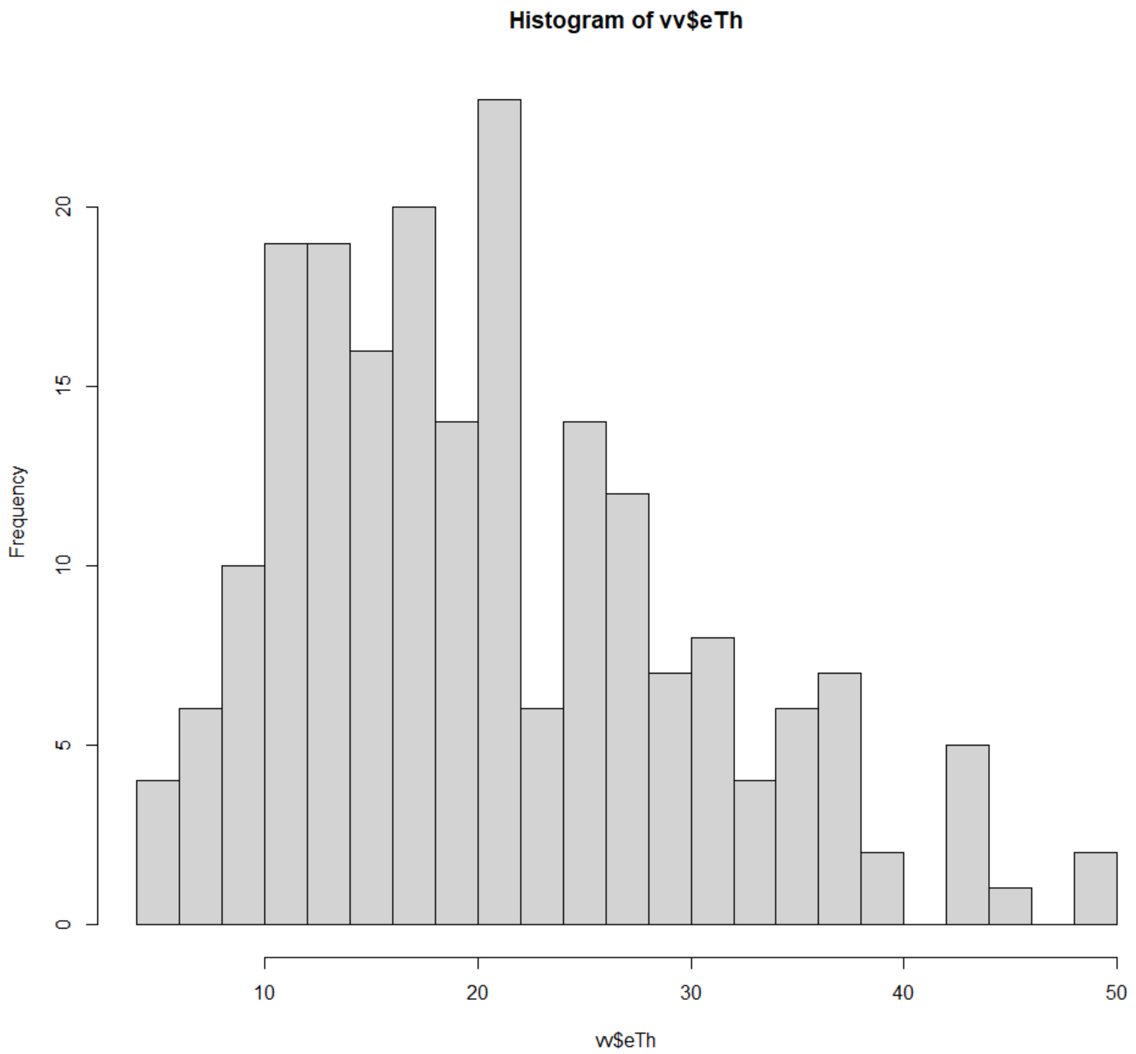

```
uClass<-u
uClass[uClass$eU >=2 & uClass$eU < 3]<-3000
uClass[uClass$eU >=0.5 & uClass$eU < 3]<-2000
uClass[uClass$eU >=3 & uClass$eU < 4.5]<-2000
uClass[uClass$eU < 0.5]<-1000
uClass[uClass$eU >= 4.5 & uClass$eU<2000]<-1000
uClass[uClass$eU == 1000]<-1
uClass[uClass$eU == 2000]<-2
uClass[uClass$eU == 3000]<-3
plot(uClass)
plot(vv,add=T,col='blue')
```



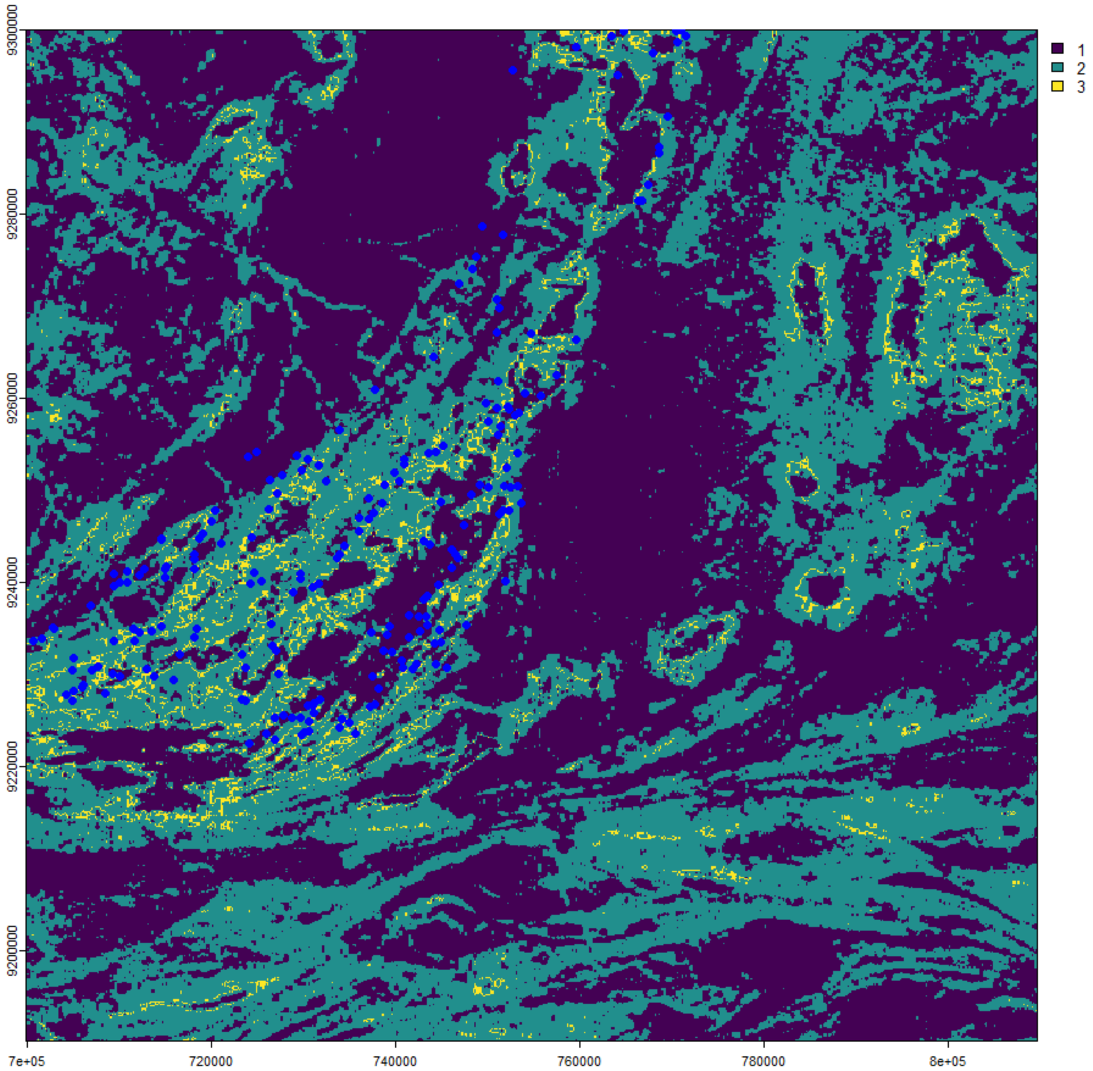

```
writeRaster(uClass, 'uPop1.tif', overwrite=TRUE)
```

Th

```
th<-targ[[8]]
v <- na.omit(terra::extract(th, train,xy=T, method = "simple", ID=F))
vv<-vect(v,geom=c('x','y'))
hist(vv$eTh,n=20)# 20 to 22 good, 10 to 20 and 22 to 28 moderate
```



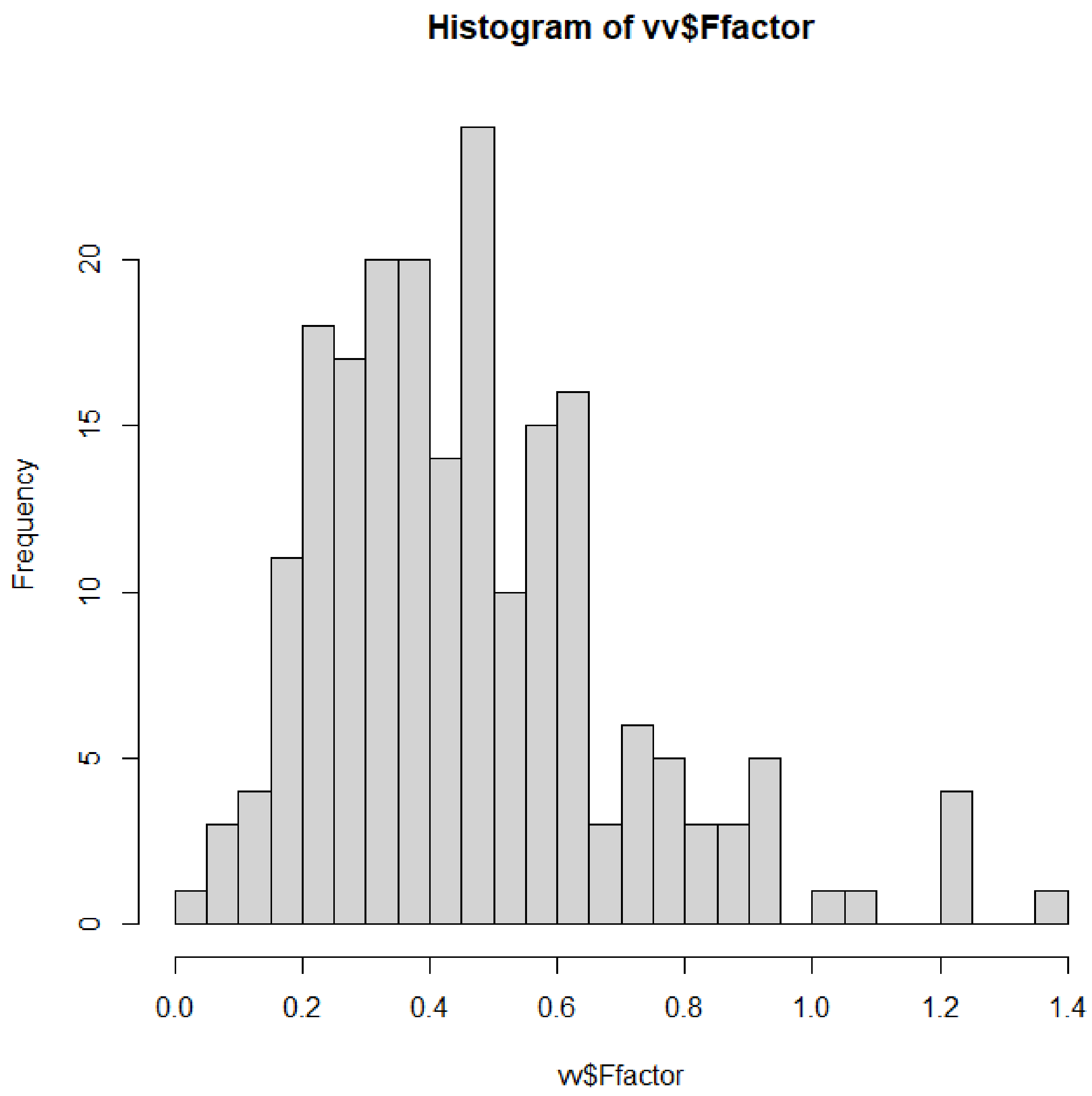

```
classTh<-th
classTh[classTh$eTh >=20 & classTh$eTh < 22]<-3000
classTh[classTh$eTh >=10 & classTh$eTh < 20]<-2000
classTh[classTh$eTh >=22 & classTh$eTh < 28]<-2000
classTh[classTh$eTh < 10]<-1000
classTh[classTh$eTh >= 28 & classTh$eTh<2000]<-1000
classTh[classTh$eTh == 1000]<-1
classTh[classTh$eTh == 2000]<-2
classTh[classTh$eTh == 3000]<-3
plot(classTh)
plot(vv,add=T,col='blue')
```



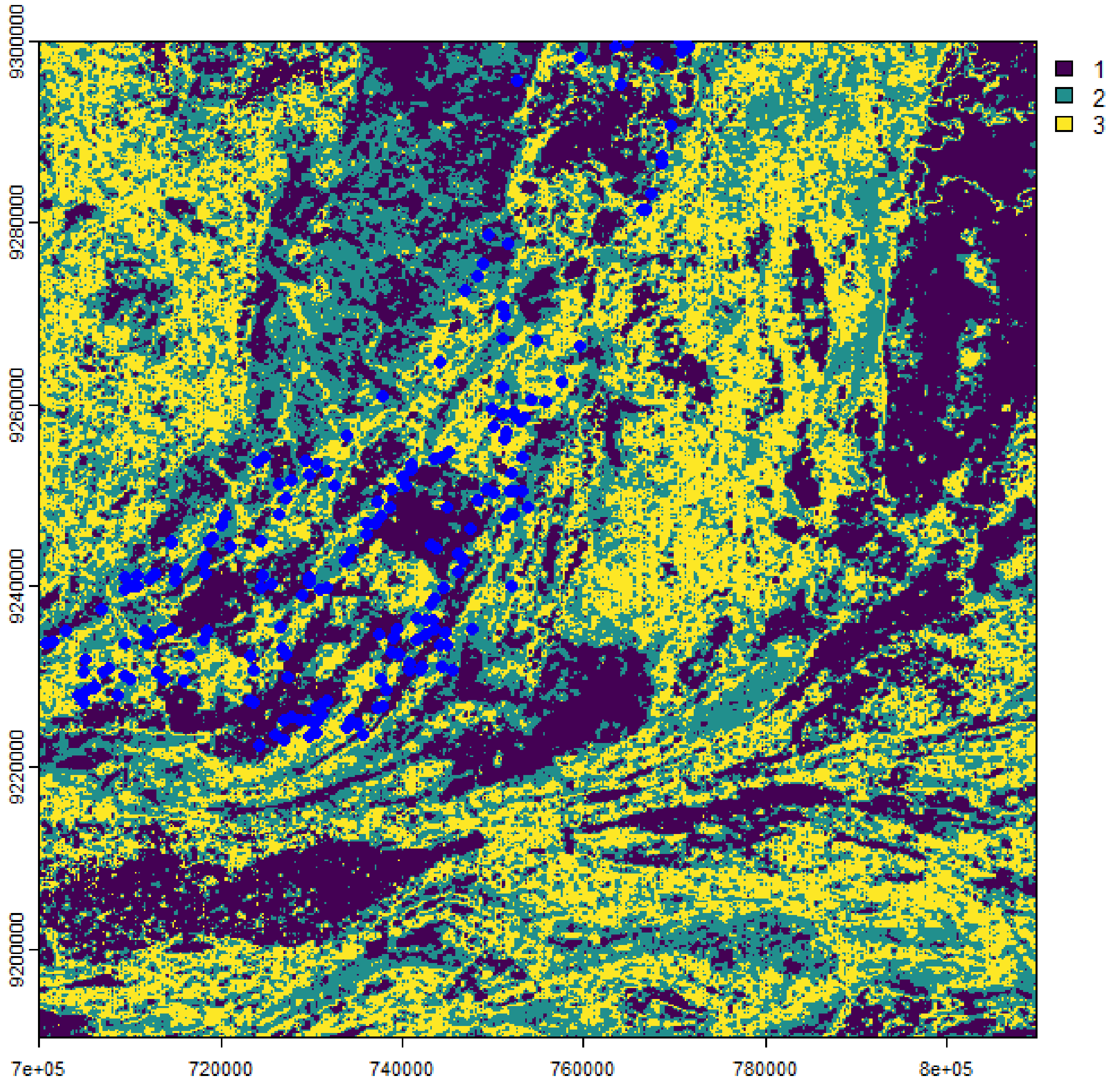

```
writeRaster(classTh, 'thPop1.tif', overwrite=TRUE)
```

F Factor

```
ff<-targ[[13]]
v <- na.omit(terra::extract(ff, train,xy=T, method = "simple", ID=F))
vv<-vect(v,geom=c('x','y'))
hist(vv$Ffactor,n=20)# 0.3 to 0.5 good,0.5 to 0.65 and 0,15 to 0.3 moderate
```



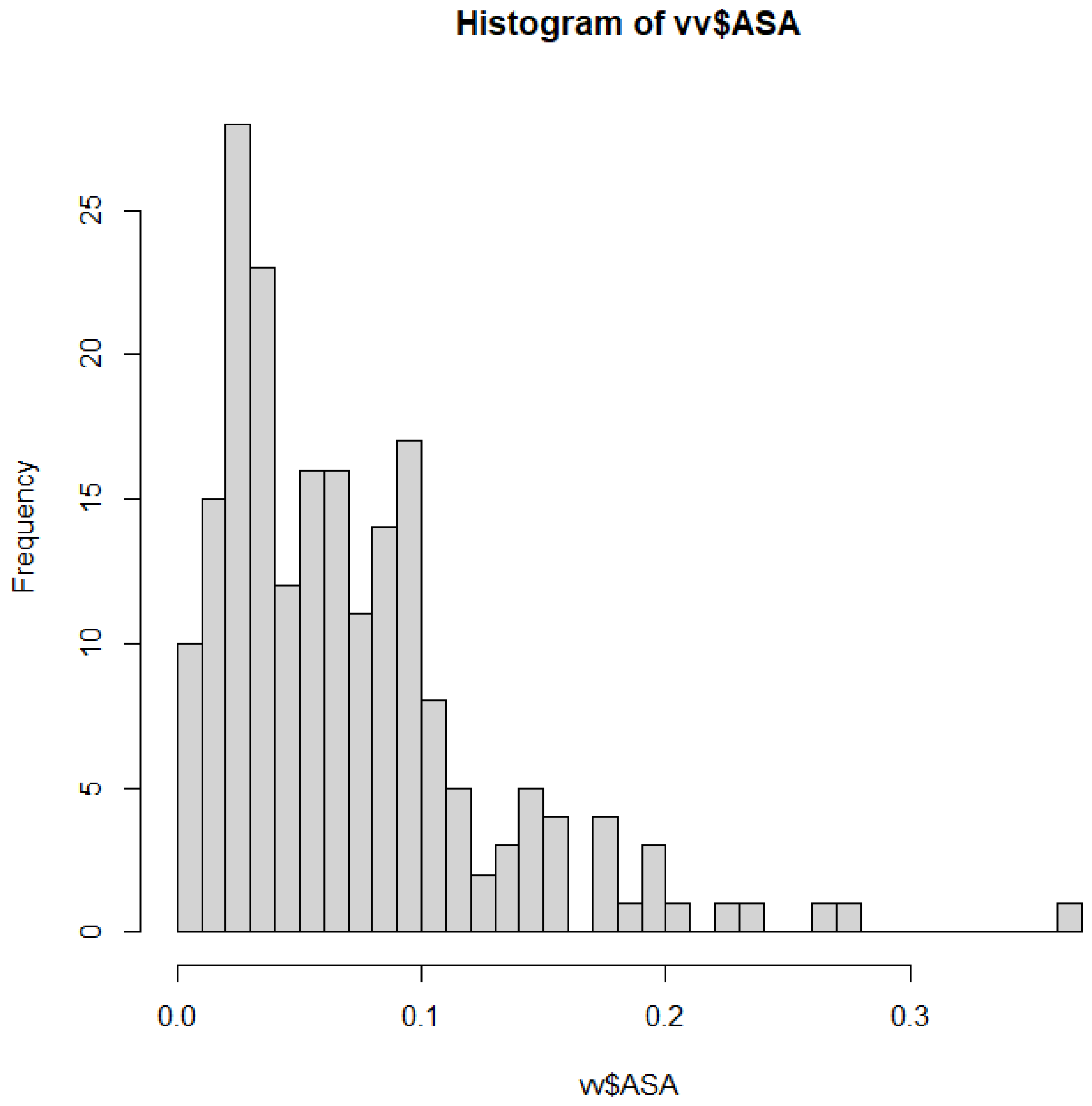

```
classFF<-ff
classFF[classFF$Ffactor >=0.3 & classFF$Ffactor < 0.5]<-3000
classFF[classFF$Ffactor >=0.5 & classFF$Ffactor < 0.65]<-2000
classFF[classFF$Ffactor >=0.15 & classFF$Ffactor < 0.3]<-2000
classFF[classFF$Ffactor < 0.15]<-1000
classFF[classFF$Ffactor >= 0.65 & classFF$Ffactor<2000]<-1000
classFF[classFF$Ffactor == 1000]<-1
classFF[classFF$Ffactor == 2000]<-2
classFF[classFF$Ffactor == 3000]<-3
plot(classFF)
plot(vv,add=T,col='blue')
```



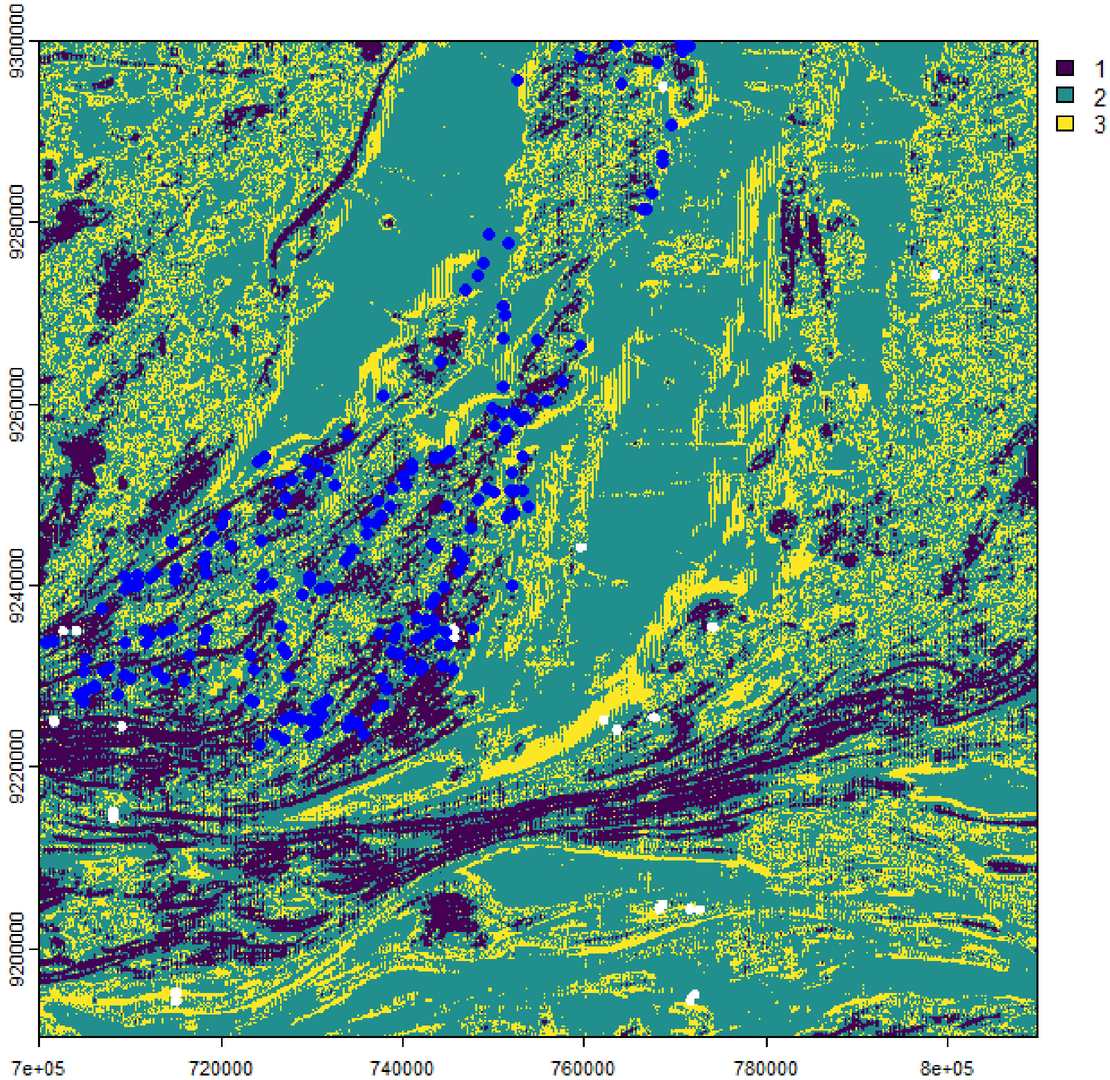

```
writeRaster(classFF, 'ffPop1.tif', overwrite=TRUE)
```

ASA

```
asa<-targ[[15]]
v <- na.omit(terra::extract(asa, train,xy=T, method = "simple", ID=F))
vv<-vect(v,geom=c('x','y'))
hist(vv$ASA,n=50)#0.02 to 0.04 good,0.04 to 0.1 and 0 to 0.02moderate
```



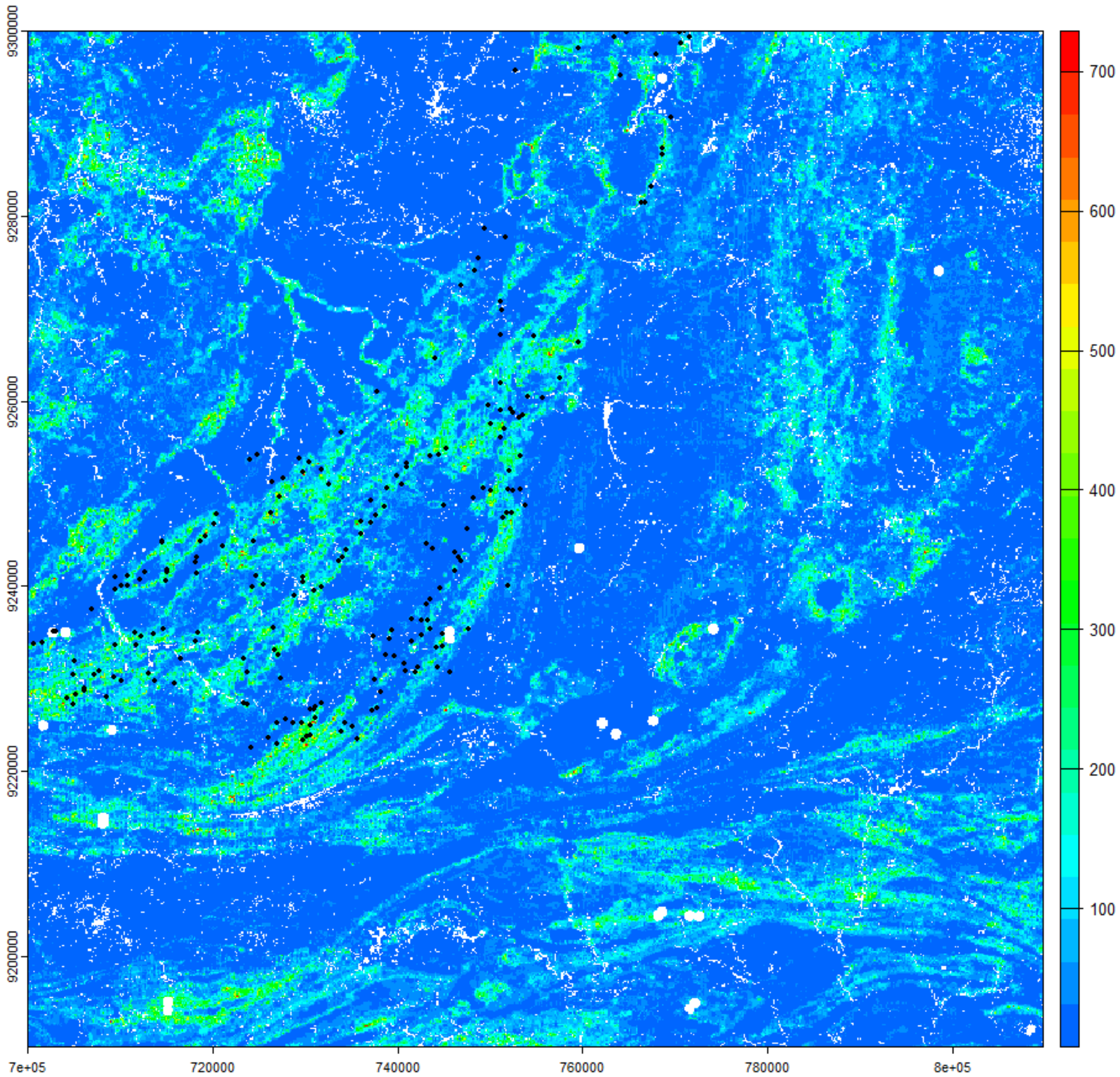

```
classASA<-asa
classASA[classASA$ASA >= 0.02 & classASA$ASA < 0.04]<-3000
classASA[classASA$ASA >= 0.04 & classASA$ASA < 0.1]<-2000
classASA[classASA$ASA >= 0.0 & classASA$ASA < 0.02]<-2000
classASA[classASA$ASA >= 0.1 & classASA$ASA < 2000]<-1000
classASA[classASA$ASA == 1000]<-1
classASA[classASA$ASA == 2000]<-2
classASA[classASA$ASA == 3000]<-3
plot(classASA)
plot(vv,add=T,col='blue')
```




```
writeRaster(classASA, 'asaPop1.tif', overwrite=TRUE)
```

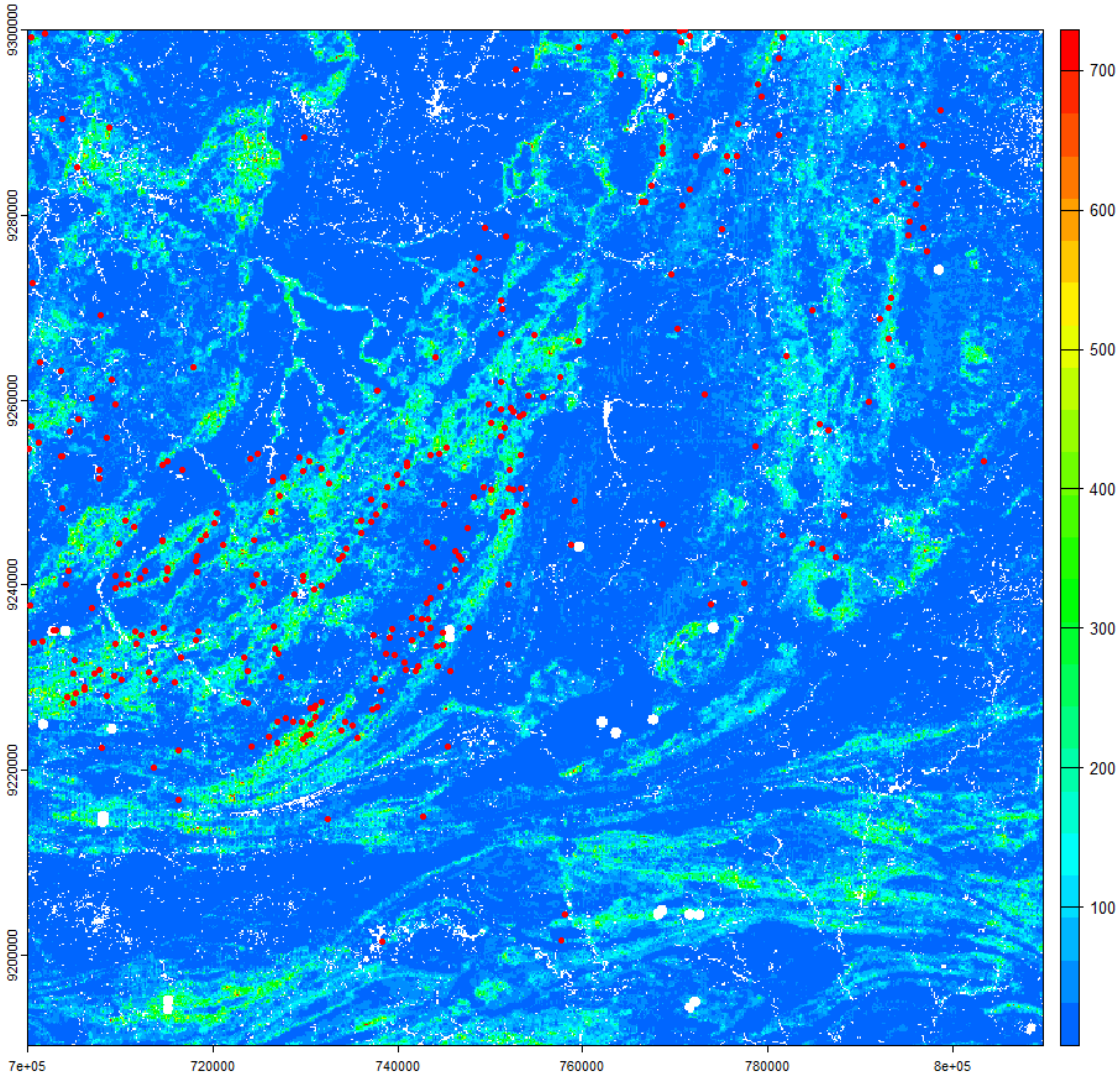
Now we construct our stack with all relevant layers resulting from the statistical analysis completed above. Multiplication of layers is done to enhance the high probability zones.

```
tgst<-rast(c('geoPop1.tif','kPop1.tif','uPop1.tif','thPop1.tif','ffPop1.tif',
             'asaPop1.tif'))
multip<-tgst[[1]]*tgst[[2]]*tgst[[3]]*tgst[[4]]*tgst[[5]]*tgst[[6]]
plot(multip,col=rainbow(24,rev=T,start=0,end=0.6))
plot(train,add=T,col='black',cex=0.5)
```



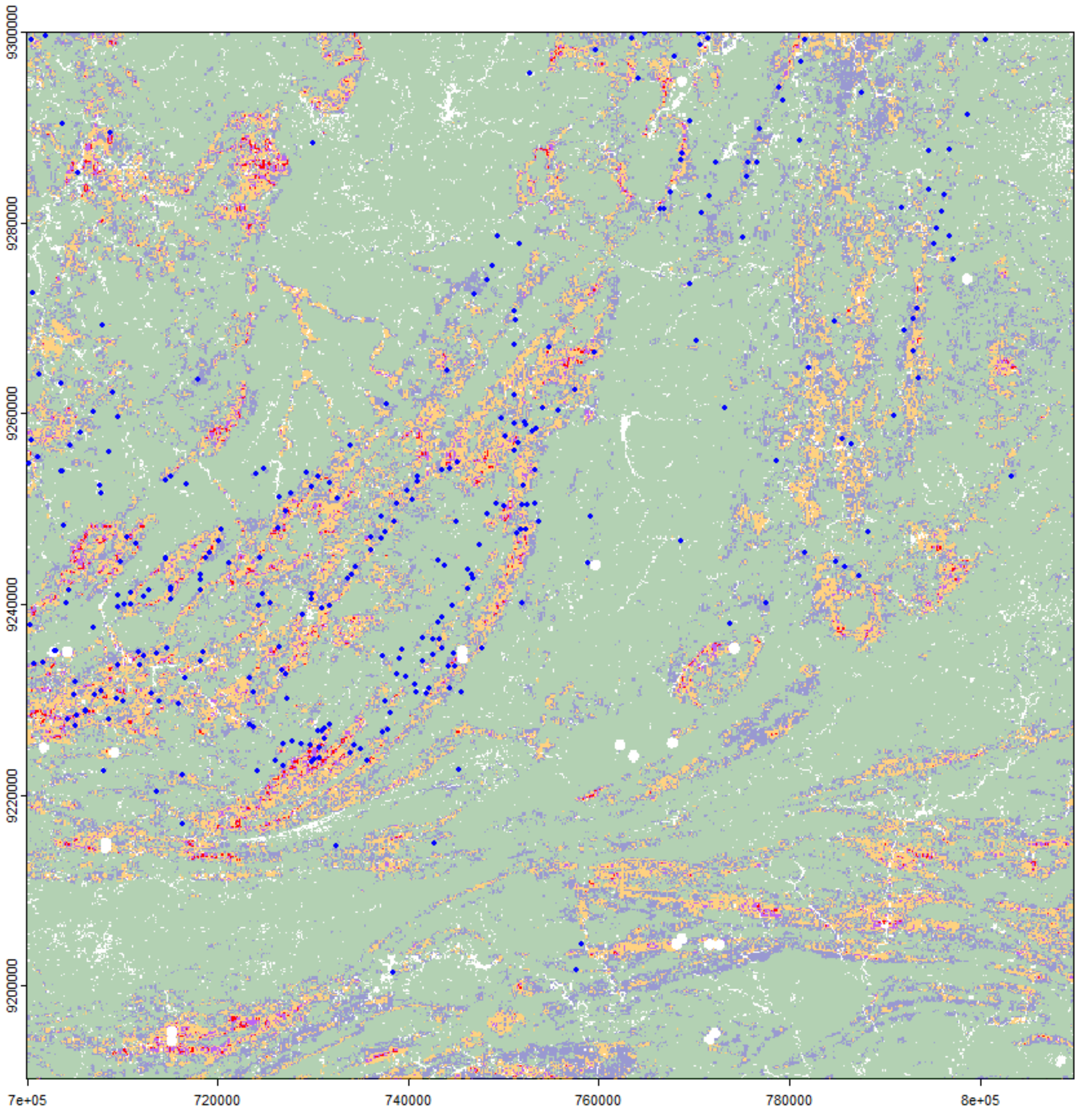
The result plotted above shows a more concise response with the new population characterization. Even for the original population plotted against this new result (plot below) shows a strong correlation. This gives us an assurance that we achieved a satisfactory targeting result using the geological knowledge to interpret and adapt the preliminary result and generate the final and refined targeting result.

```
plot(multip,col=rainbow(24,rev=T,start=0,end=0.6))
ori<-vect('tungst_occu.shp')
plot(ori,add=T,col='red',cex=0.7)
```



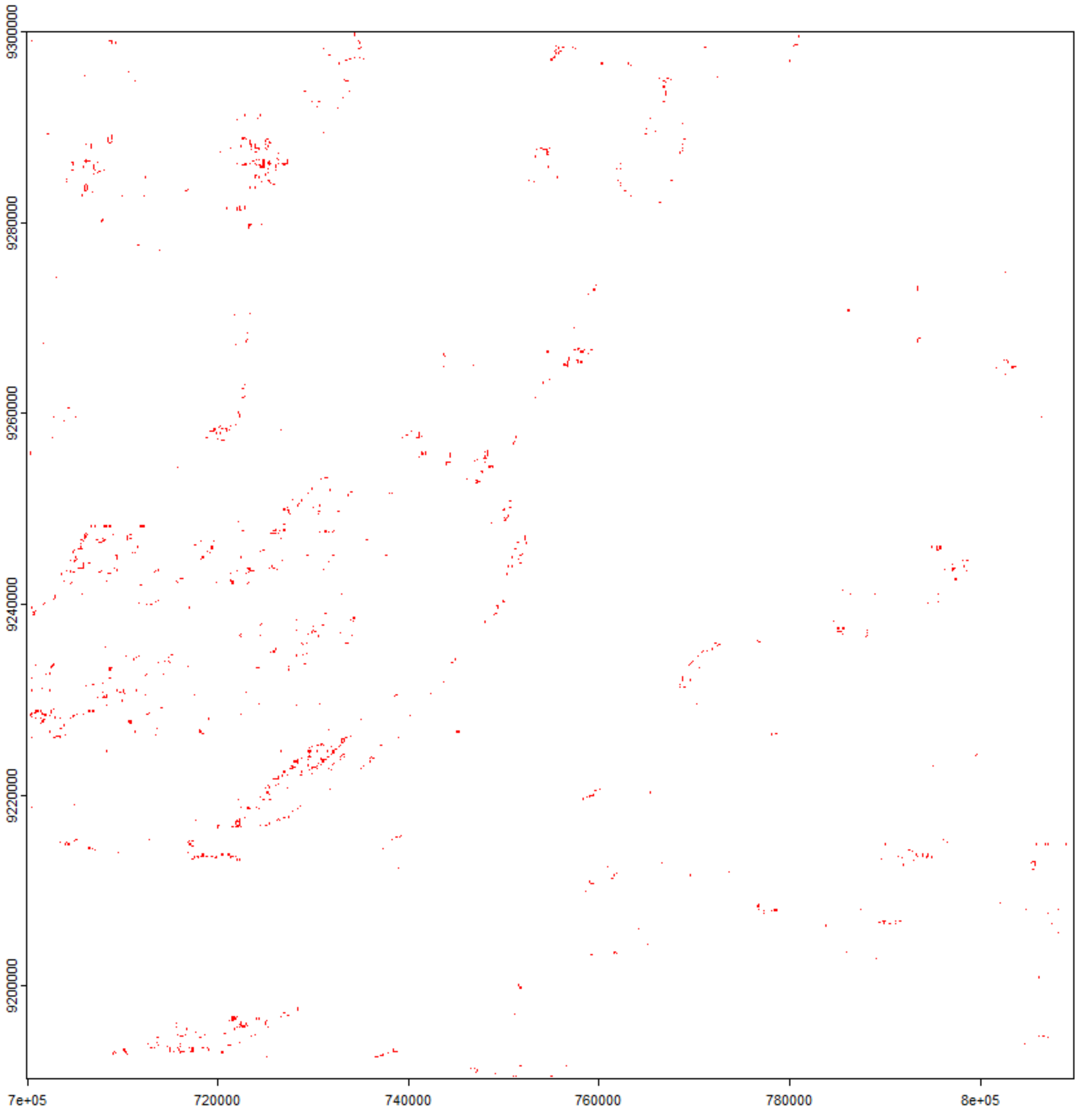
The plot below will use ranges that will illustrate the categories achieved in this resulting layer.

```
plot(multip,range=c(480,729),col='red',legend=F)
plot(multip,range=c(320,480),col='purple',add=T,legend=F,alpha=0.7)
plot(multip,range=c(100,320),col='orange',add=T,legend=F,alpha=0.5)
plot(multip,range=c(50,100),col='darkblue',add=T,legend=F,alpha=0.4)
plot(multip,range=c(0,50),col='darkgreen',add=T,legend=F,alpha=0.3)
plot(ori,add=T,col='blue',cex=0.5)
```



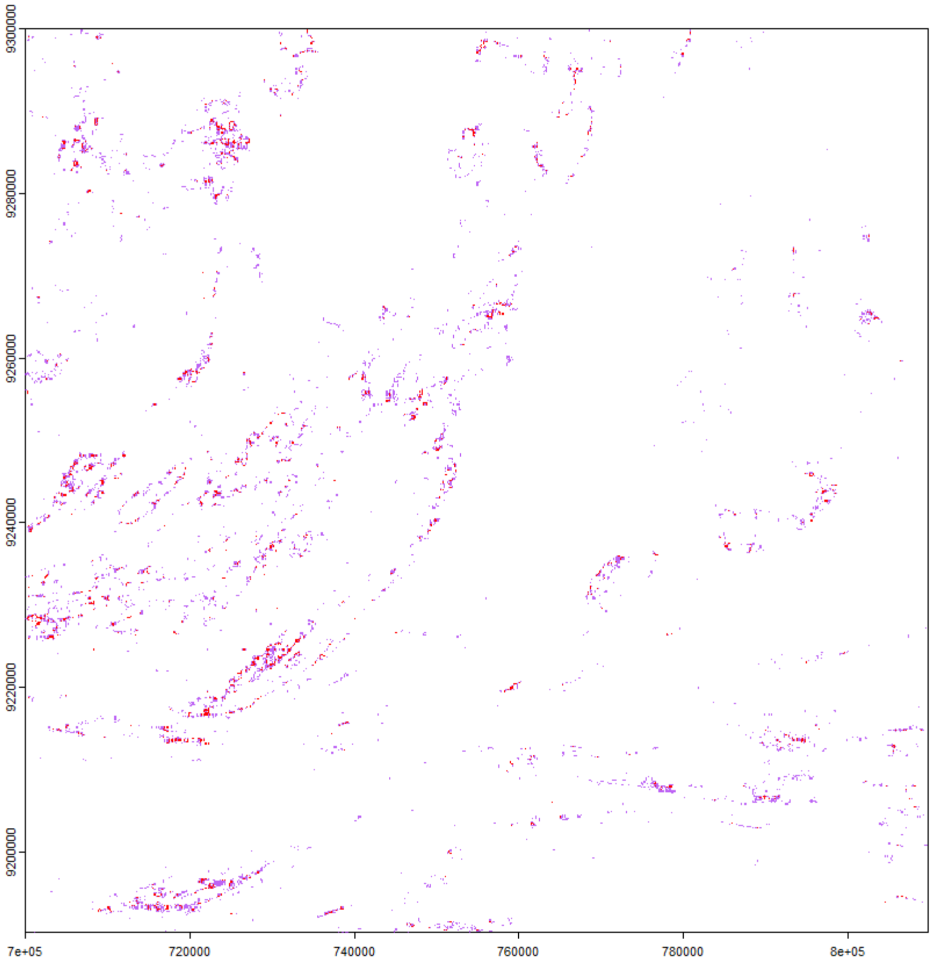
Best results plot.

```
plot(multip,range=c(480,729),col='red',legend=F)
```



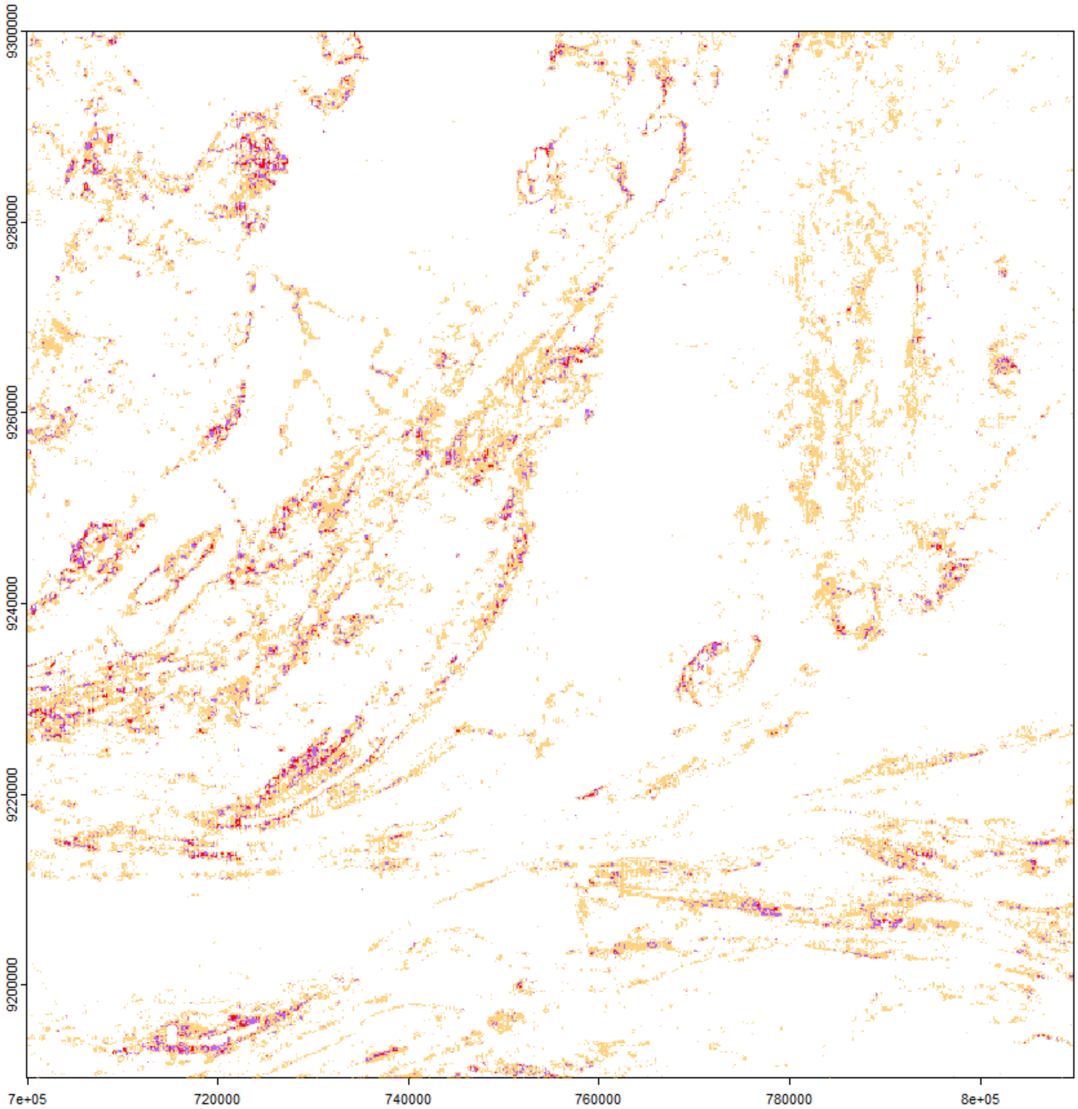
Best and second best results plot.

```
plot(multip,range=c(480,729),col='red',legend=F)
plot(multip,range=c(320,480),col='purple',add=T,legend=F,alpha=0.7)
```



Best, second best and third best results plot.

```
plot(multip,range=c(480,729),col='red',legend=F)
plot(multip,range=c(320,480),col='purple',add=T,legend=F,alpha=0.7)
plot(multip,range=c(100,320),col='orange',add=T,legend=F,alpha=0.5)
```



Conclusion

We conclude by creating a final ranking layer from 1 to 5 where:

5 → High Probability to find W mineralization.

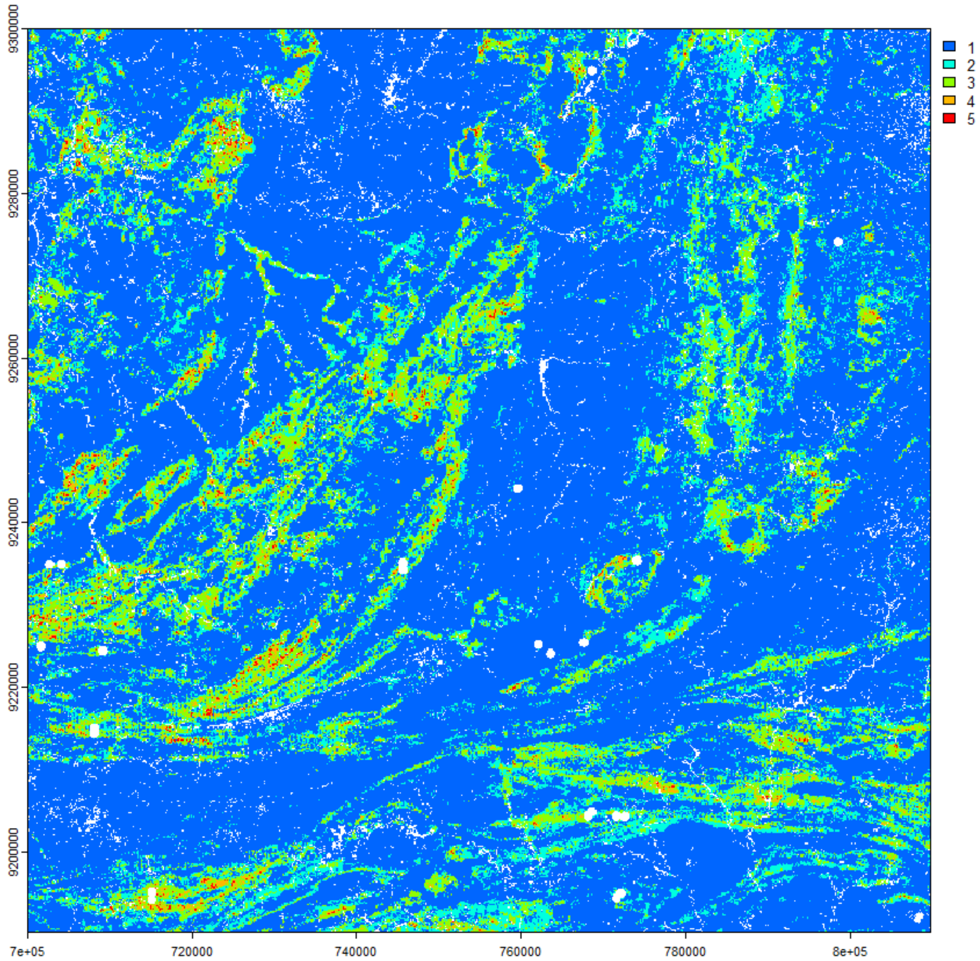
4 → Considerable Probability to find W mineralization.

3 → Moderate Probability to find W mineralization.

2 → Low Probability to find W mineralization.

1 → Very Little to No Probability to find W mineralization.

```
wTarg<-multip
wTarg [wTarg > 0 & wTarg <= 50]<-1
wTarg [wTarg > 50 & wTarg <= 100]<-2
wTarg [wTarg > 100 & wTarg <= 320]<-3
wTarg [wTarg > 320 & wTarg <= 480]<-4
wTarg [wTarg > 480]<-5
plot(wTarg,col=rainbow(6,rev=T,start=0.0,end=0.6))
```




```
writeRaster(wTarg, 'Wtarg_final.tif', overwrite=TRUE)
```