ARR2016 Temporal Patterns for Urban Drainage and Flood-Modelling. Do We Need To Run Them All?

Glenn Ottrey

ENGENY
WATER MANAGEMENT

ARR 2016 Ensemble Approach

- 10 Temporal Patterns for each duration
  - 20% AEP – 1 to 10
  - 10% and 5% AEP – 11 to 20
  - 2% and 1% AEP – 21 to 30
- Aim by running 10 patterns is to better understand the uncertainty associated with the temporal pattern
- How much variation is there between the patterns and resulting flood depths?
- Chose the average result – median (rank 5 of 10) has been used

ENGENY
WATER MANAGEMENT

Why is this a challenge?

- 10x increase in run times for hydraulic models
- Complicates results processing – significantly for some results
- If you could choose to do nine sensitivity runs, would you really do them all on temporal pattern?
- Can the median pattern be predicted?
  - Potential to reduce total model runtime
  - Assist in processing results if a single representative pattern for each duration can be chosen

ENGENY
WATER MANAGEMENT

Data available for this presentation

- 6 models for 1% AEP, all temporal patterns up to at least 3 hour
- 4 models also run for more frequent return periods
- Models spread around Melbourne (Southern Slopes Mainland), three in the north, one in the east and two in the south east.

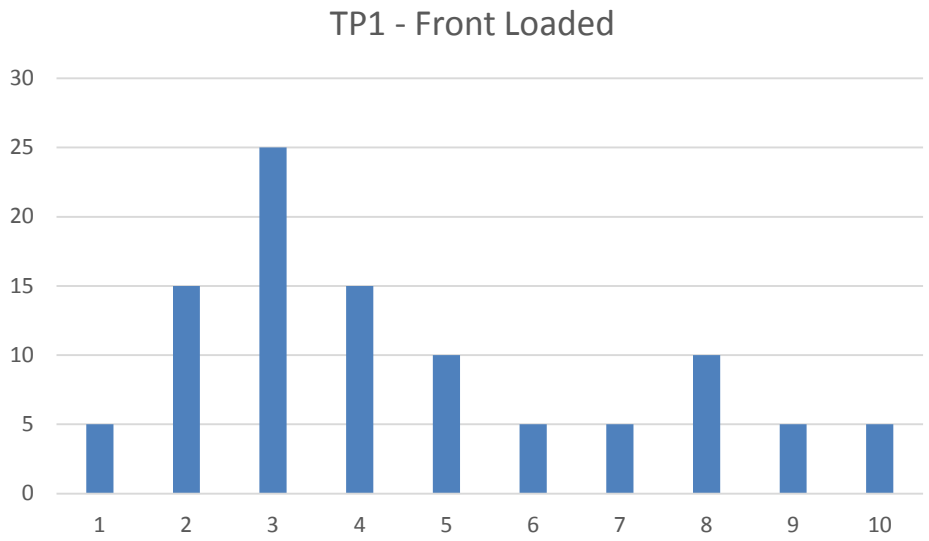
ENGENY
WATER MANAGEMENT

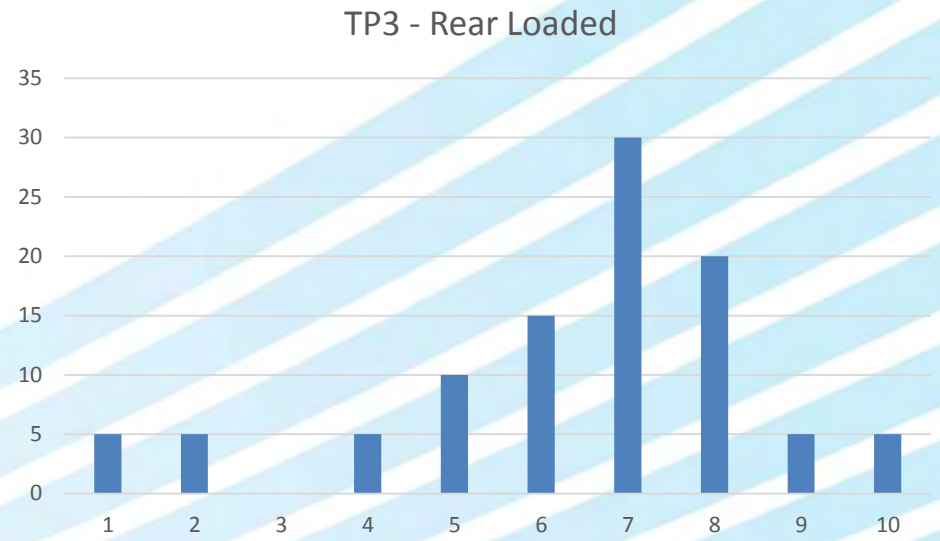
How much variation is there between the 10 patterns?

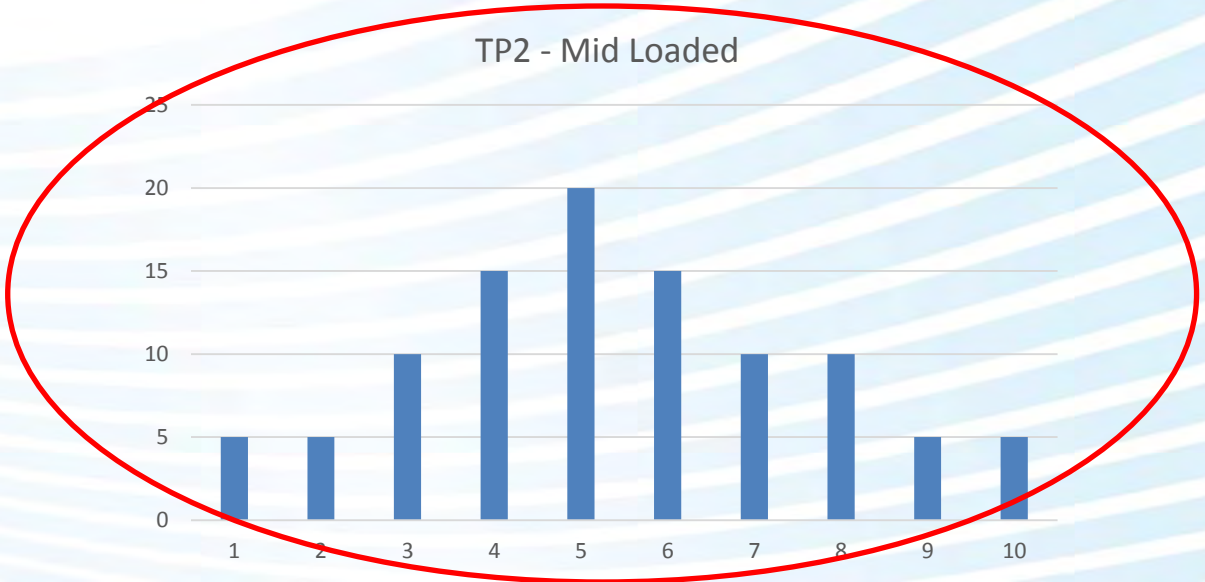
- Overall?
- What about retarding basins?
- Can we predict the median pattern based on the hyetograph shape?
- Could the same set of patterns selected patterns approximate the median result in multiple catchments?

ENGENY
WATER MANAGEMENT

How would we choose the median temporal pattern?

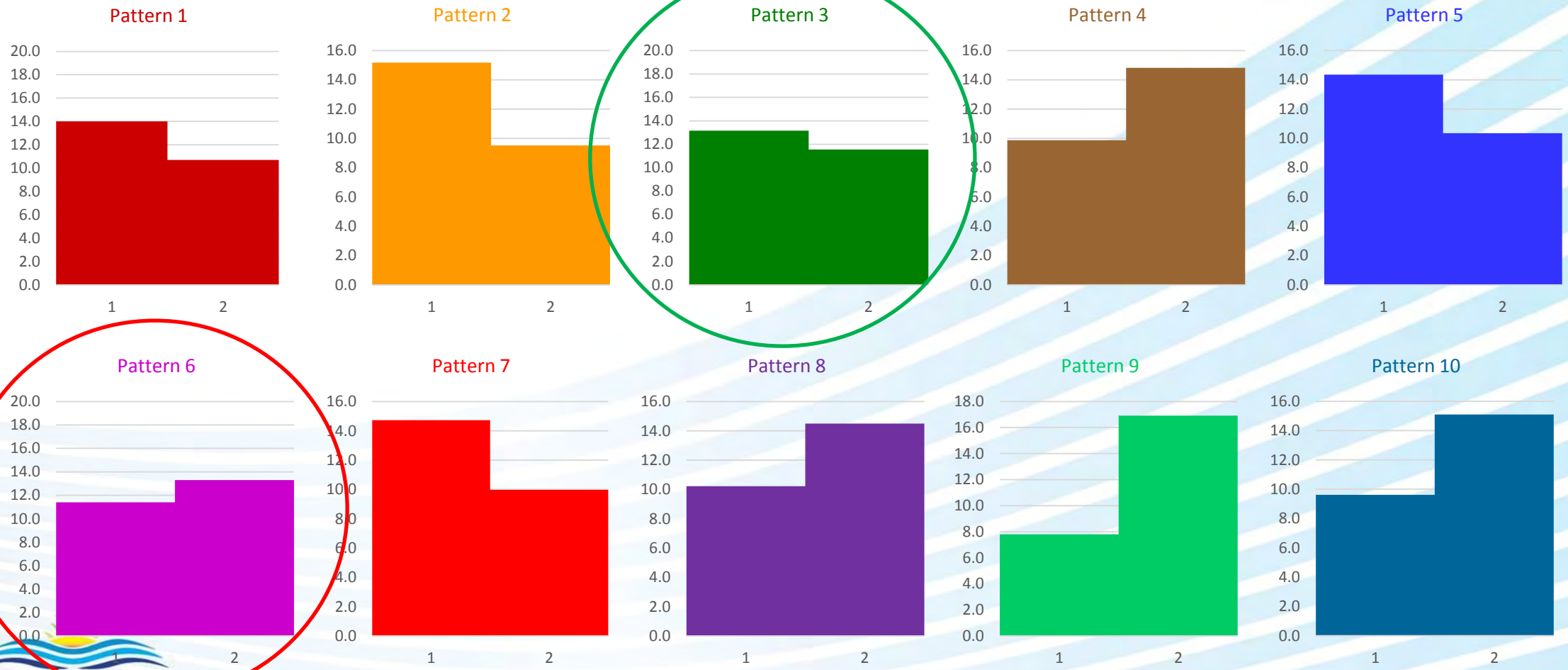






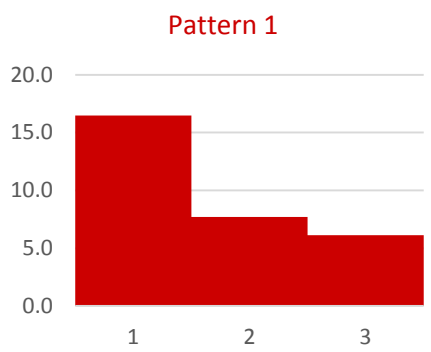
ENGENY
WATER MANAGEMENT

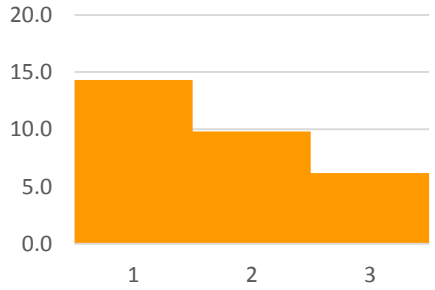
10 minute 1% AEP

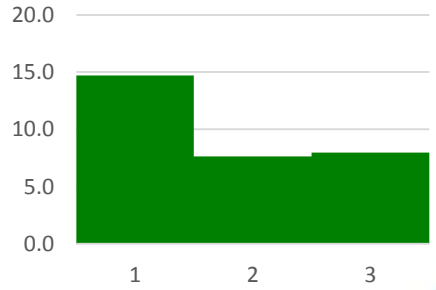


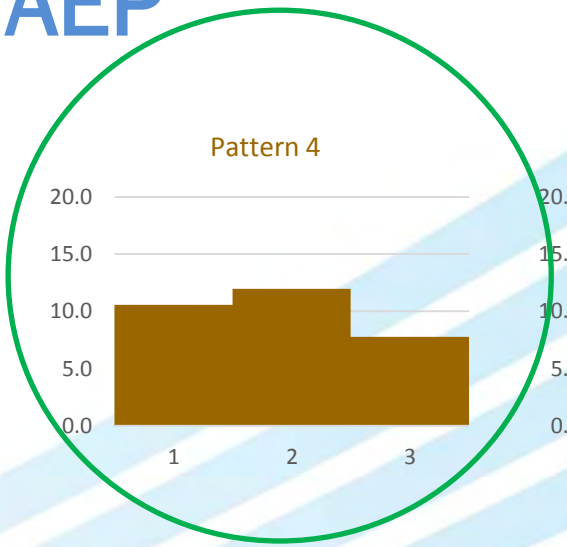
ENGENY
WATER MANAGEMENT

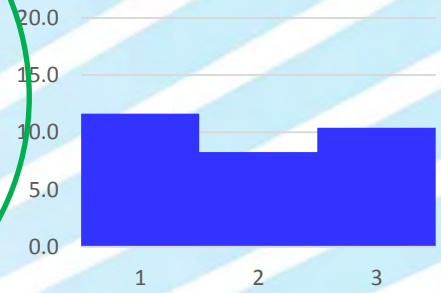
15 minute 1% AEP

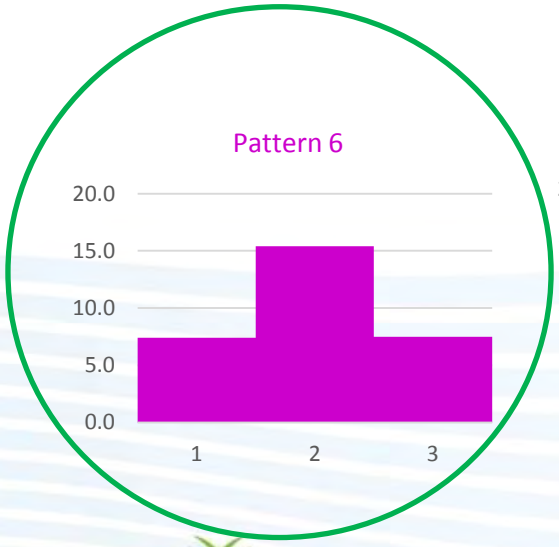


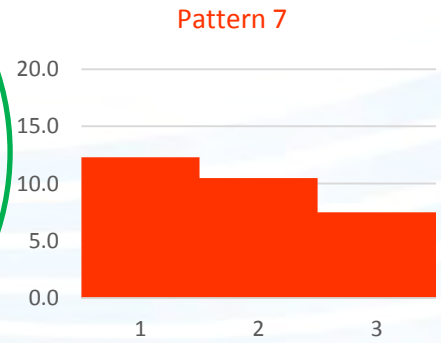


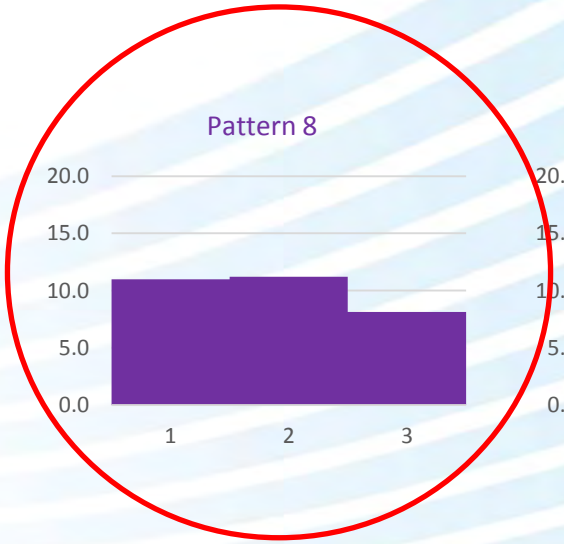


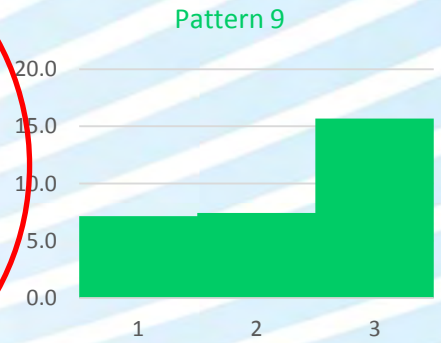


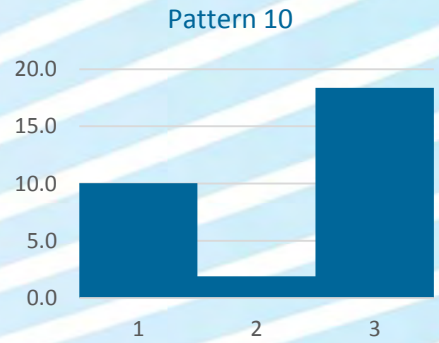










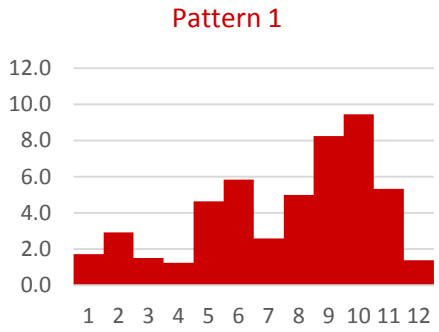


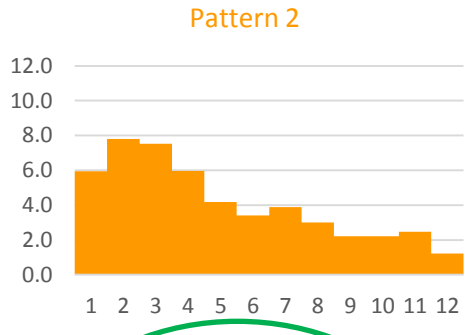
ENGENY
WATER MANAGEMENT

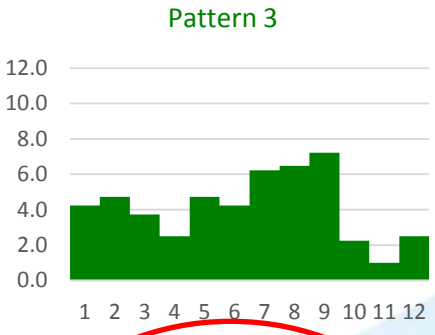
30 minute 1% AEP

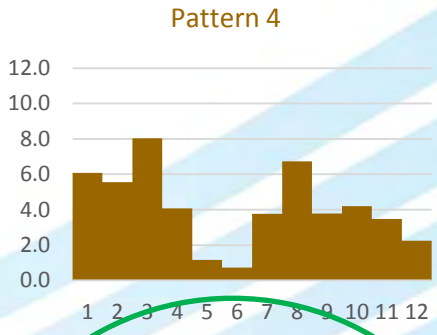
ENGENY
WATER MANAGEMENT

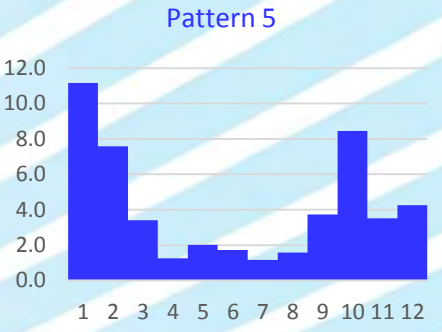
60 minute 1% AEP

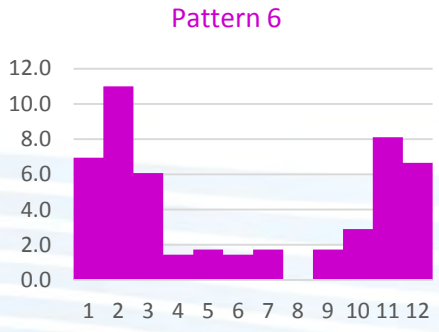


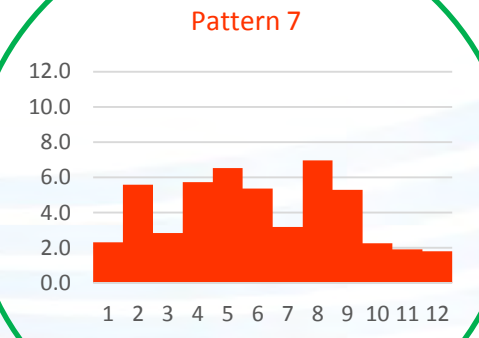


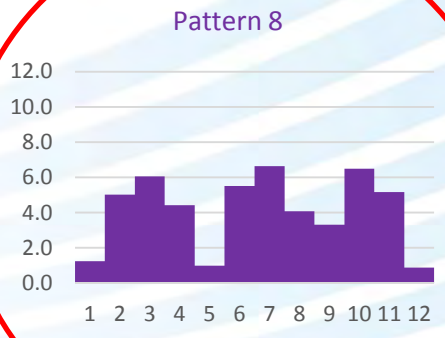


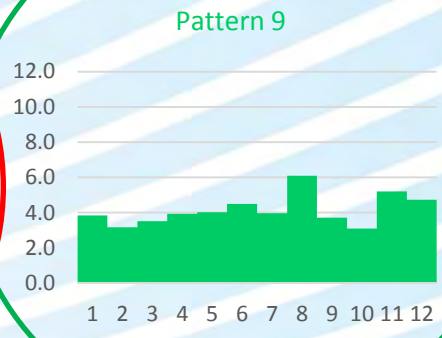


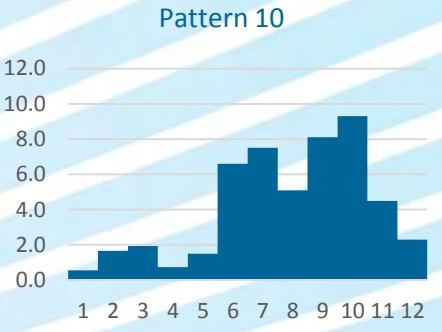






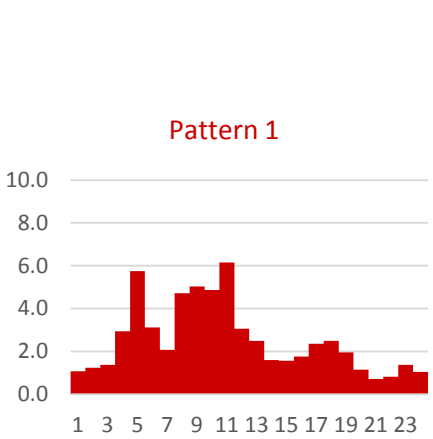


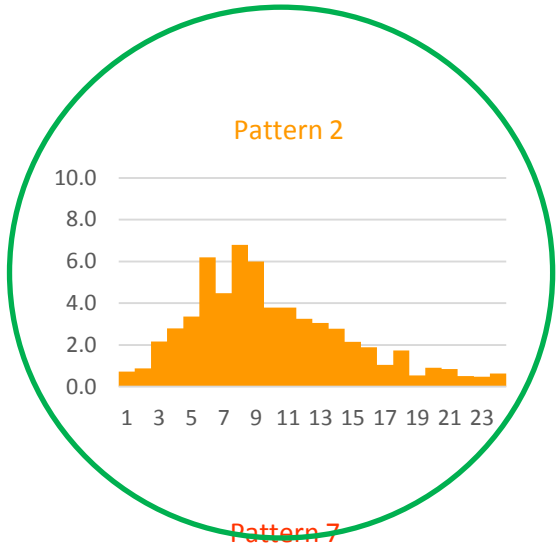


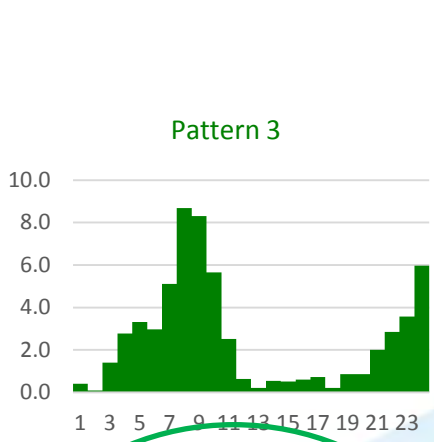


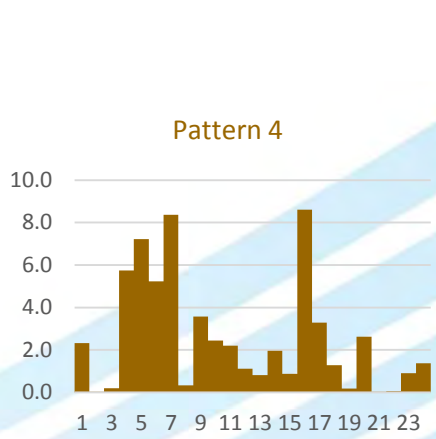
ENGENY
WATER MANAGEMENT

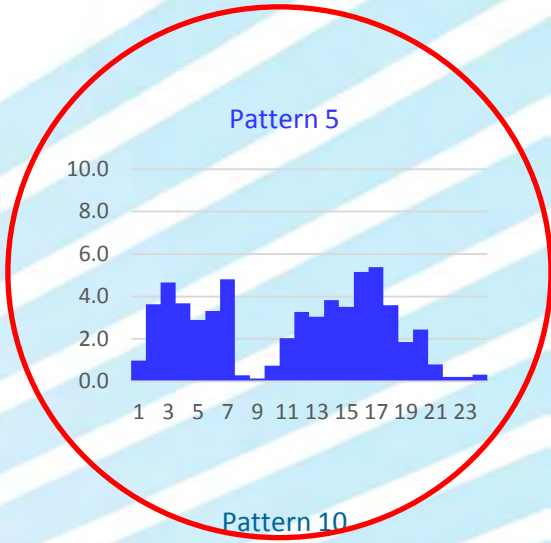
120 minute 1% AEP

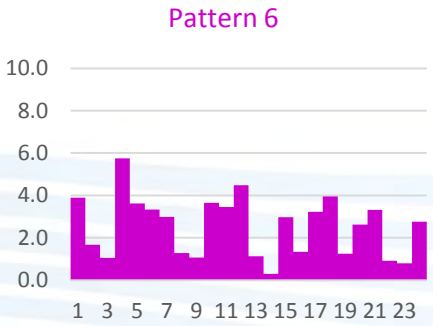


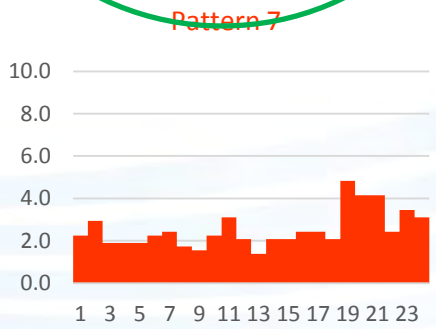


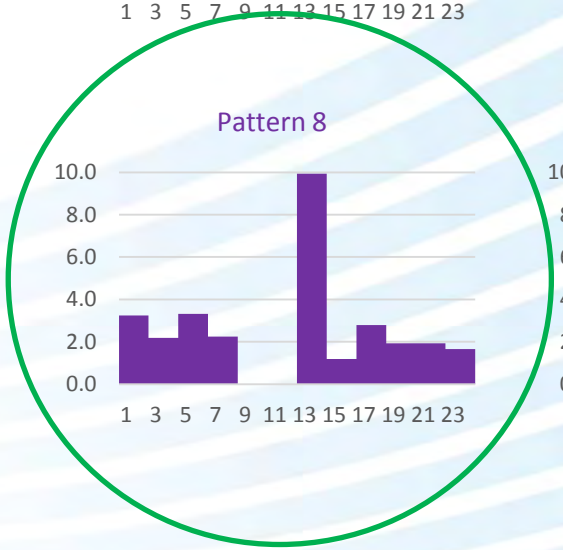


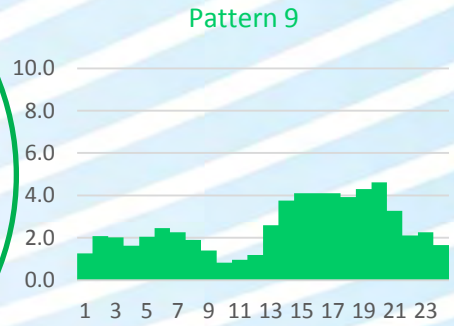


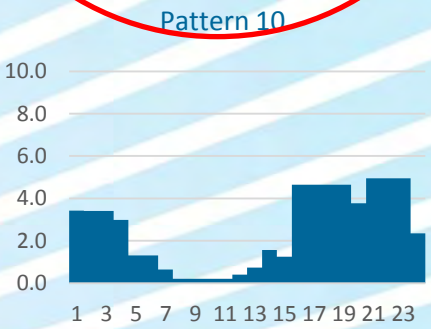






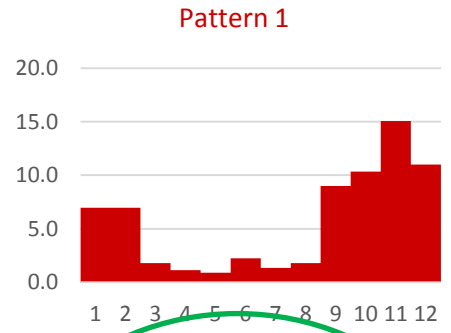


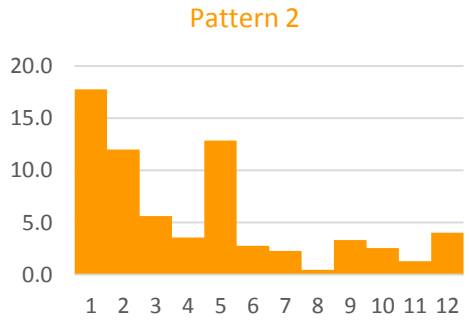


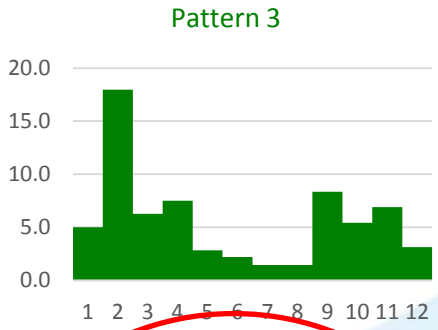


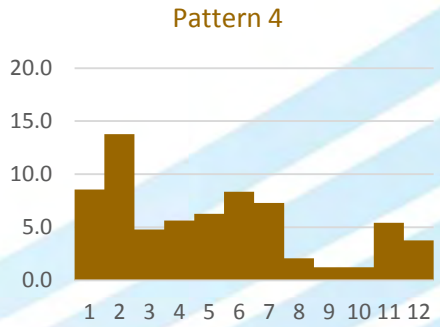
ENGENY
WATER MANAGEMENT

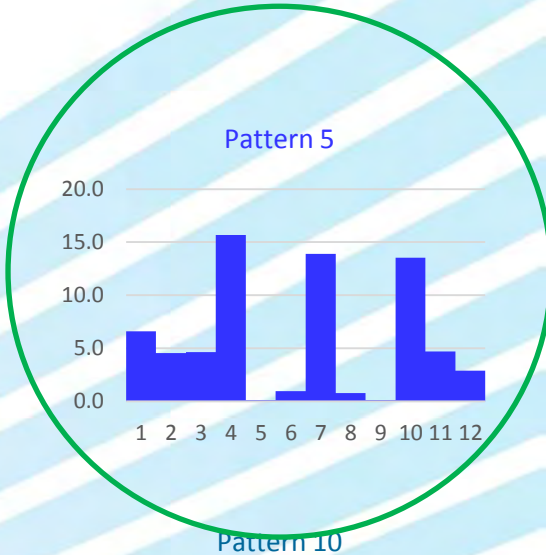
180 minute 1% AEP

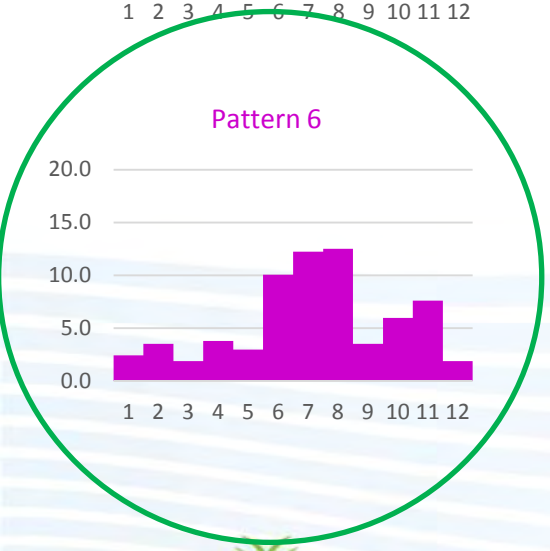


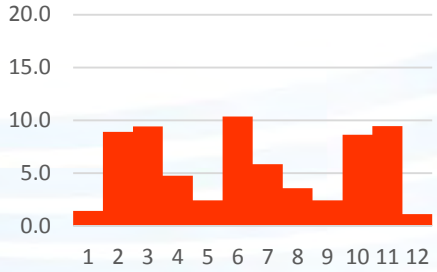


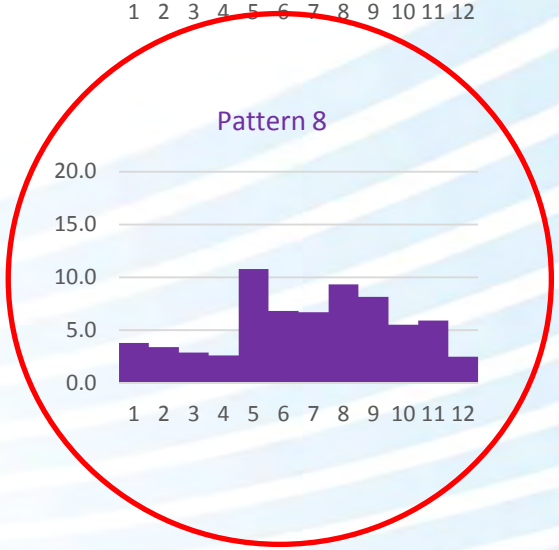


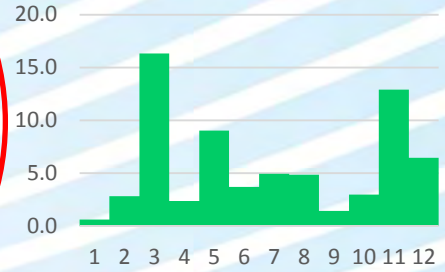


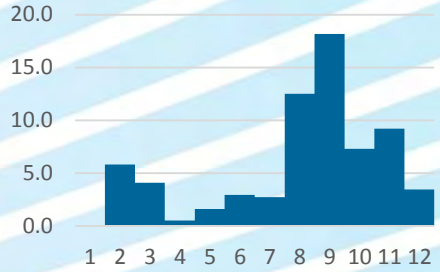




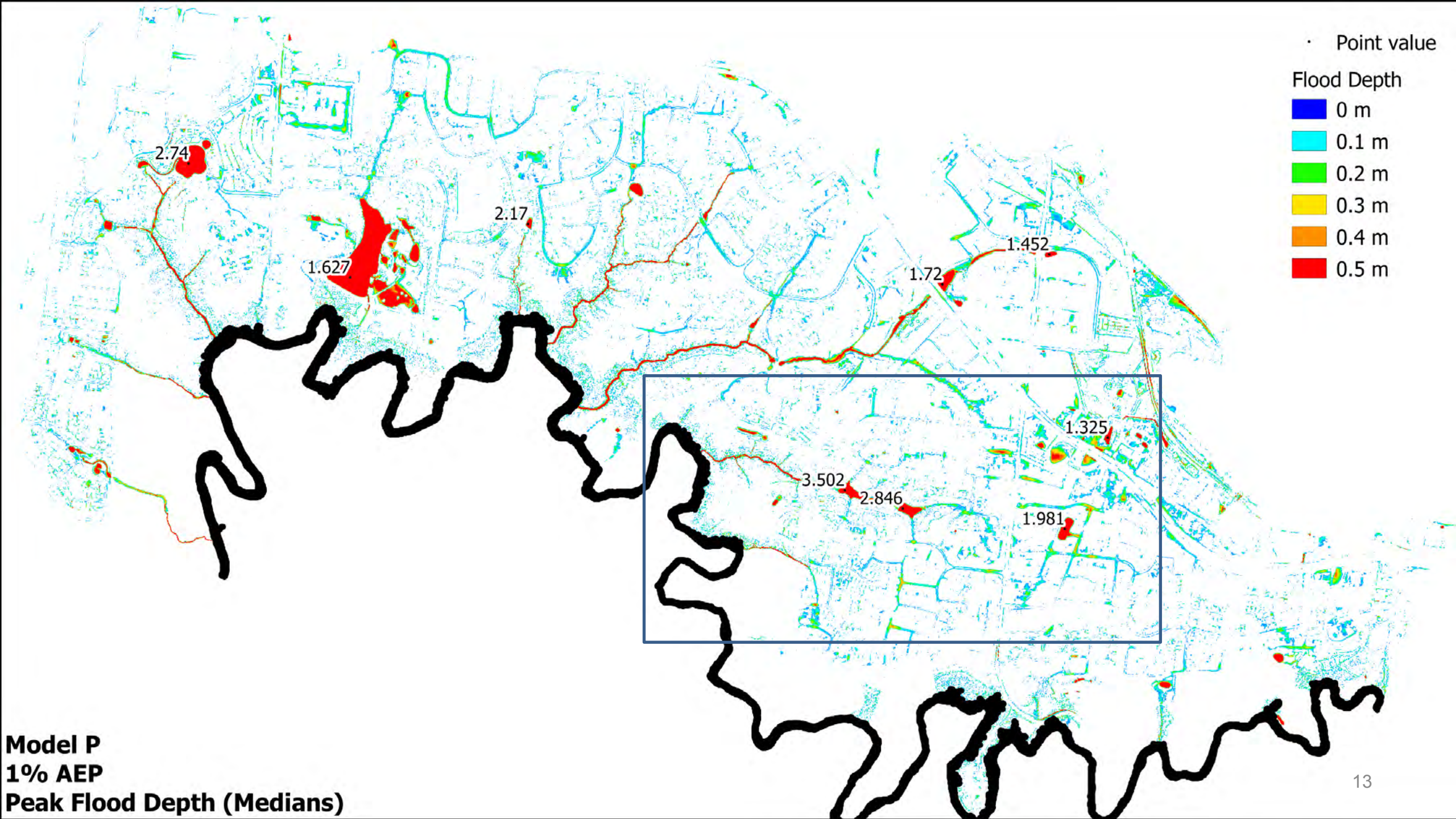




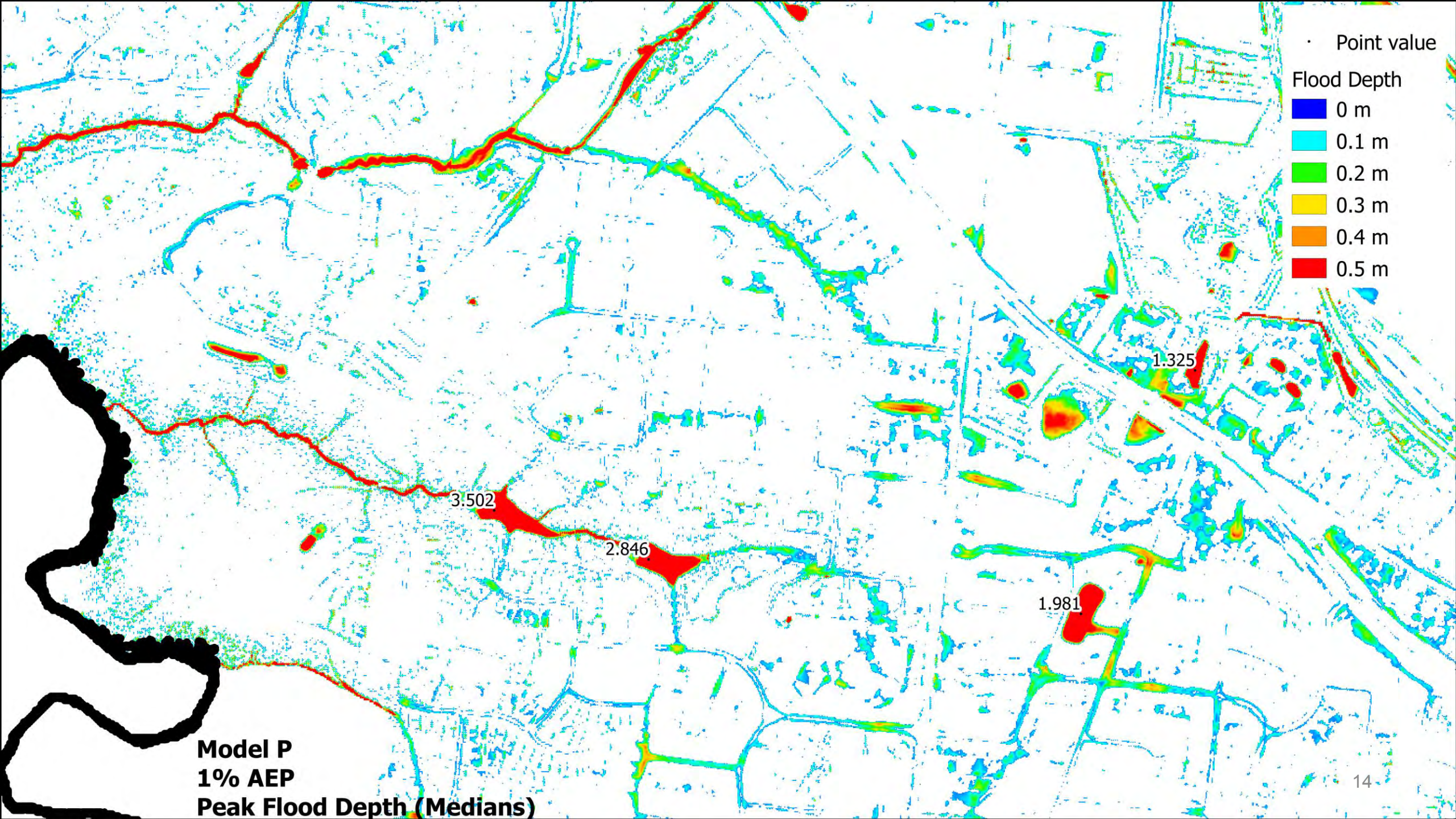


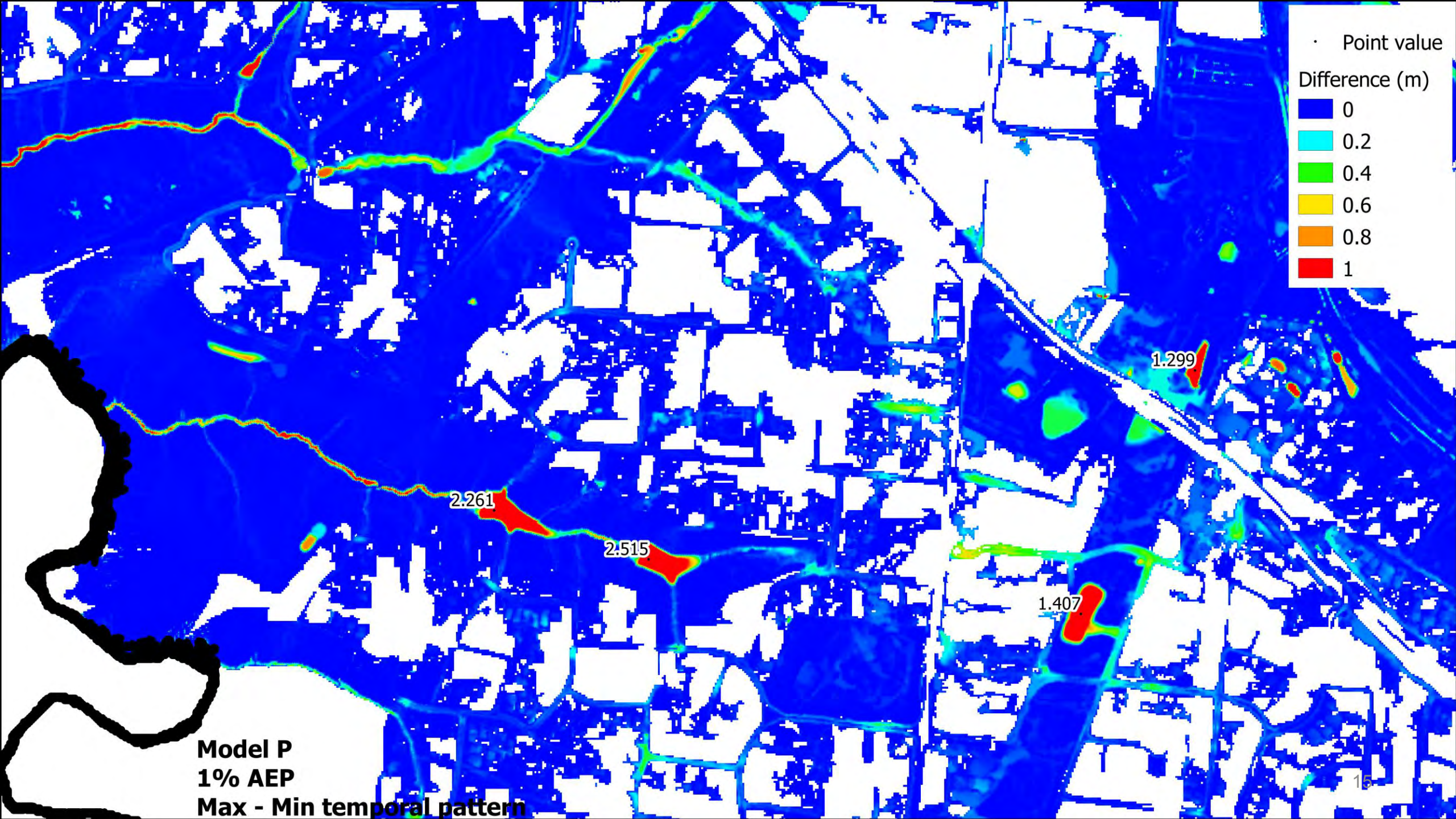


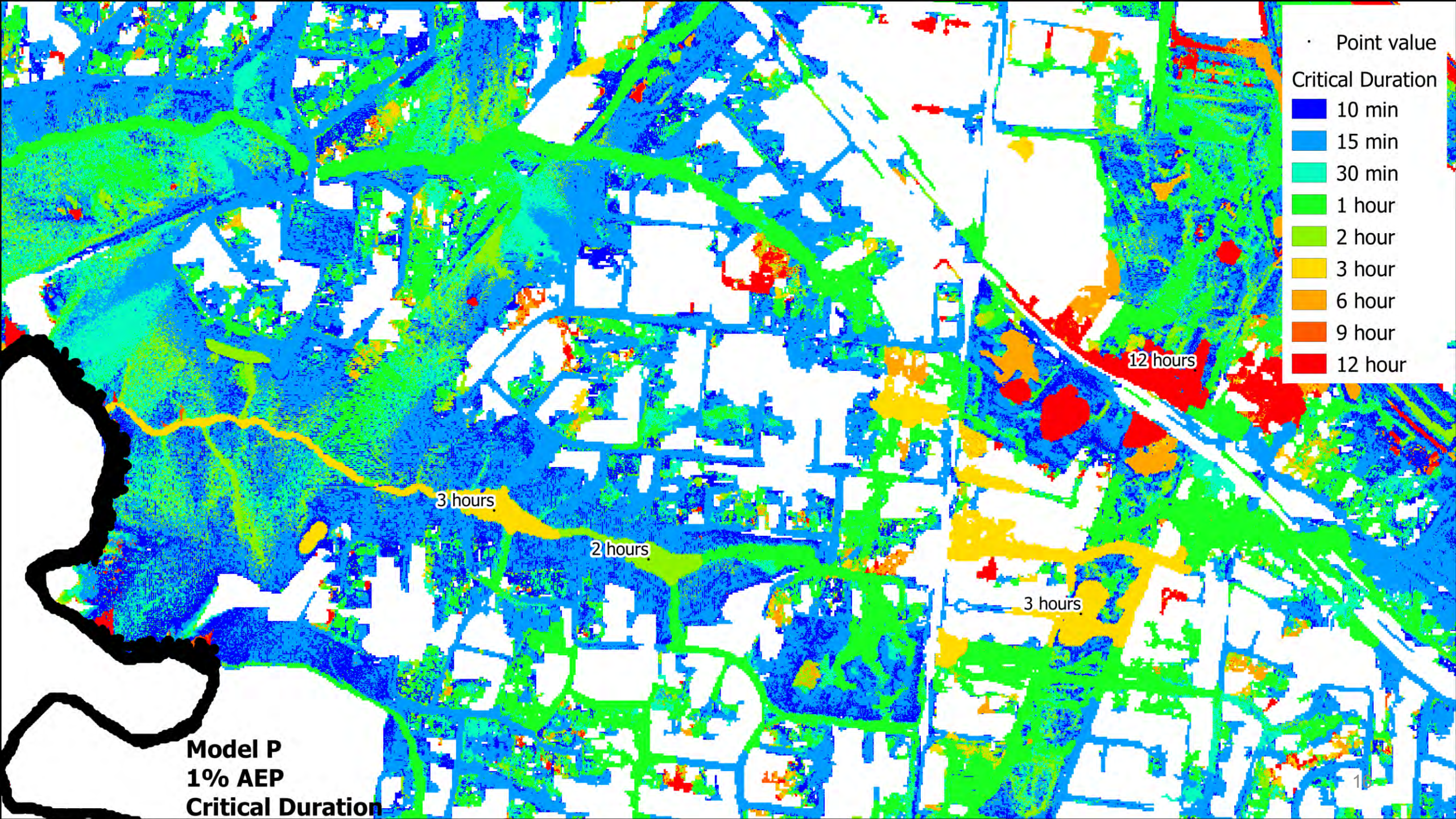
ENGENY
WATER MANAGEMENT

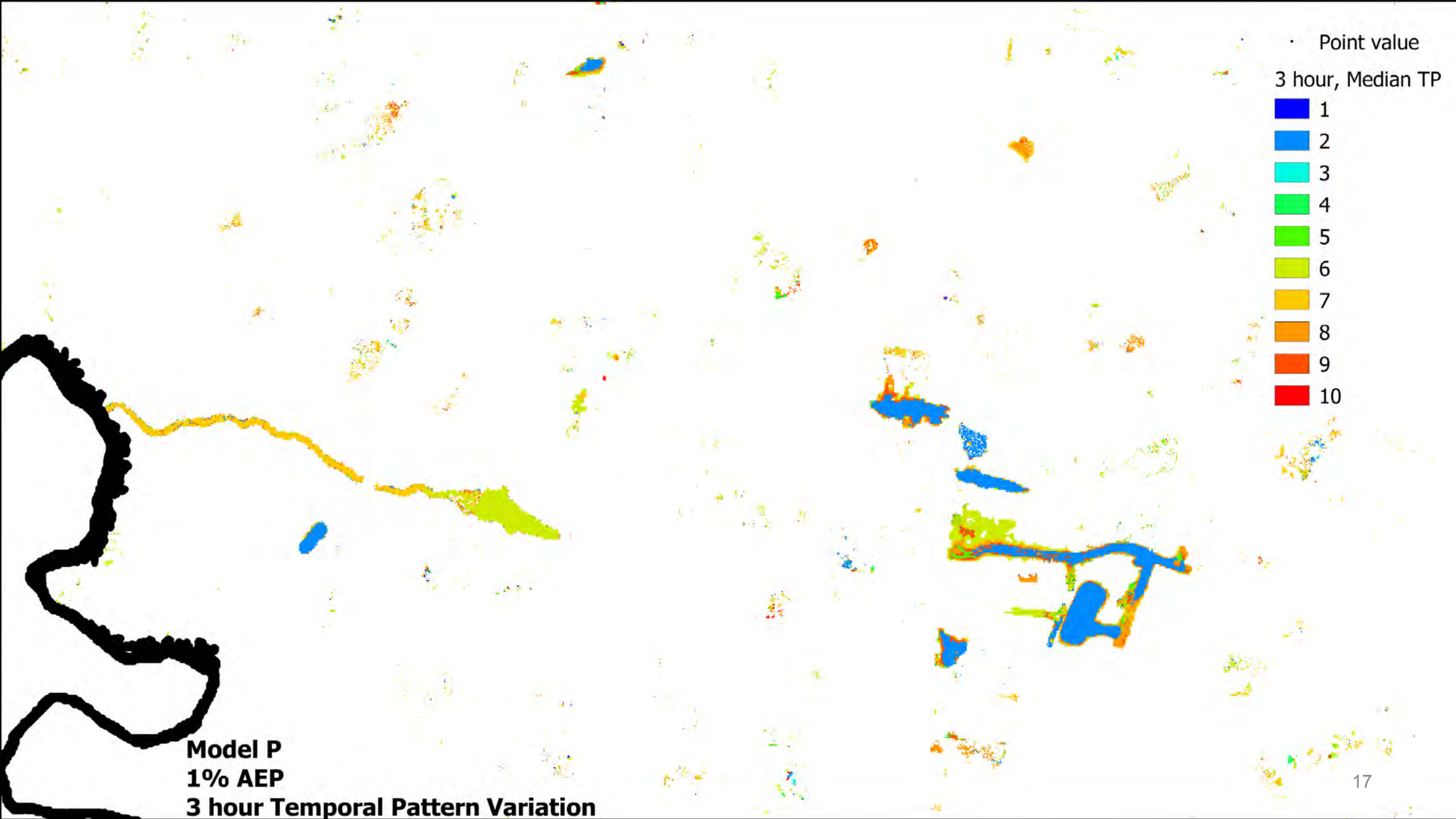


Model P
1% AEP
Peak Flood Depth (Medians)


Point value
Flood Depth
0 m
0.1 m
0.2 m
0.3 m
0.4 m
0.5 m
1.325
3.502
2.846
1.981
Model P
1% AEP
Peak Flood Depth (Medians)

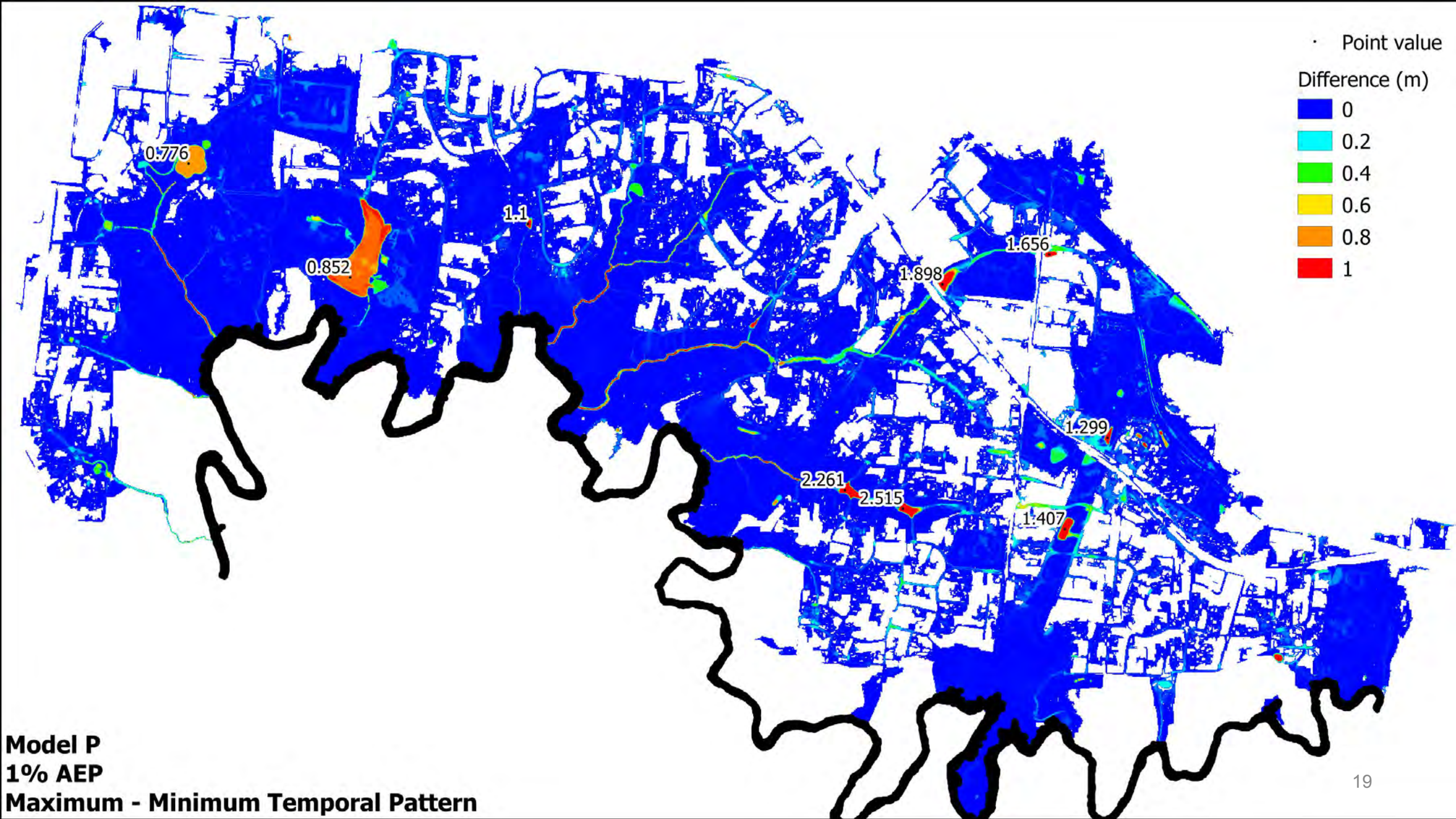

Point value
Difference (m)
0
0.2
0.4
0.6
0.8
1
1.299
2.261
2.515
1.407
Model P
1% AEP
Max - Min temporal pattern


Point value
Critical Duration
10 min
15 min
30 min
1 hour
2 hour
3 hour
6 hour
9 hour
12 hour
12 hours
3 hours
2 hours
3 hours
Model P
1% AEP
Critical Duration

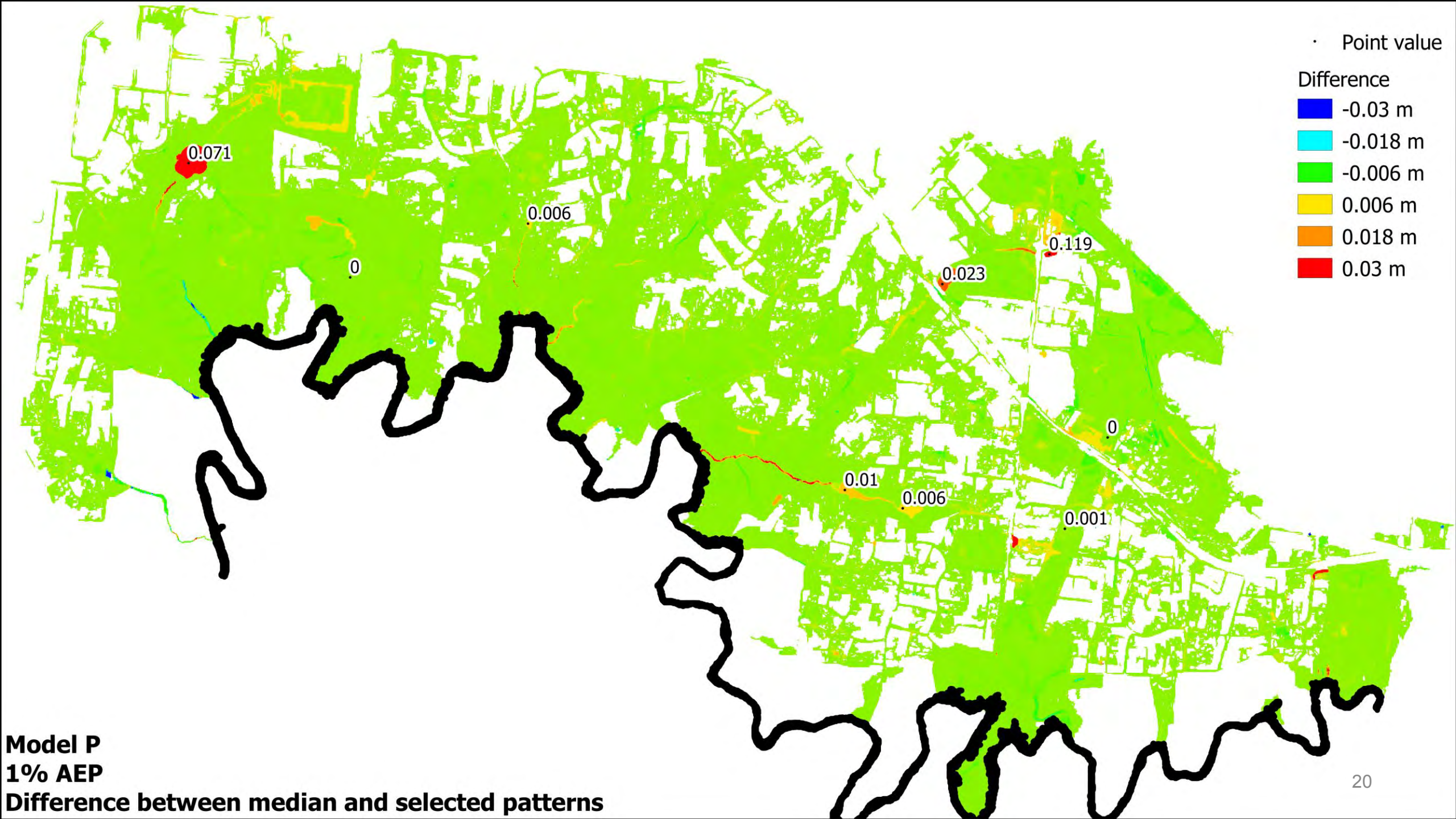


Model P
1% AEP
3 hour Temporal Pattern Variation


Point value
Difference
-0.03 m
-0.018 m
-0.006 m
0.006 m
0.018 m
0.03 m
0
0.01
0.006
0.001
Model P
1% AEP
Difference between median and selected patterns

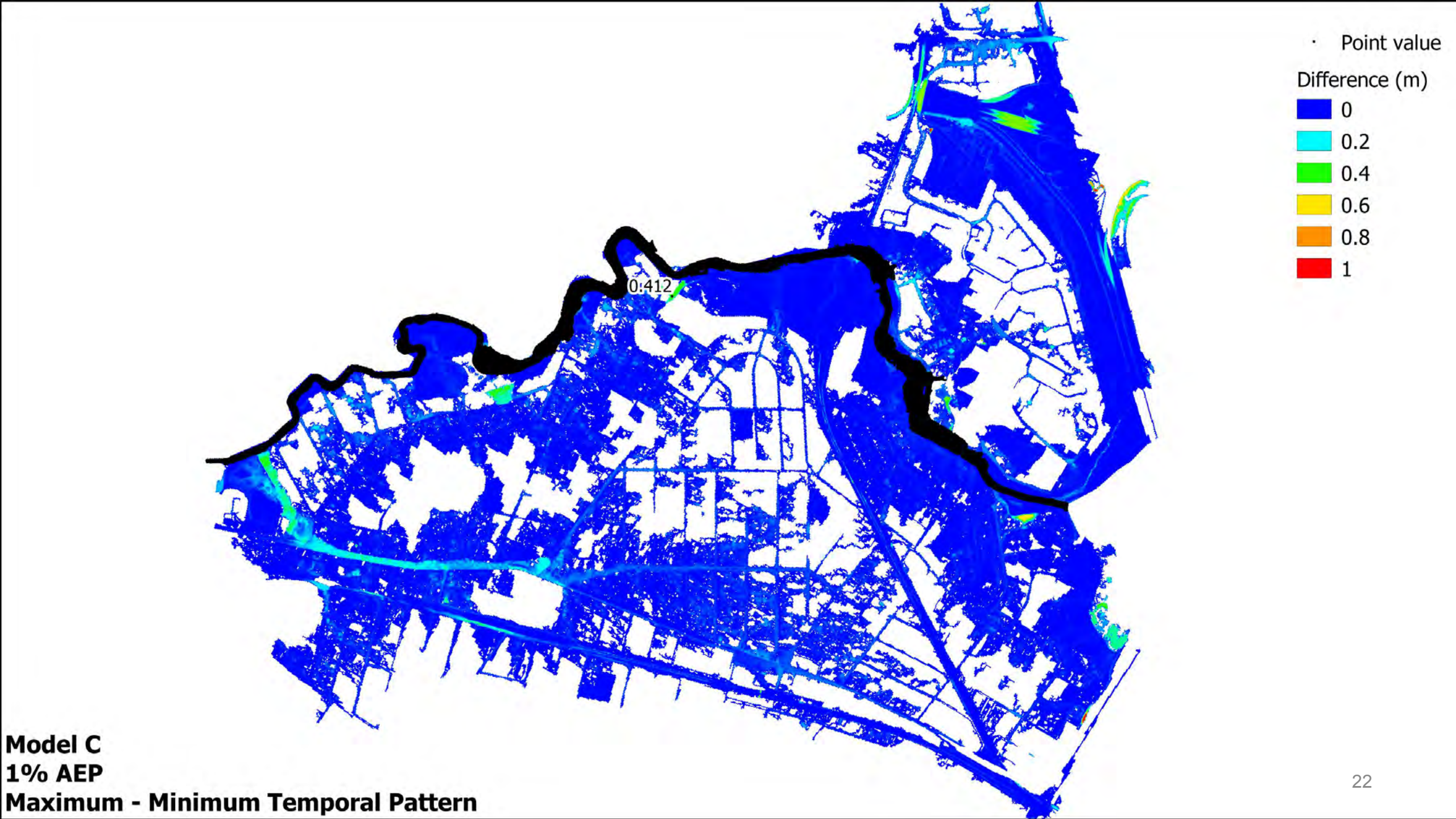


Model P
1% AEP
Maximum - Minimum Temporal Pattern

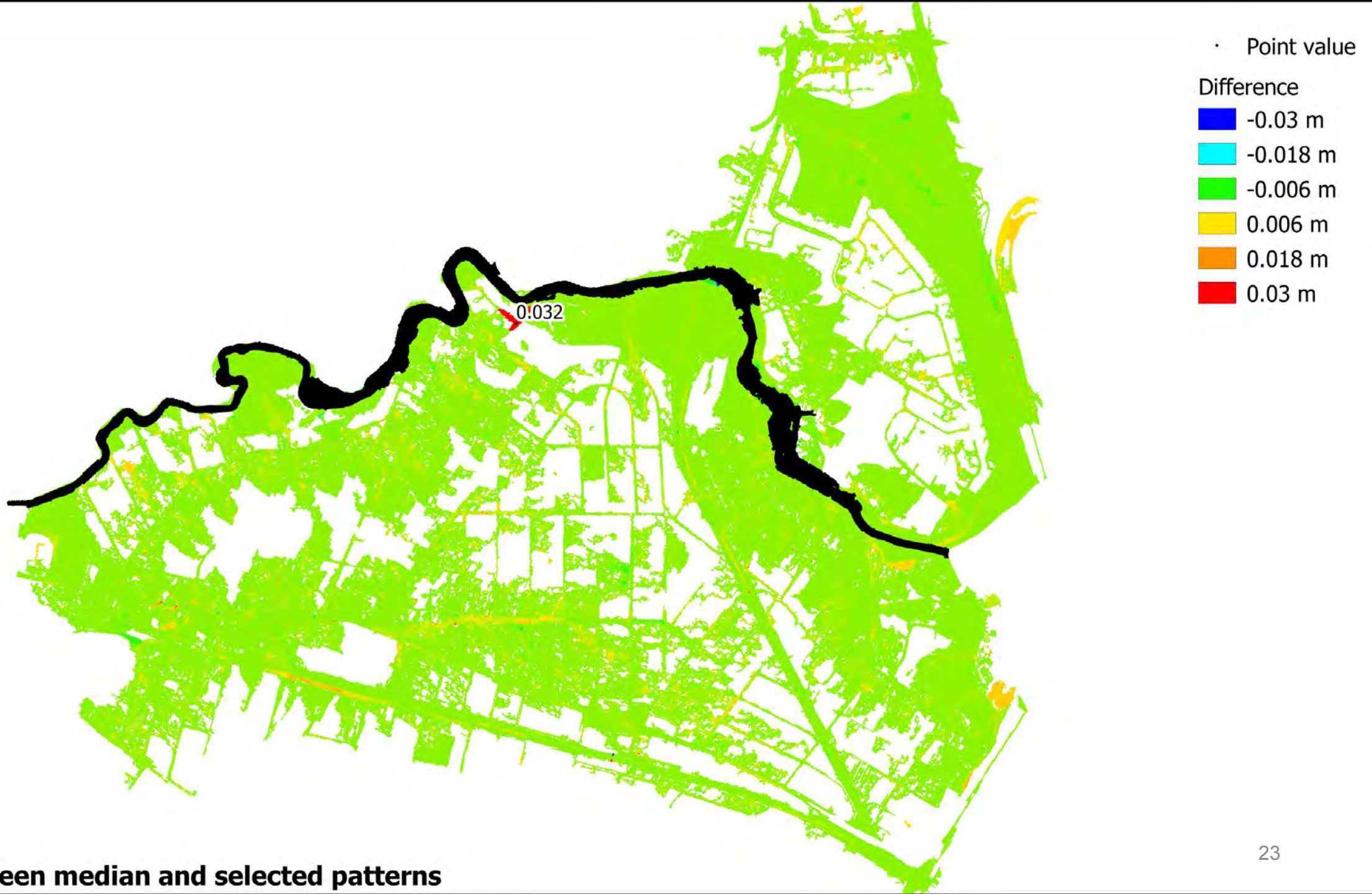


Model P
1% AEP
Difference between median and selected patterns

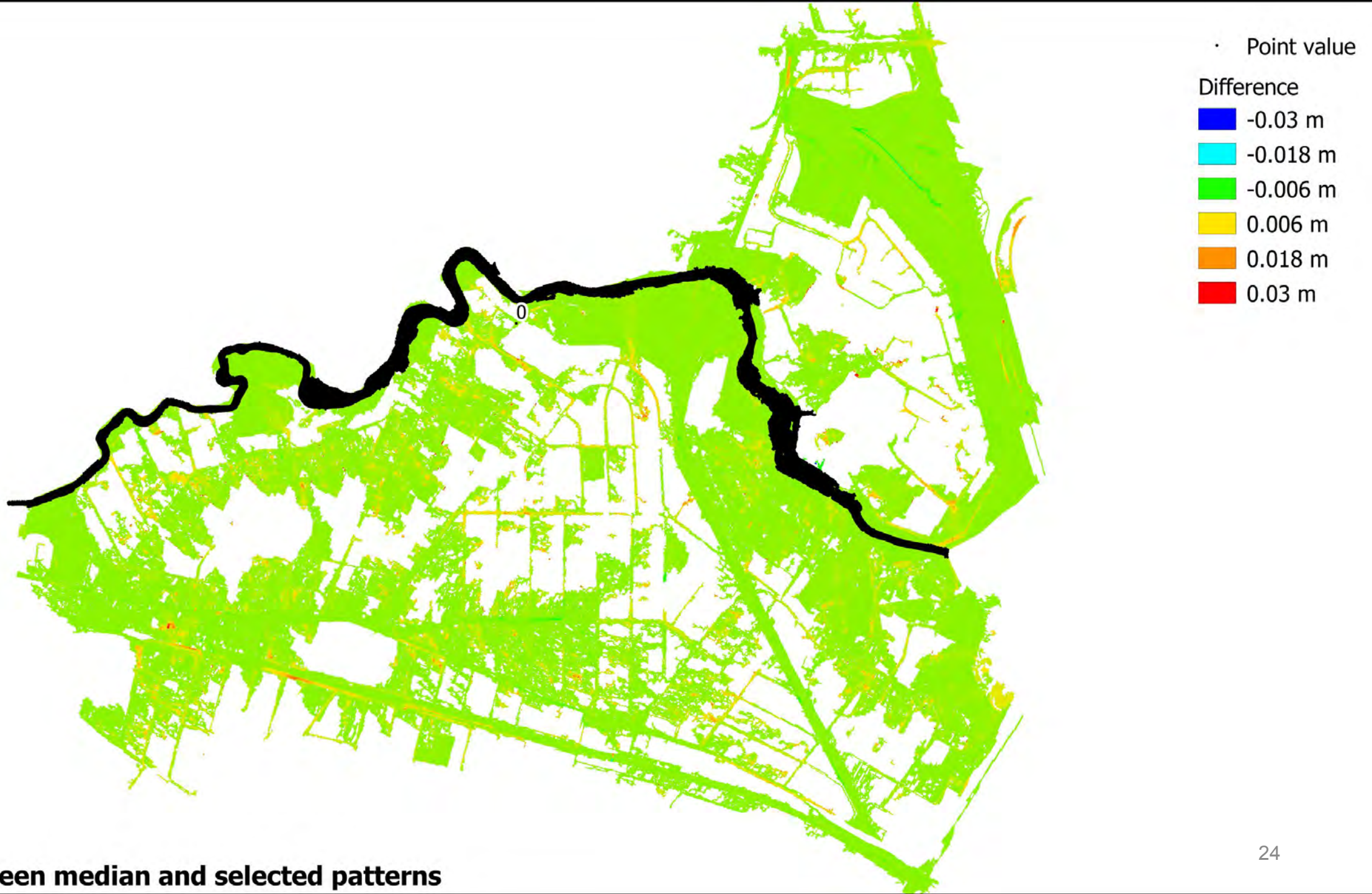
Model C
1% AEP
Peak Flood Depths (Medians)



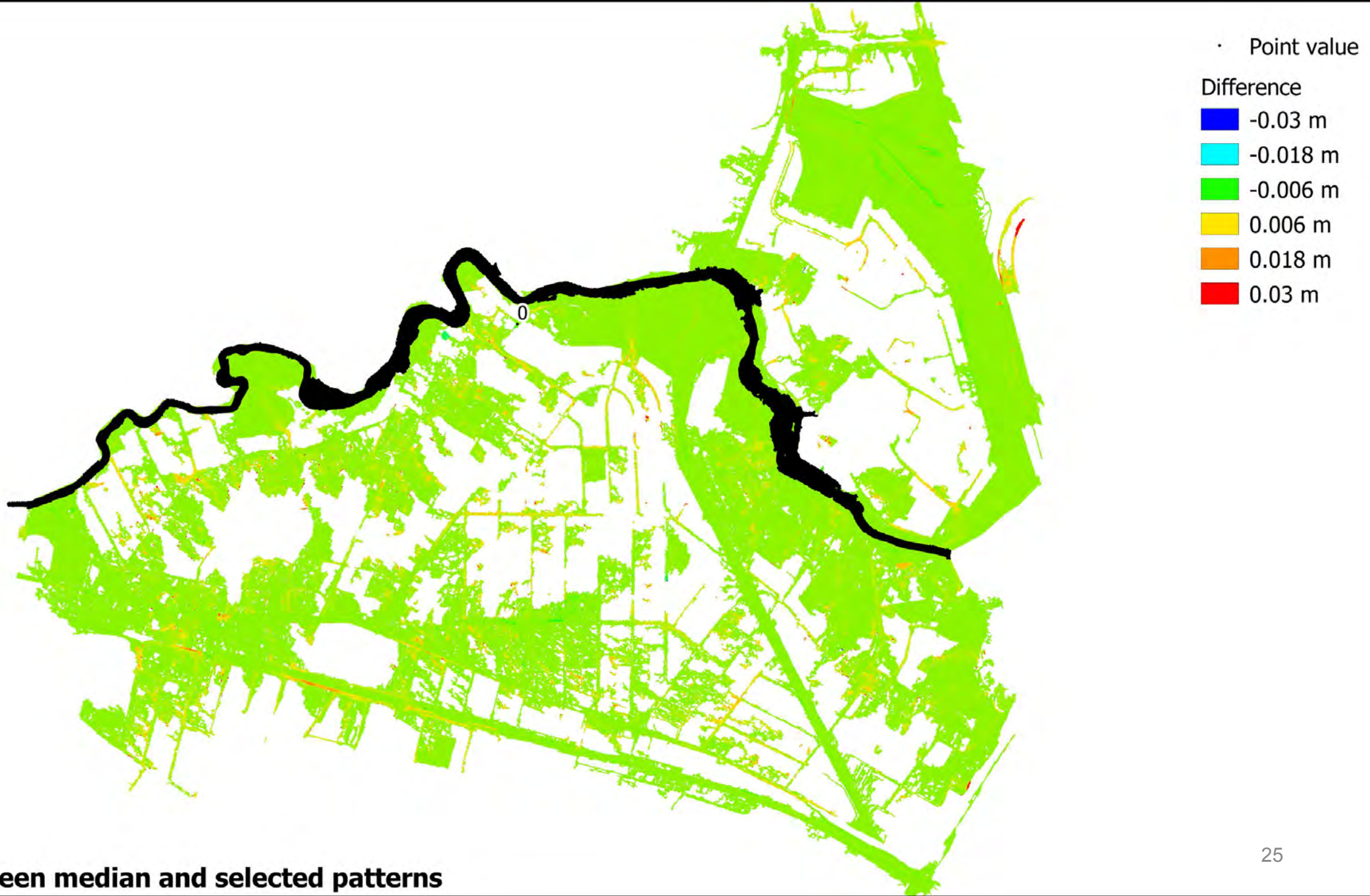
Model C
1% AEP
Maximum - Minimum Temporal Pattern



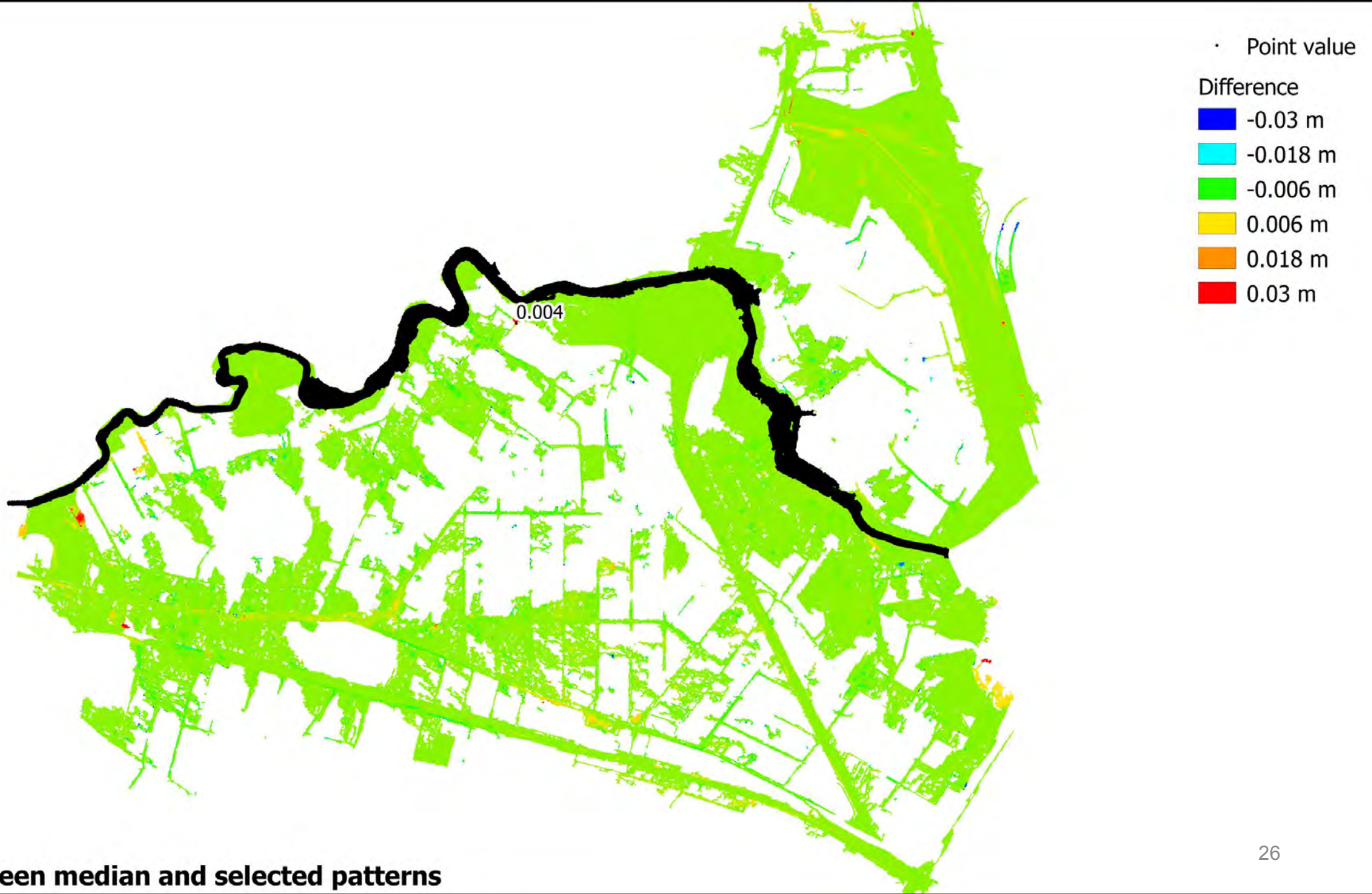
Model C
1% AEP
Difference between median and selected patterns



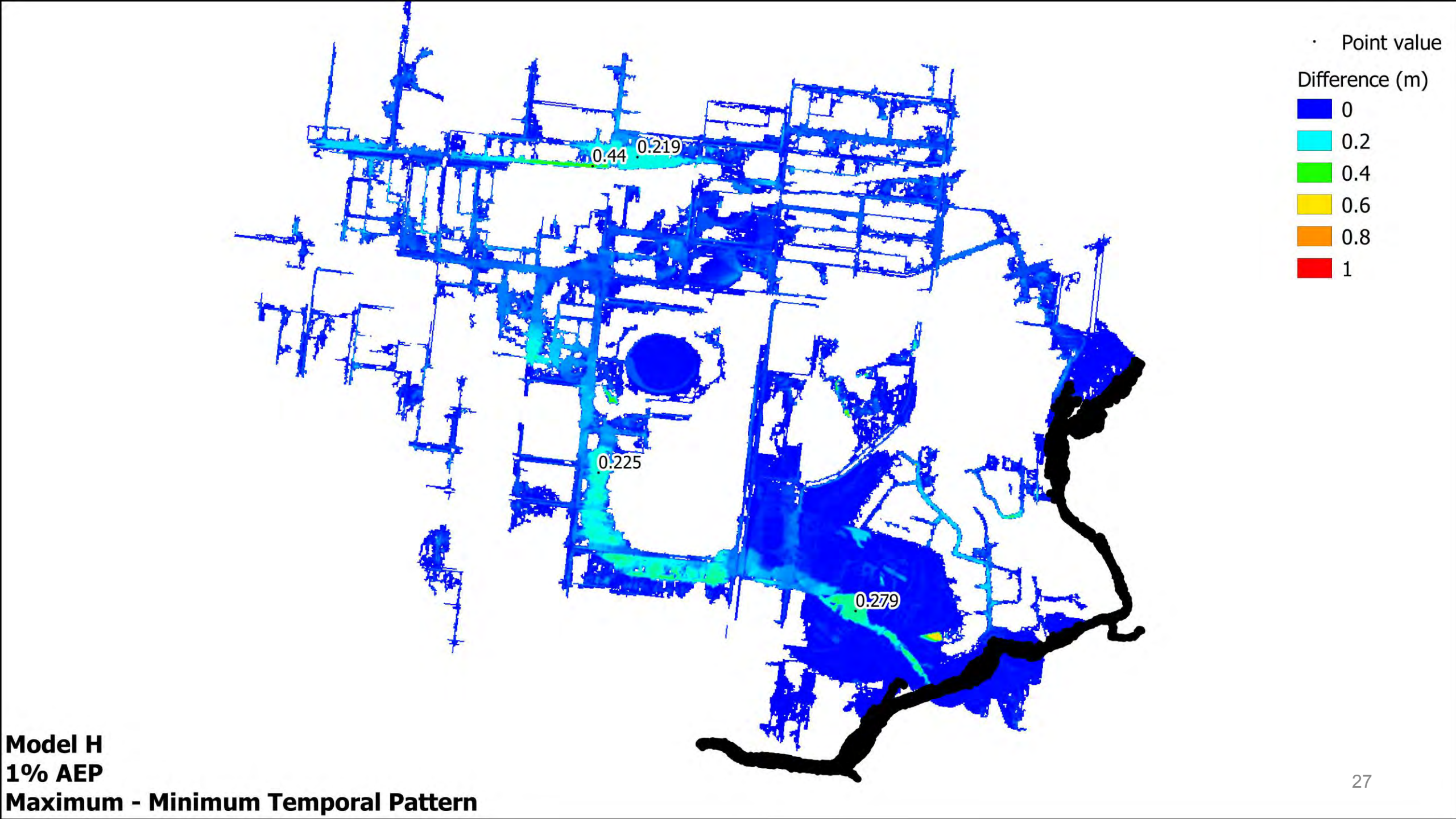
Model C
5% AEP
Difference between median and selected patterns



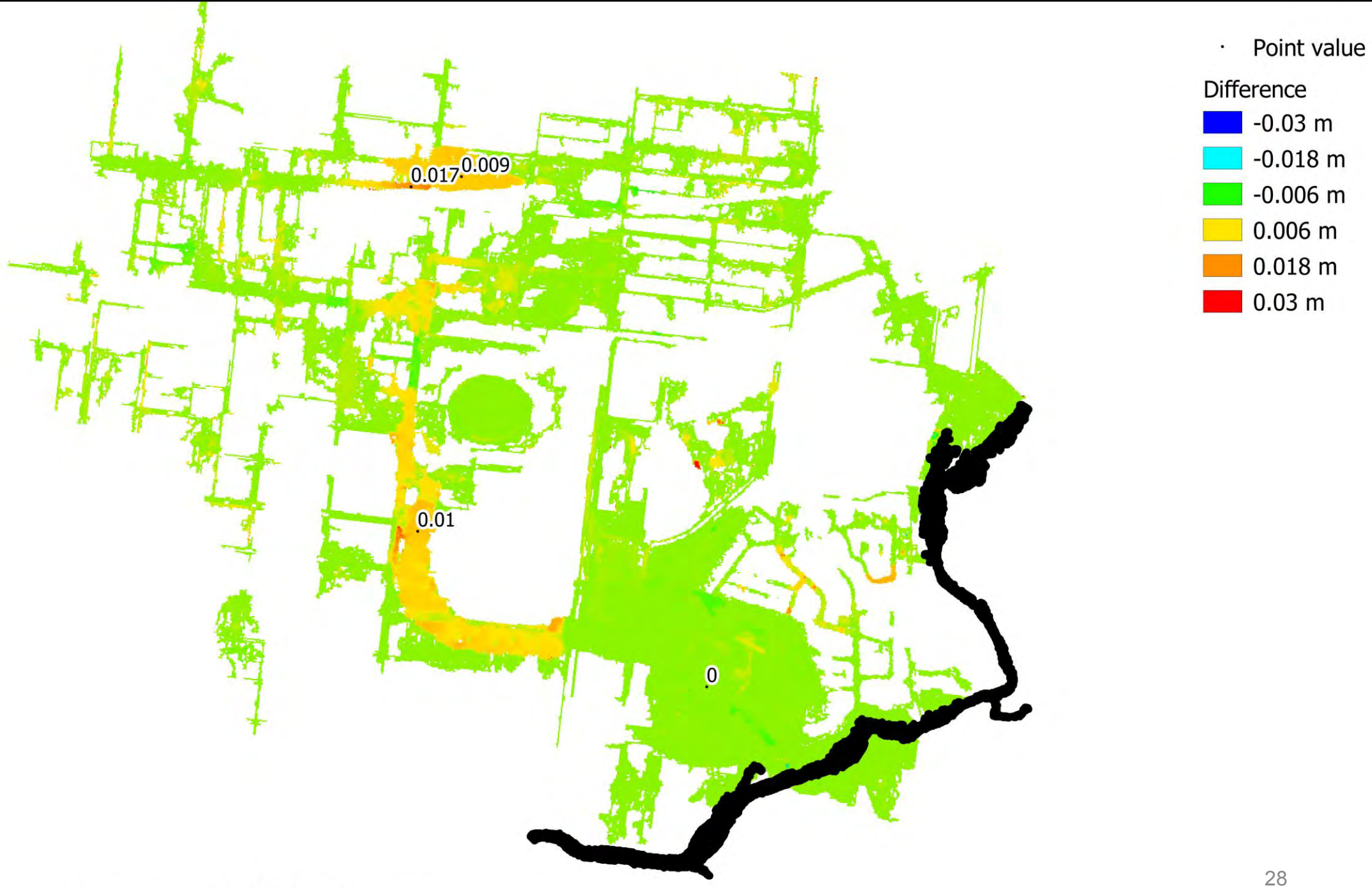
Model C
10% AEP
Difference between median and selected patterns



Model C
20% AEP
Difference between median and selected patterns

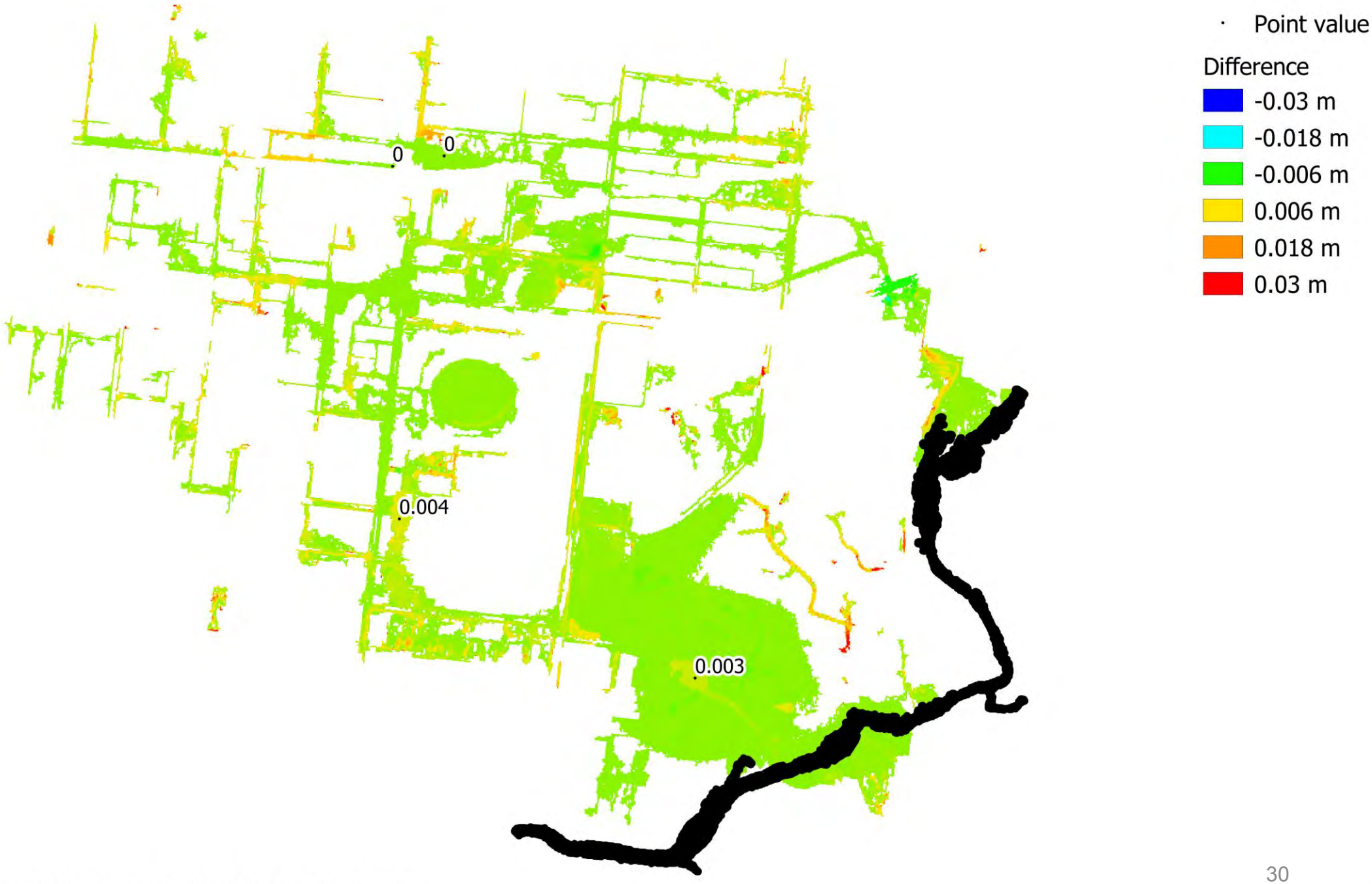


Model H
1% AEP
Maximum - Minimum Temporal Pattern

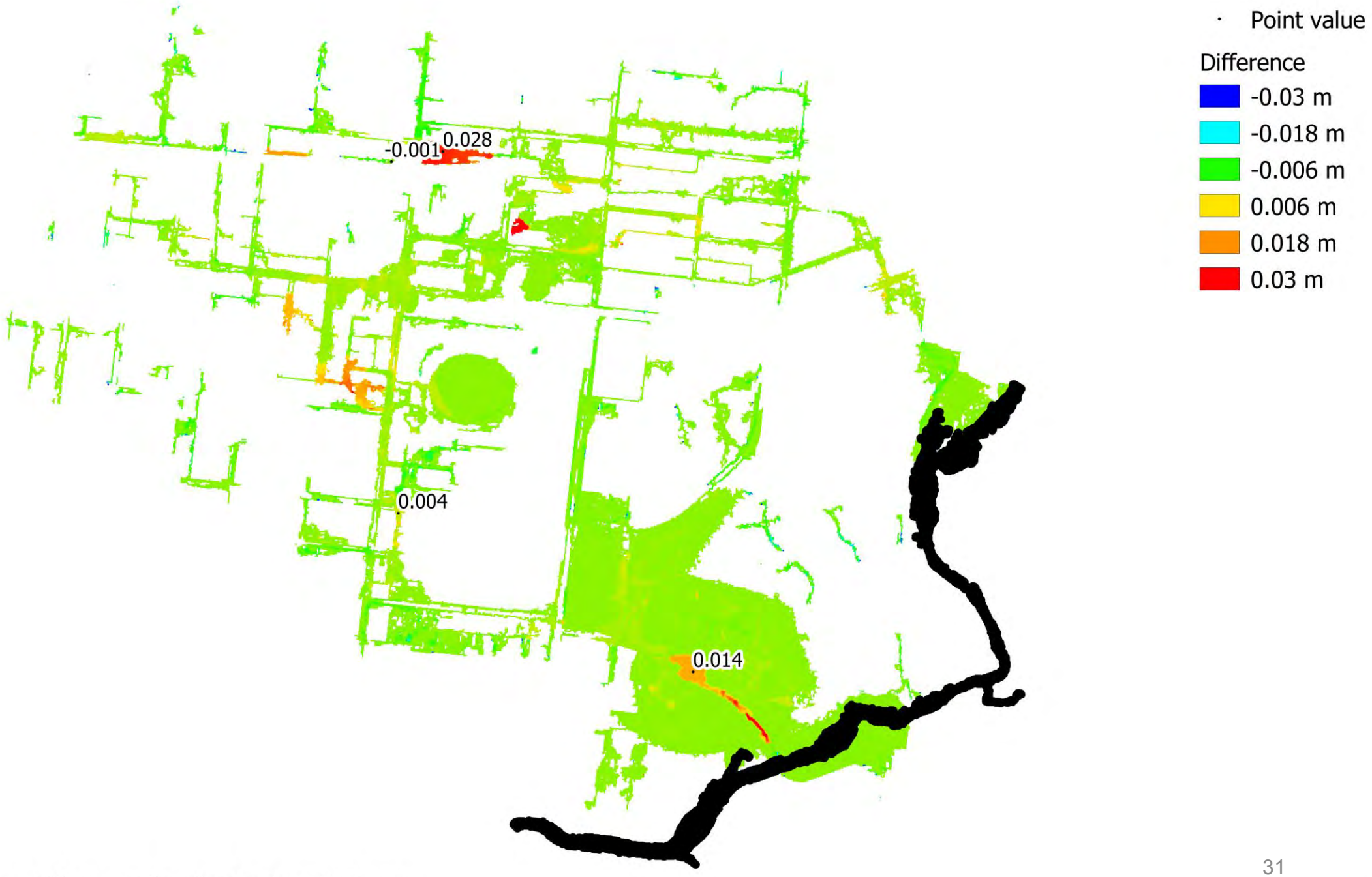


Model H
1% AEP
Difference between median and selected patterns

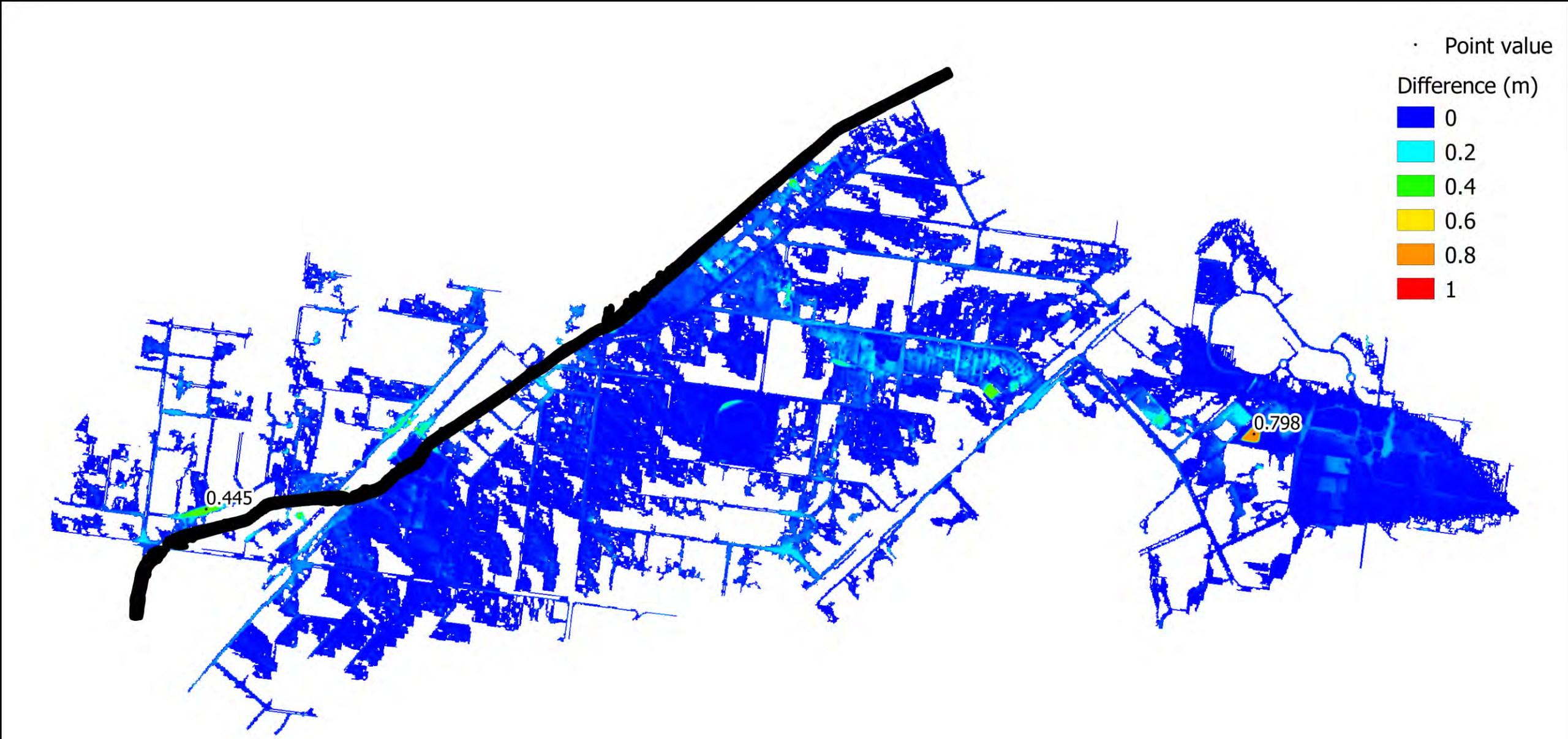
Model H
5% AEP
Difference between median and selected patterns



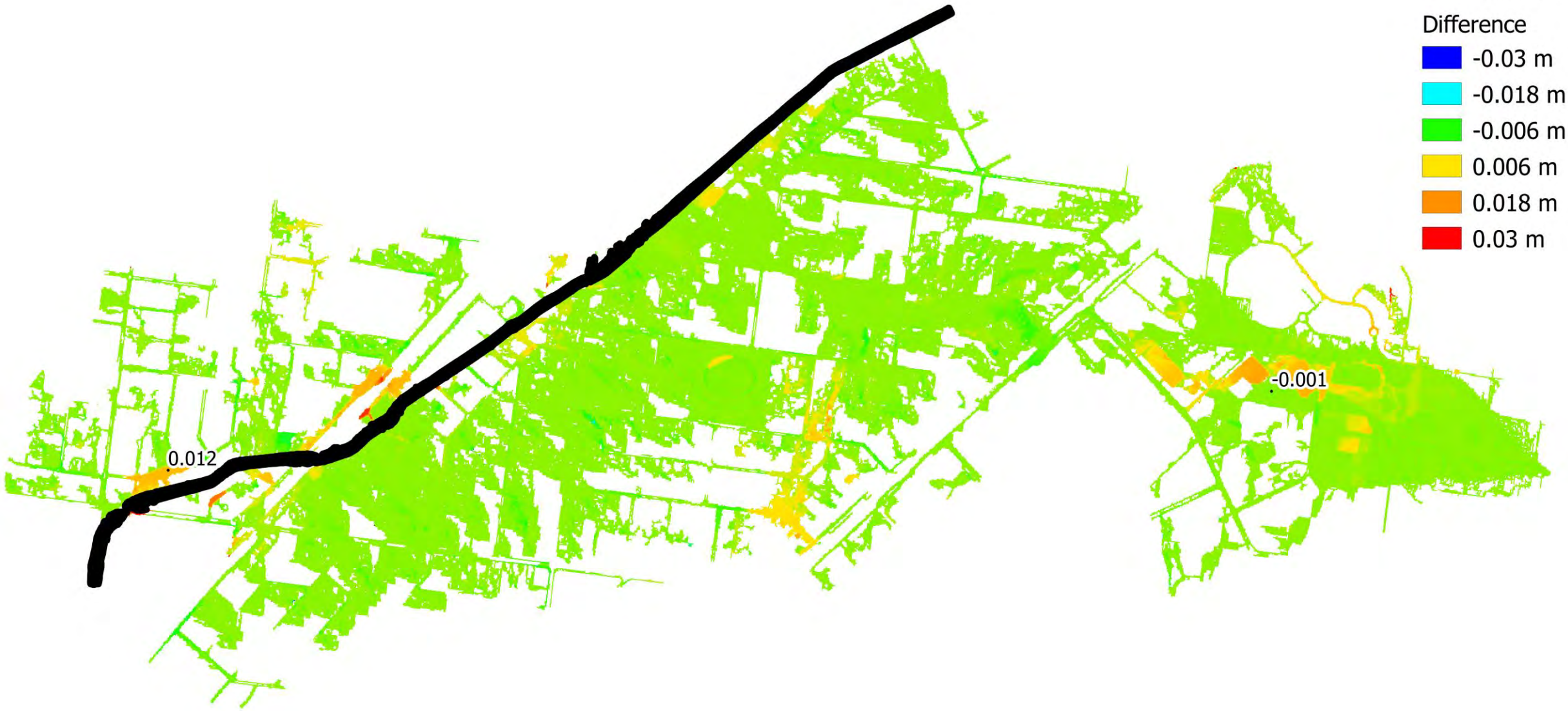
Model H
10% AEP
Difference between median and selected patterns



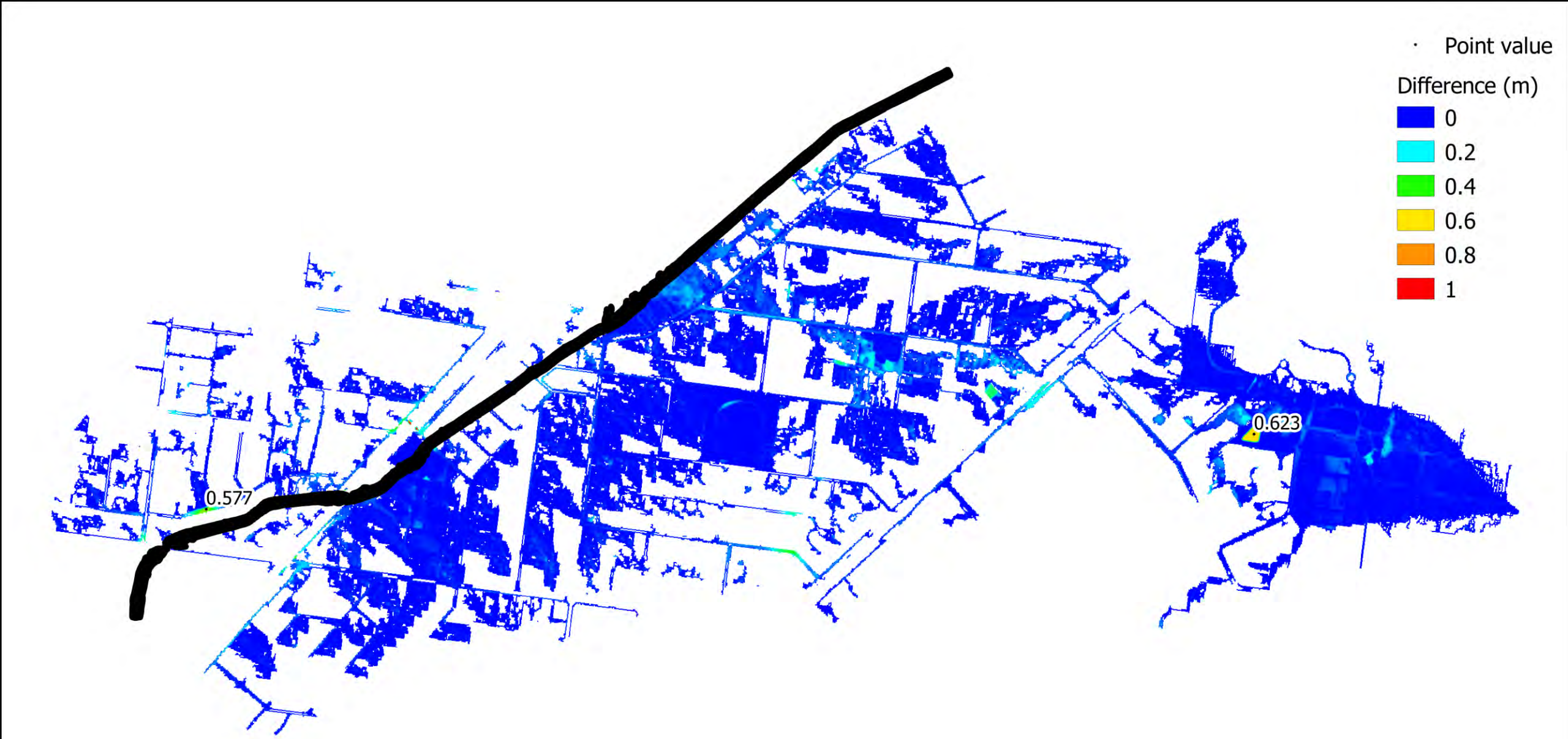
Model H
20% AEP
Difference between median and selected patterns



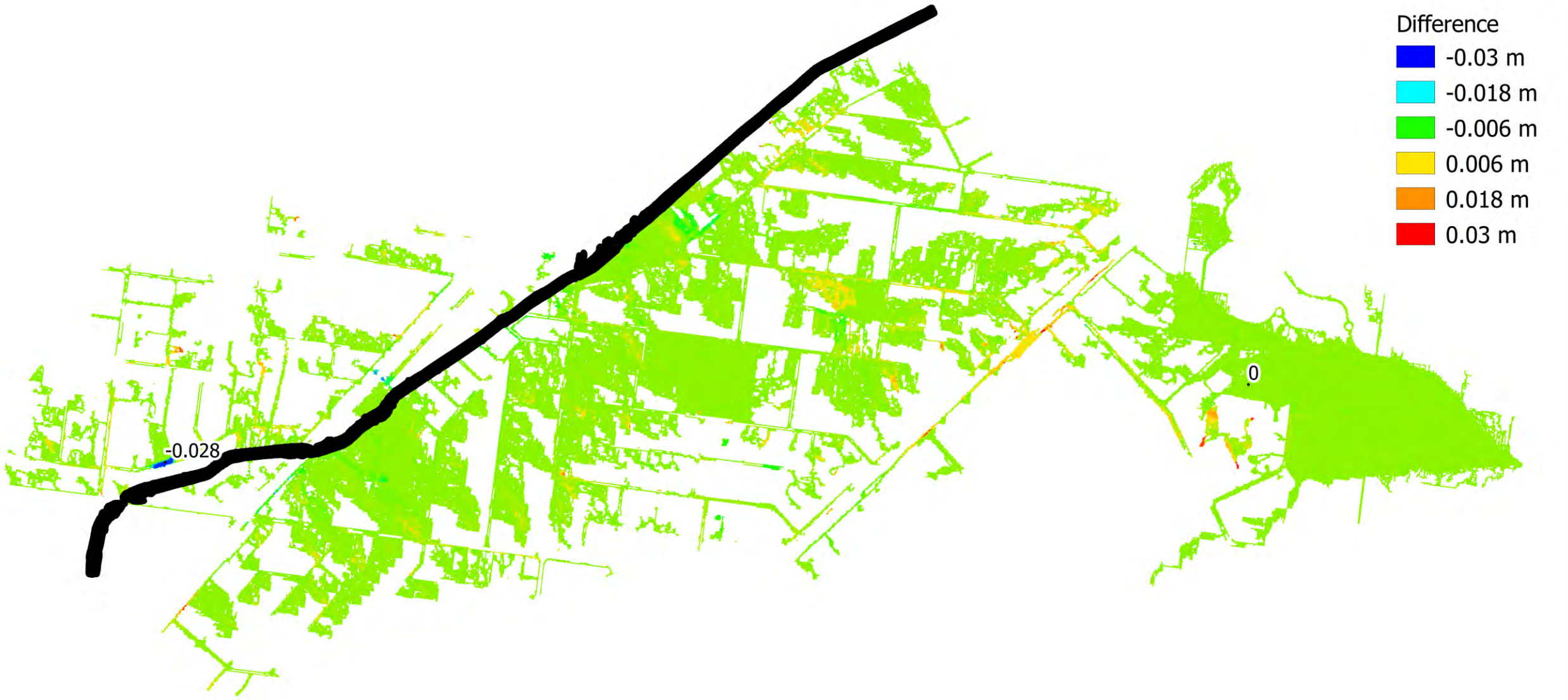
Model D
1% AEP
Maximum - Minimum Temporal Pattern



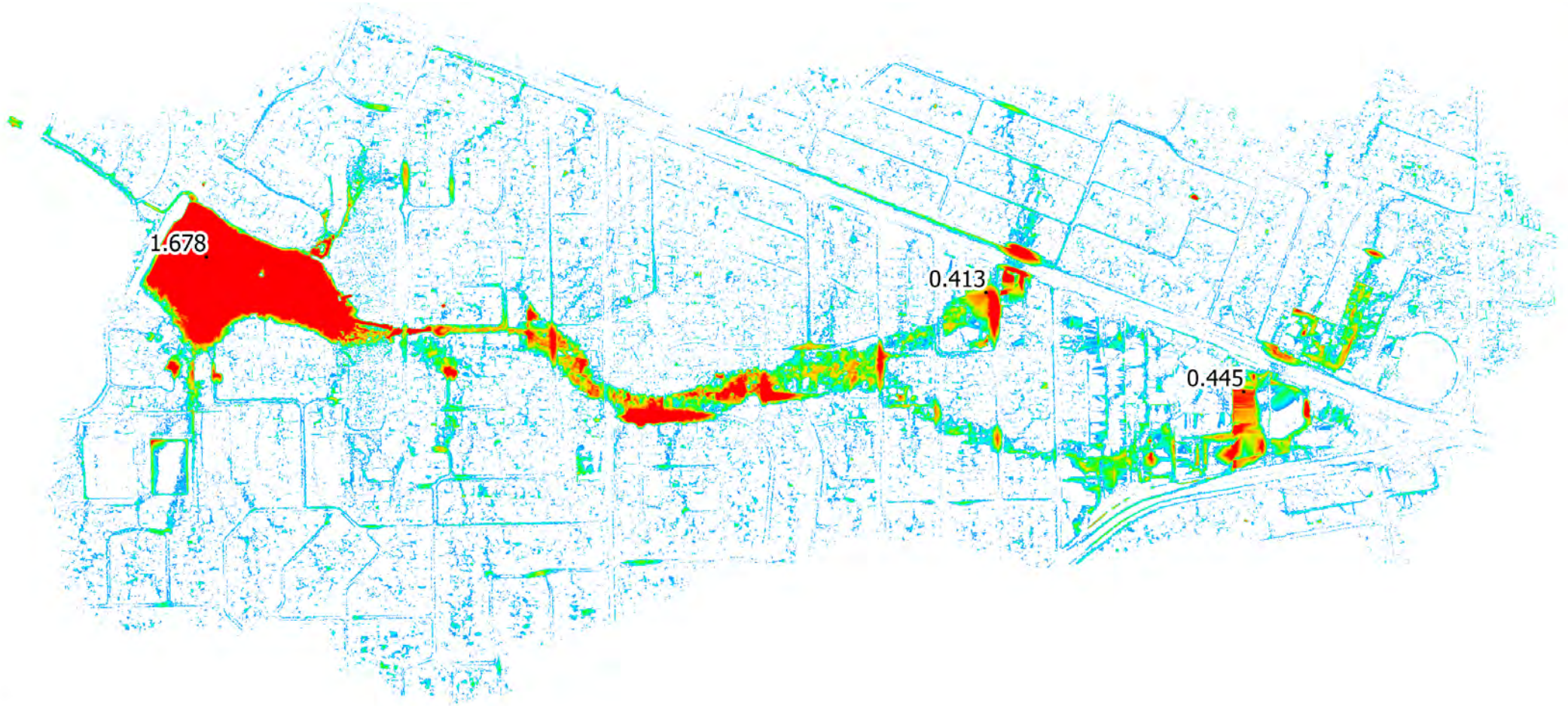
Model D
1% AEP
Difference between median and selected patterns



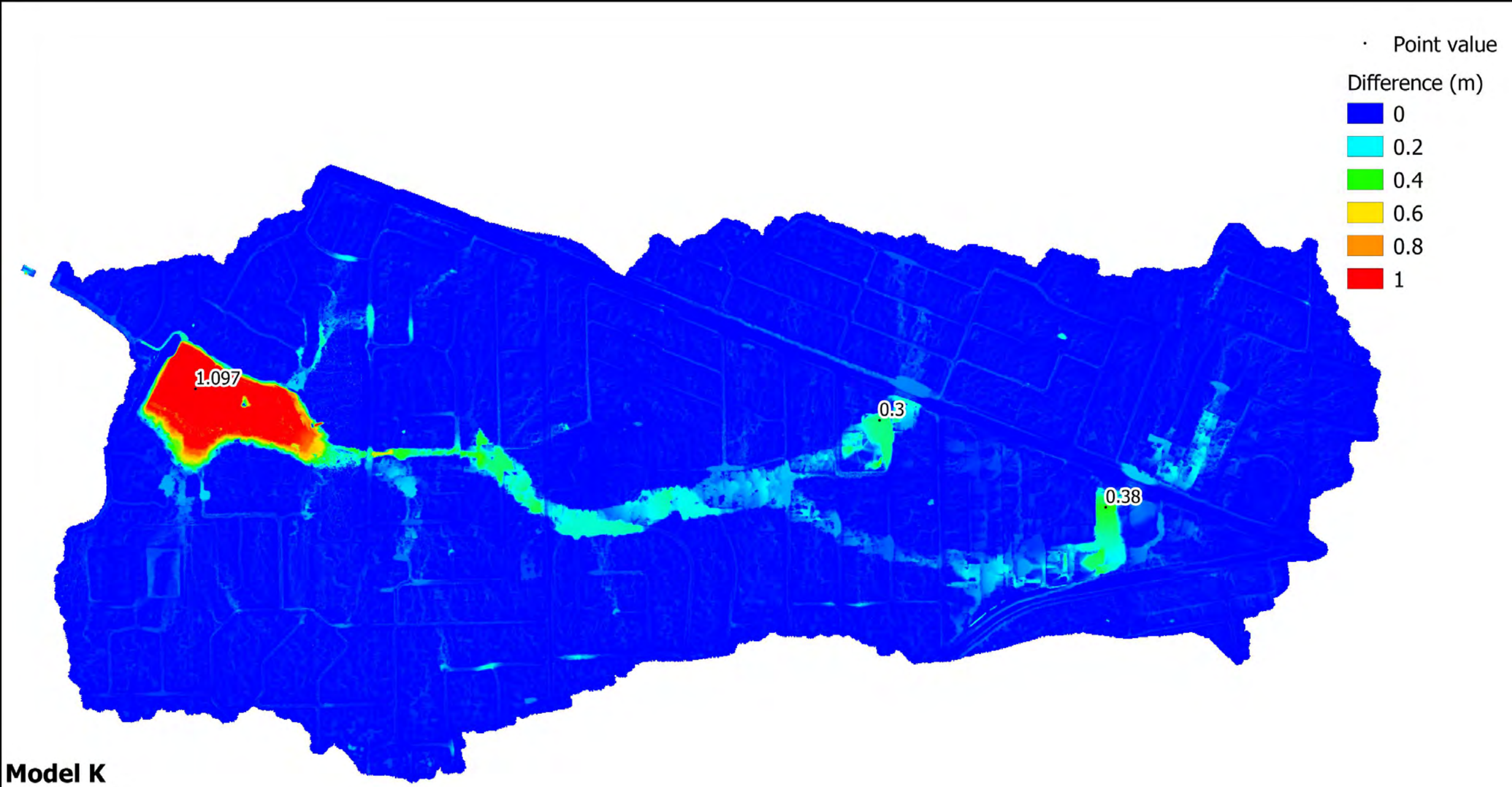
Model D
10% AEP
Maximum - Minimum Temporal Pattern



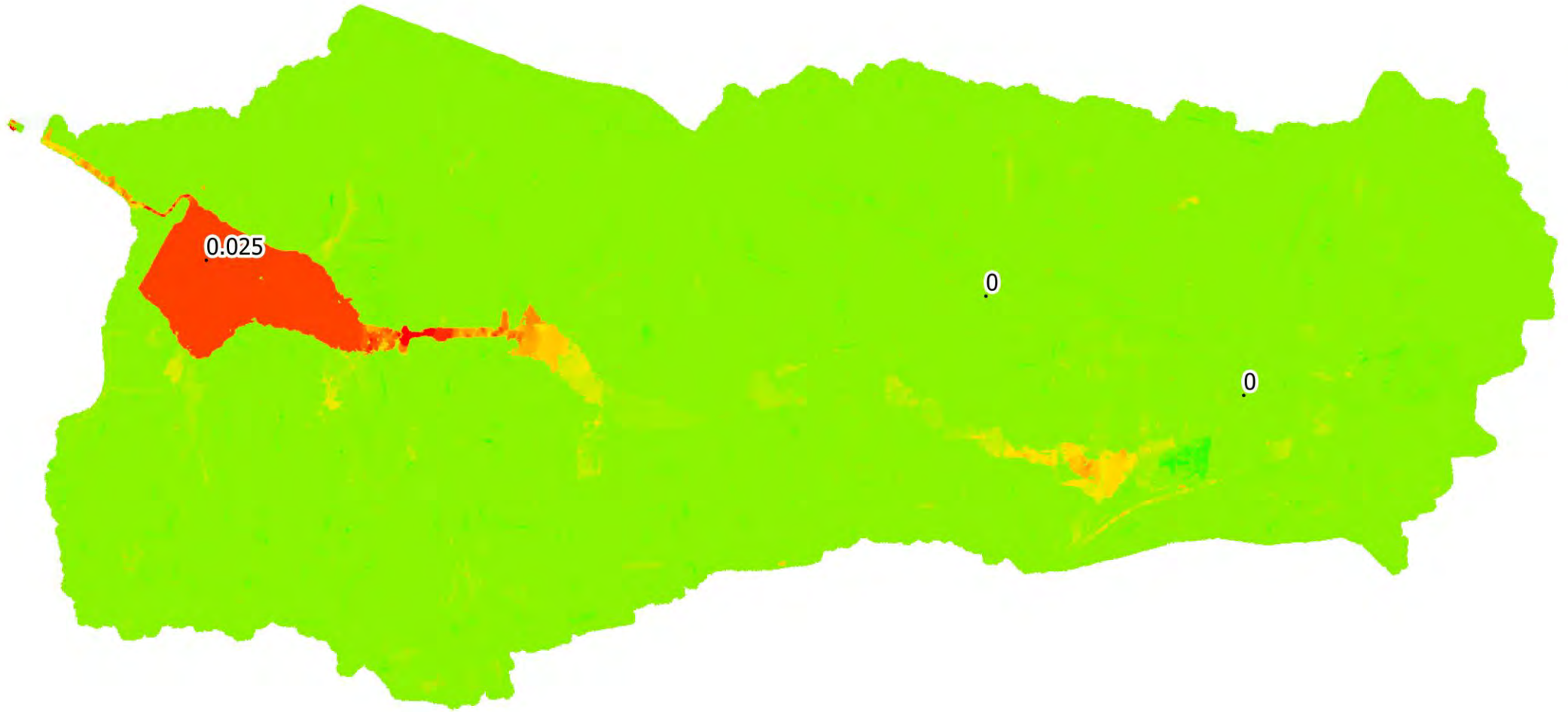
Model D
10% AEP
Difference between median and selected patterns



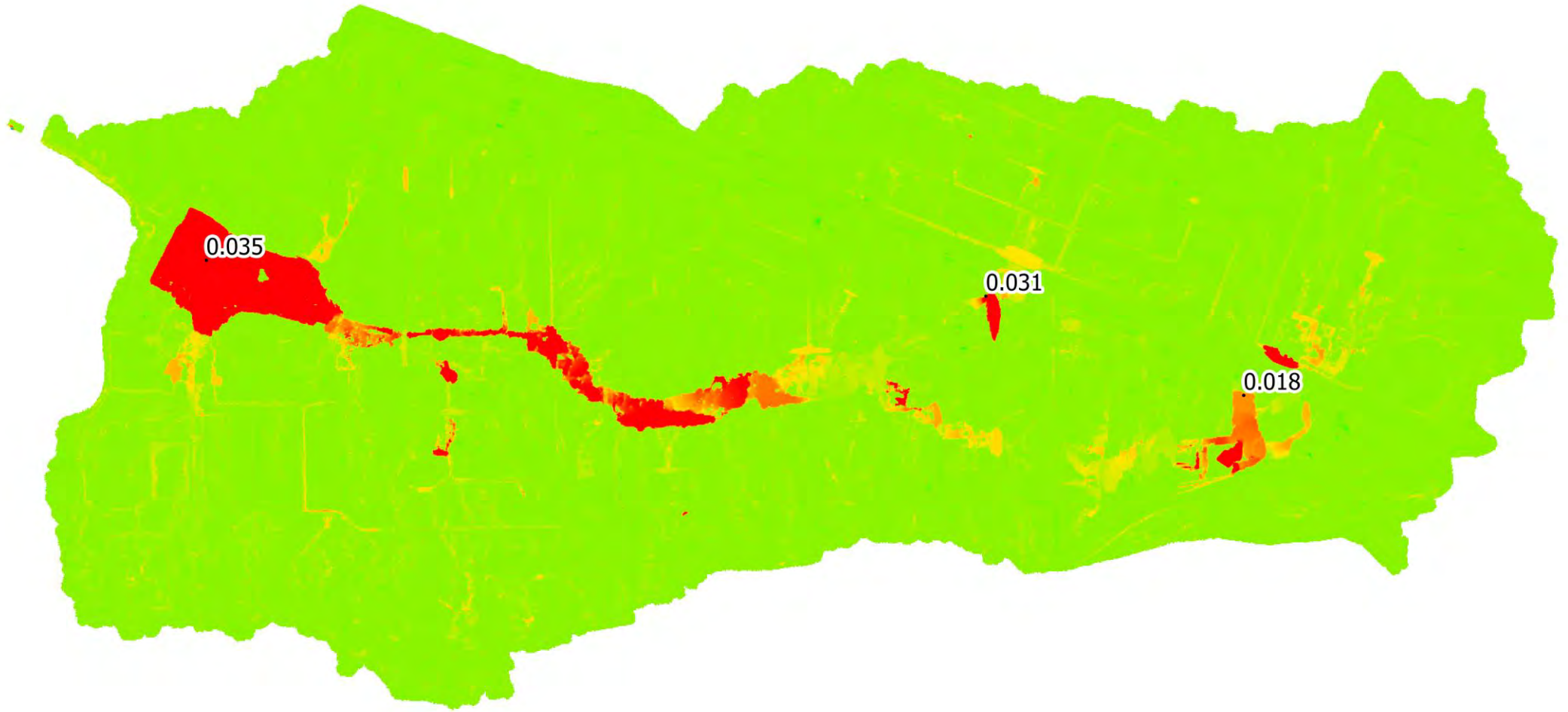
Model K
1% AEP
Peak Flood Depths (Medians)



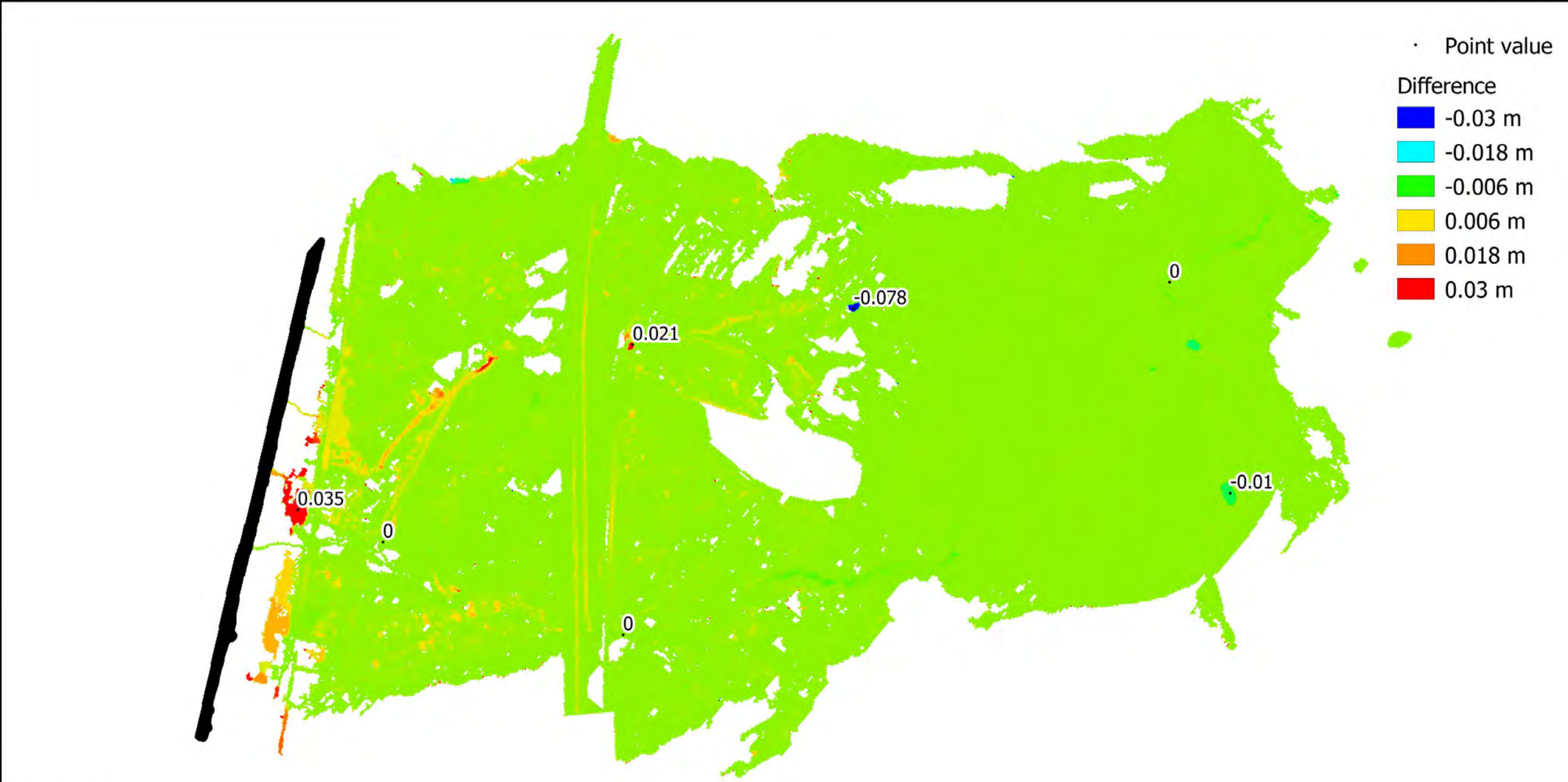
Model K
1% AEP
Maximum - Minimum Temporal Pattern



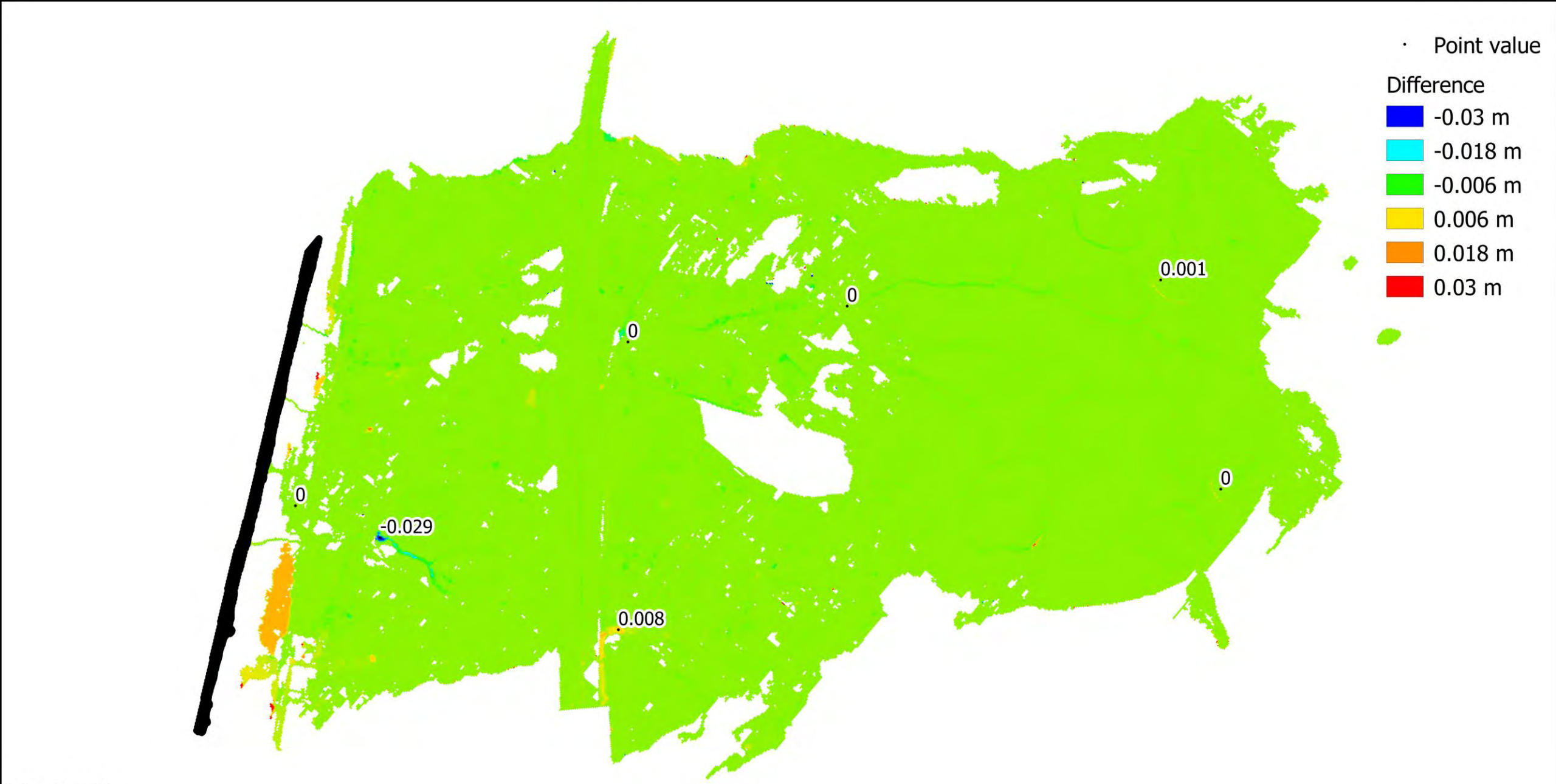
Model K
1% AEP
Difference between median and selected patterns



Model K
20% AEP
Difference between median and selected patterns

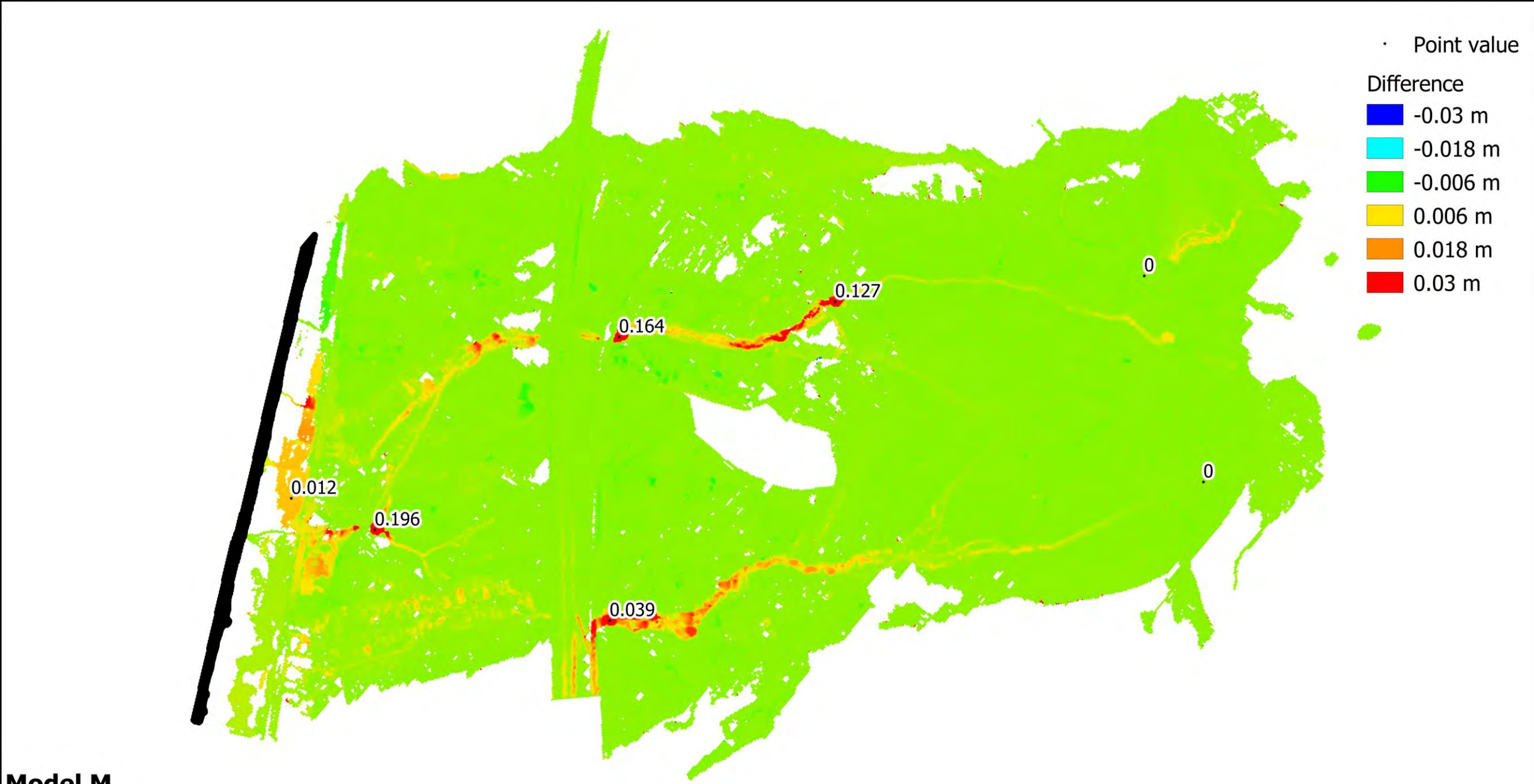


Model M
20% AEP
Difference between median and selected patterns

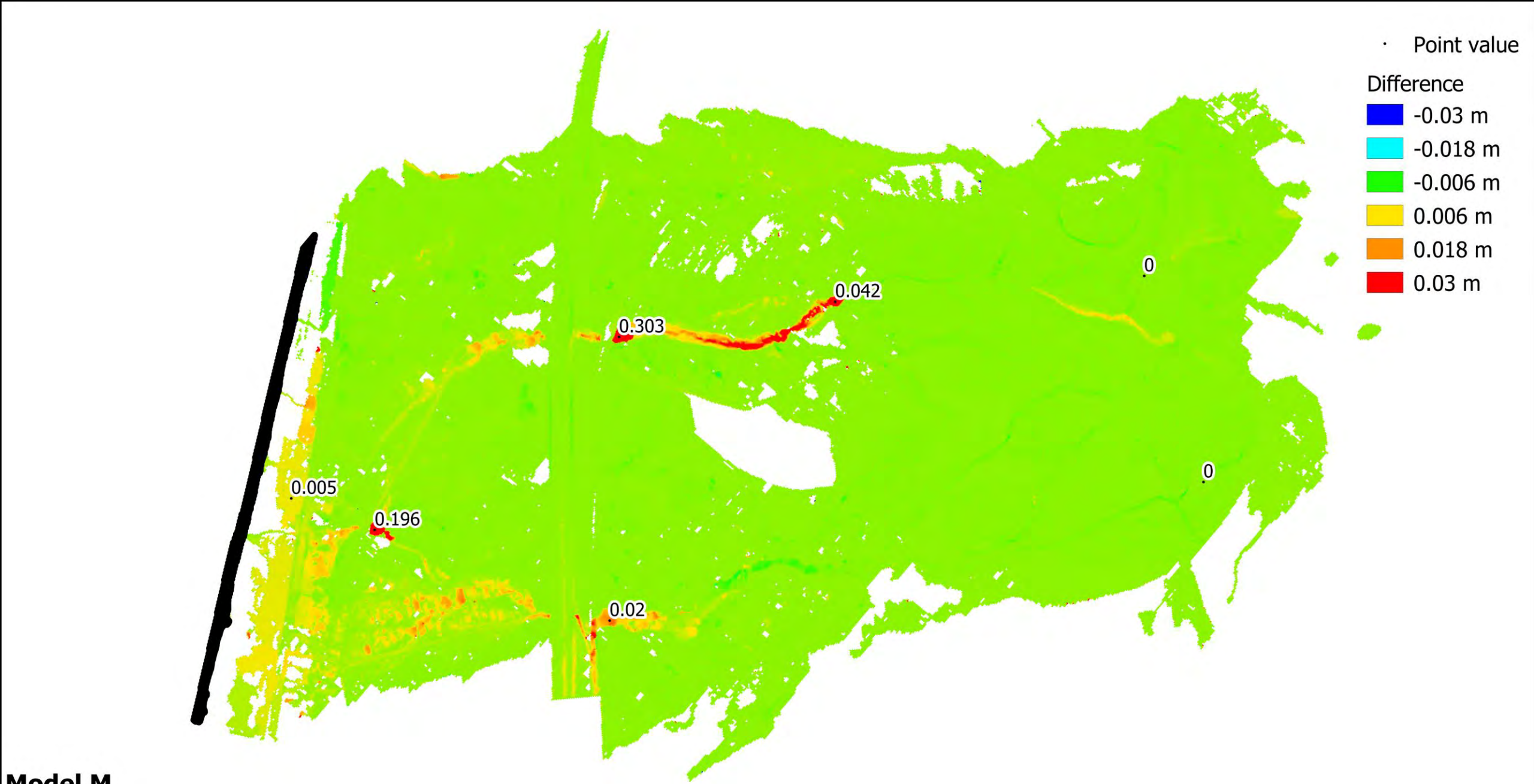


Model M
10% AEP
Difference between median and selected patterns

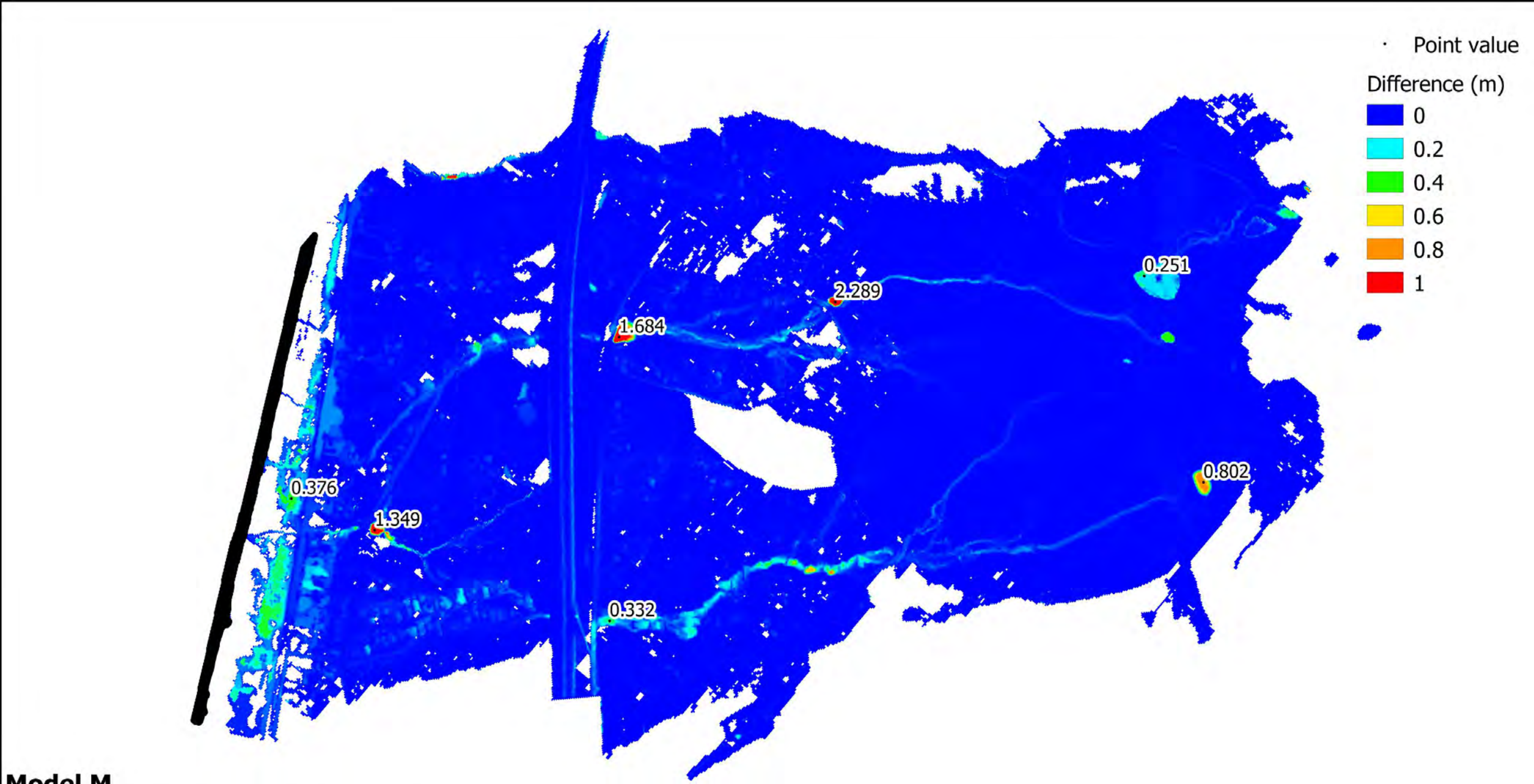
Model M
5% AEP
Difference between median and selected patterns



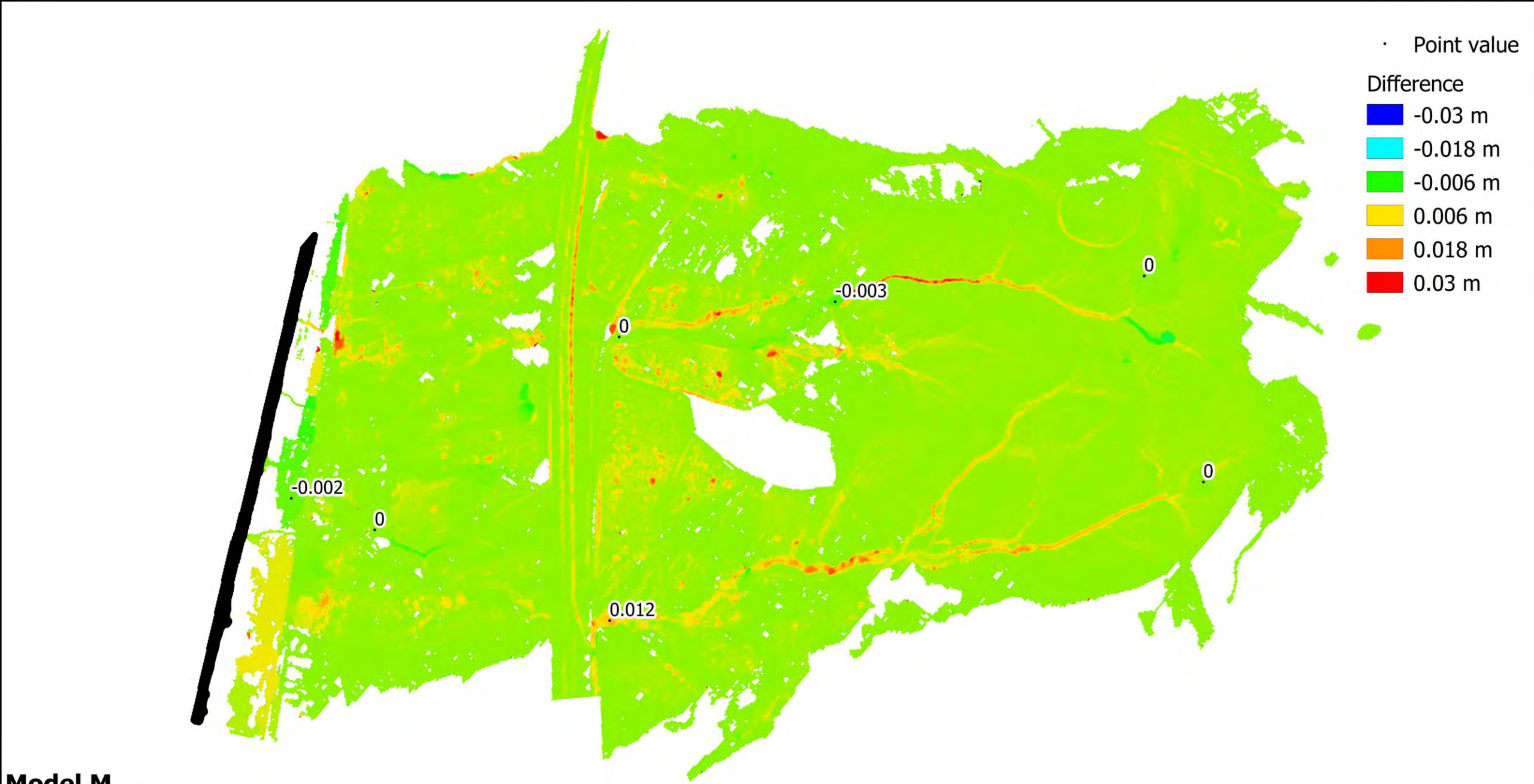
Model M
2% AEP
Difference between median and selected patterns



Model M
1% AEP
Difference between median and selected patterns



Model M
1% AEP
Maximum - Minimum Temporal Pattern



Model M
1% AEP
Difference between median and alternative selected patterns

Statistics 1% AEP

Model	AEP	Mean difference (mm)	Difference - Standard Deviation (mm)	Maximum underestimate (mm)	Maximum overestimate (mm)
H	100y	2.3	3.6	-33	109
C	100y	1.1	3.1	-126	121
M	100y	3.6	18.9	-424	304
K	100y	5.9	10.0	-24	332
D	100y	1.6	4.3	-42	70
P	100y	2.4	12.6	-141	428

ENGENY
WATER MANAGEMENT

Statistics 10% and 20% AEP

Model	AEP	Mean difference (mm)	Difference - Standard Deviation (mm)	Maximum underestimate (mm)	Maximum overestimate (mm)
C	20%	0.4	4.2	-150	133
H	20%	2.7	7.7	-59	88
K	20%	17.6	16.3	-113	99
M	20%	1.7	6.6	-78	154
C	10%	1.0	3.0	-27	85
D	10%	0.4	4.2	-42	36
H	10%	1.6	3.4	-17	194
M	10%	0.5	3.4	-240	43

Which patterns best match the median results?

Duration	20% AEP	10% and 5% AEP	2%, 1% and 0.5% AEP
10 min	1	16	26
15 min	8	17	28
30 min	6	18	28
60 min	6	18	28
120 min	9	17	25
180 min	4	15	28

ENGENY
WATER MANAGEMENT

Discussion

- Can chose one TP from each duration to match closely to the median result
- Appears to be fairly set of patterns consistent across 6 catchments tested
- Some areas of outliers in some models
  - have tended to be more on the conservative side (high flood level)
  - can also predict where these areas may be located (RB's and defacto RBs)

ENGENY
WATER MANAGEMENT

Discussion – Does it make sense?

- Don’t want an extreme, want the middle
- Limited possible variation within a short time period for shorter storms
  - little value variation in storms under 60 minutes
  - Total rainfall depth more important – impact of initial loss
- More variation possible in longer storms, would expect more variation
- Steeper catchments show more variation
  - less attenuation of runoff so flow patterns match temporal patterns more closely

ENGENY
WATER MANAGEMENT

Can we just run one TP?

- Yes, it is a valid estimate of the AEP flood (we did this for 30 years… all that work is not “wrong”)
- Running more patterns will quantify the uncertainty better
- Consider running a front and back loaded pattern to understand the variability

ENGENY
WATER MANAGEMENT

Where should we put our effort?

- Initial loss (data hub data is low confidence and highly variable, particularly around Melbourne, between 8 mm and 32 mm west to east sides of the bay)
- Continuing loss (data hub data is low confidence)
- Climate change
- Future development

ENGENY
WATER MANAGEMENT

Finally

- All modelling is wrong
  - Aim to minimise by how much
  - The median (or mean) of the temporal patterns is not the perfect answer
- Be an Engineer and not a Scientist!
  - We should not be obsessing over millimetre differences between temporal patterns
  - Safety factor (freeboard)
  - Acknowledge or quantify the uncertainty and move on
  - Make a practical call on if the uncertainty is important

ENGENY
WATER MANAGEMENT