Hybrid modelling for real-time urban pluvial flood mapping

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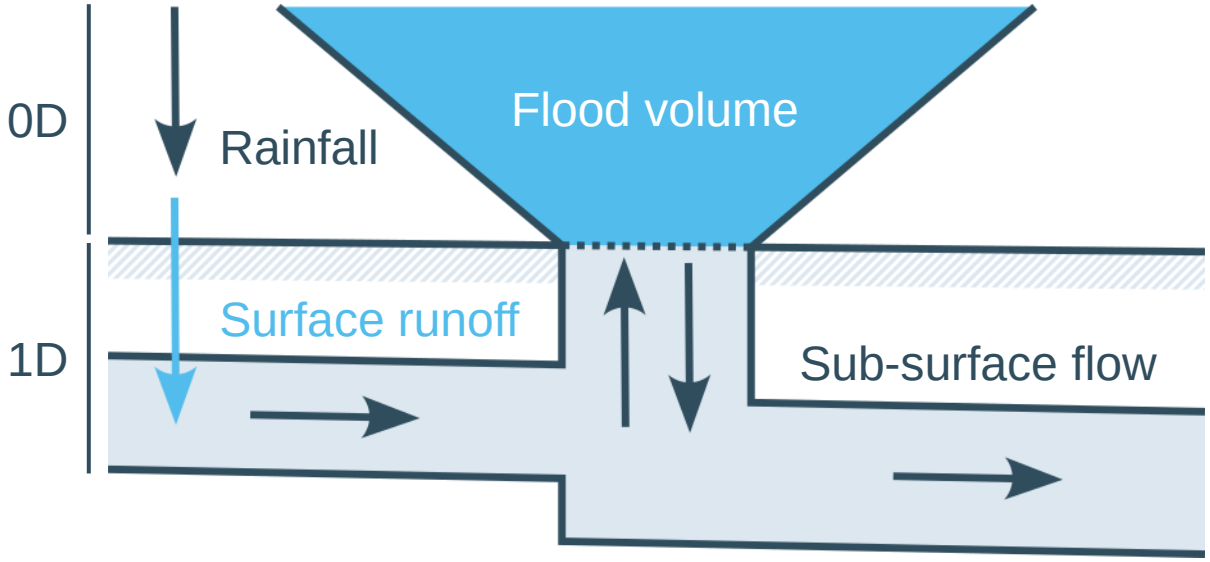
Hydraulics & Geotechnics | Department of Civil Engineering

Flood models

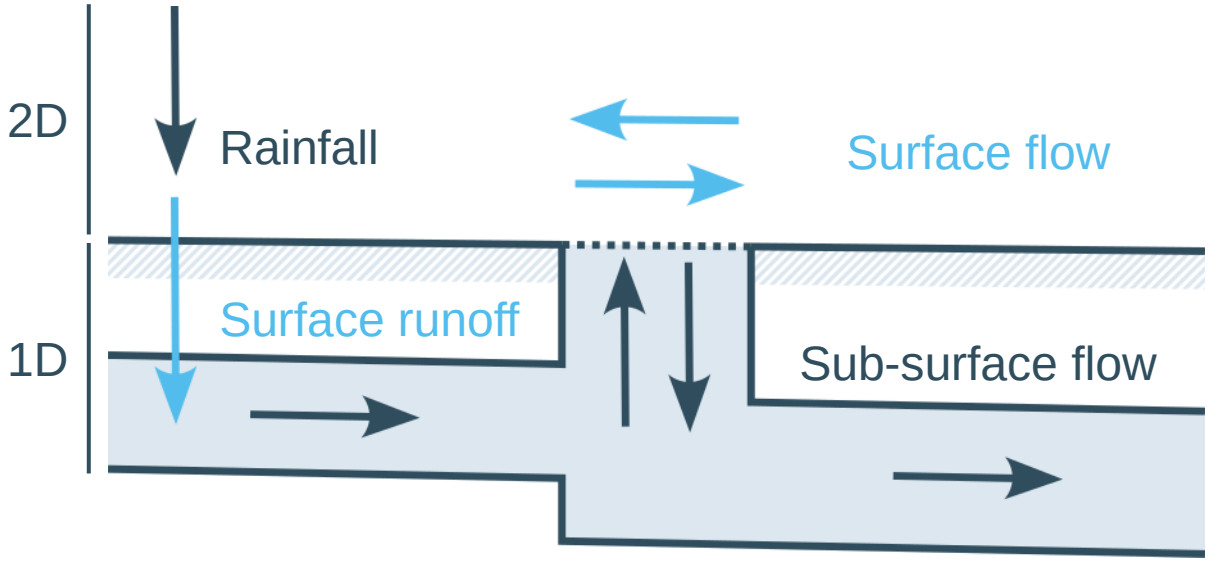
Saint-Venant equations (1D)

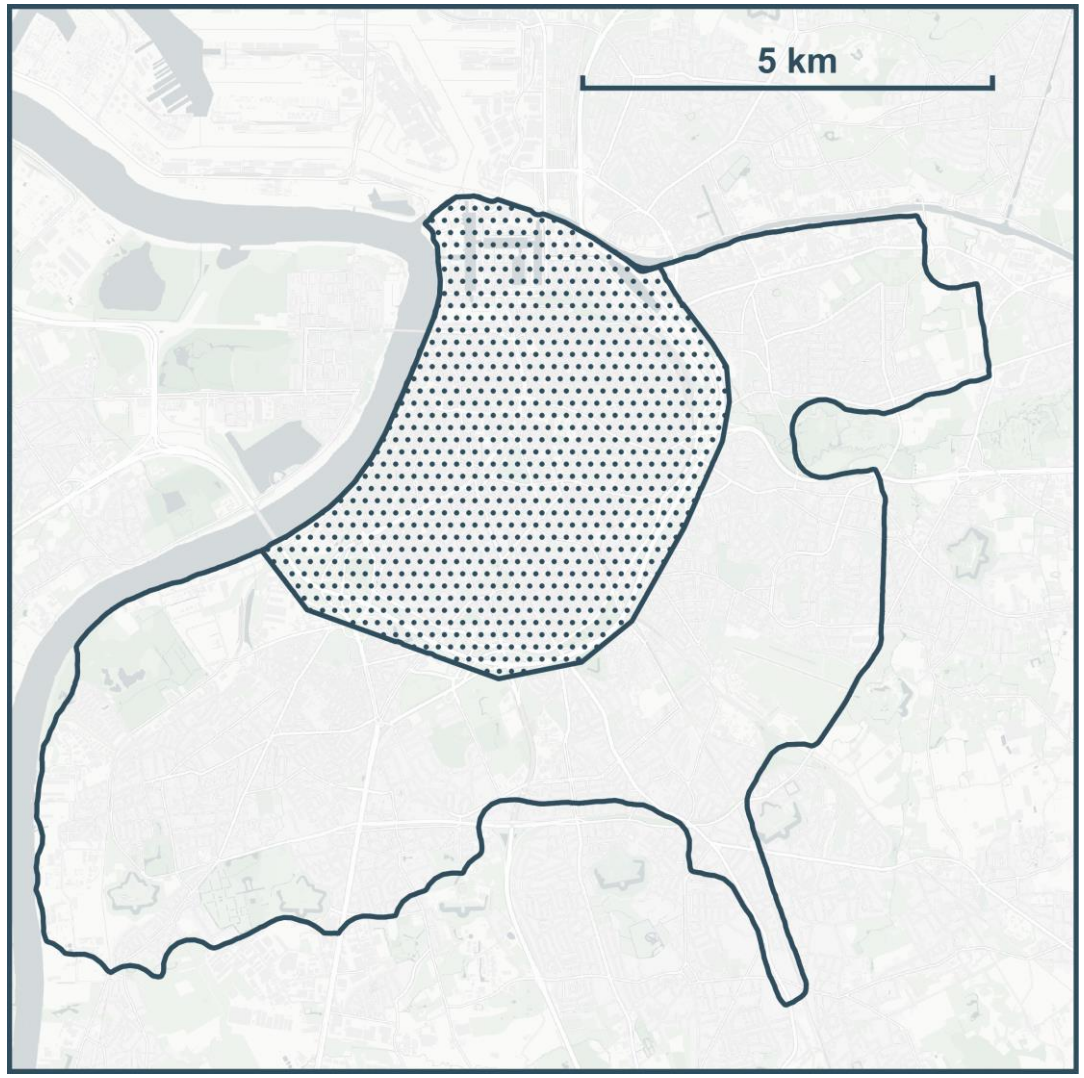


Flood models

Saint-Venant equations (1D)

Shallow-water equations (2D)



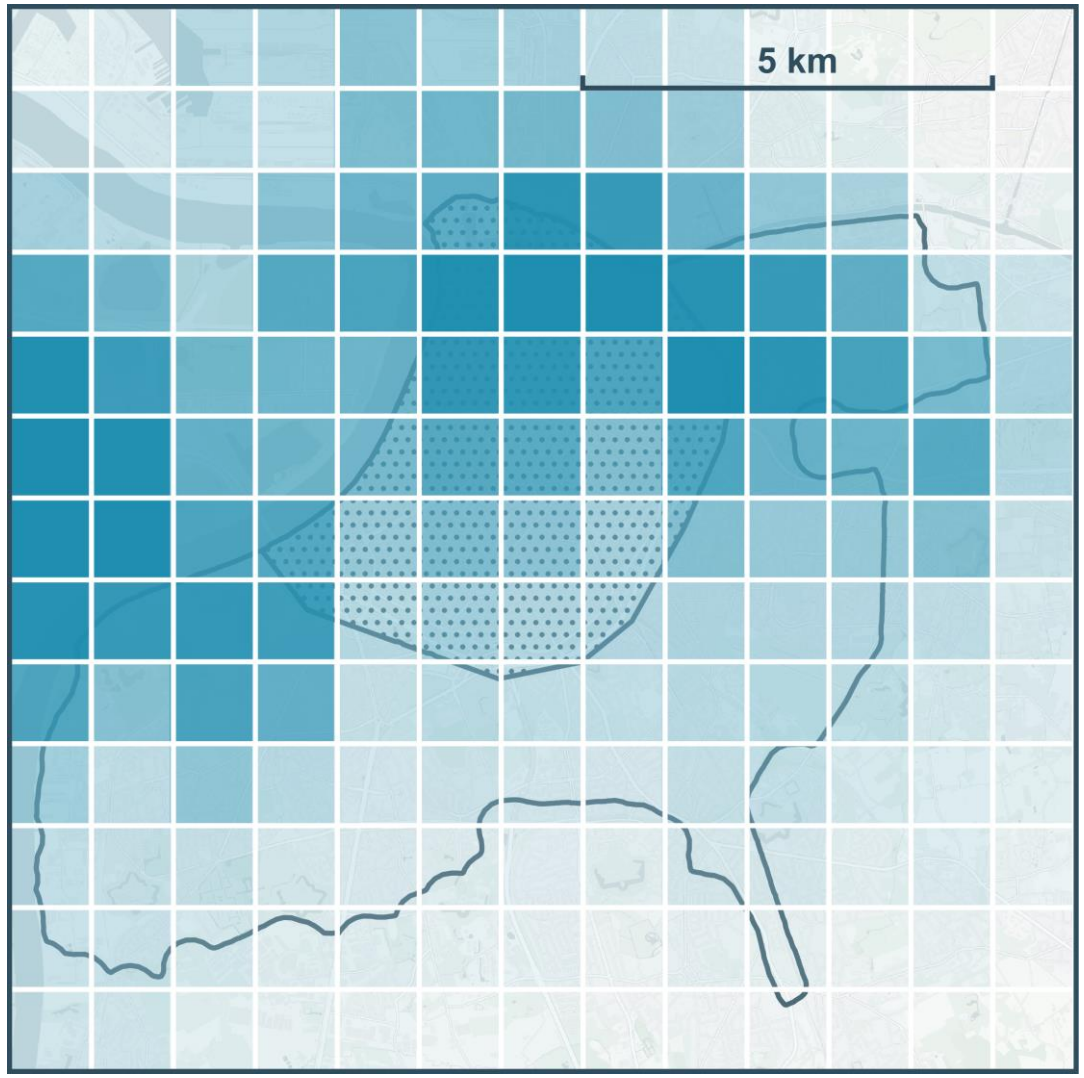


Flood forecast

Radar precipitation estimation

Precipitation nowcast

► Computational constraint



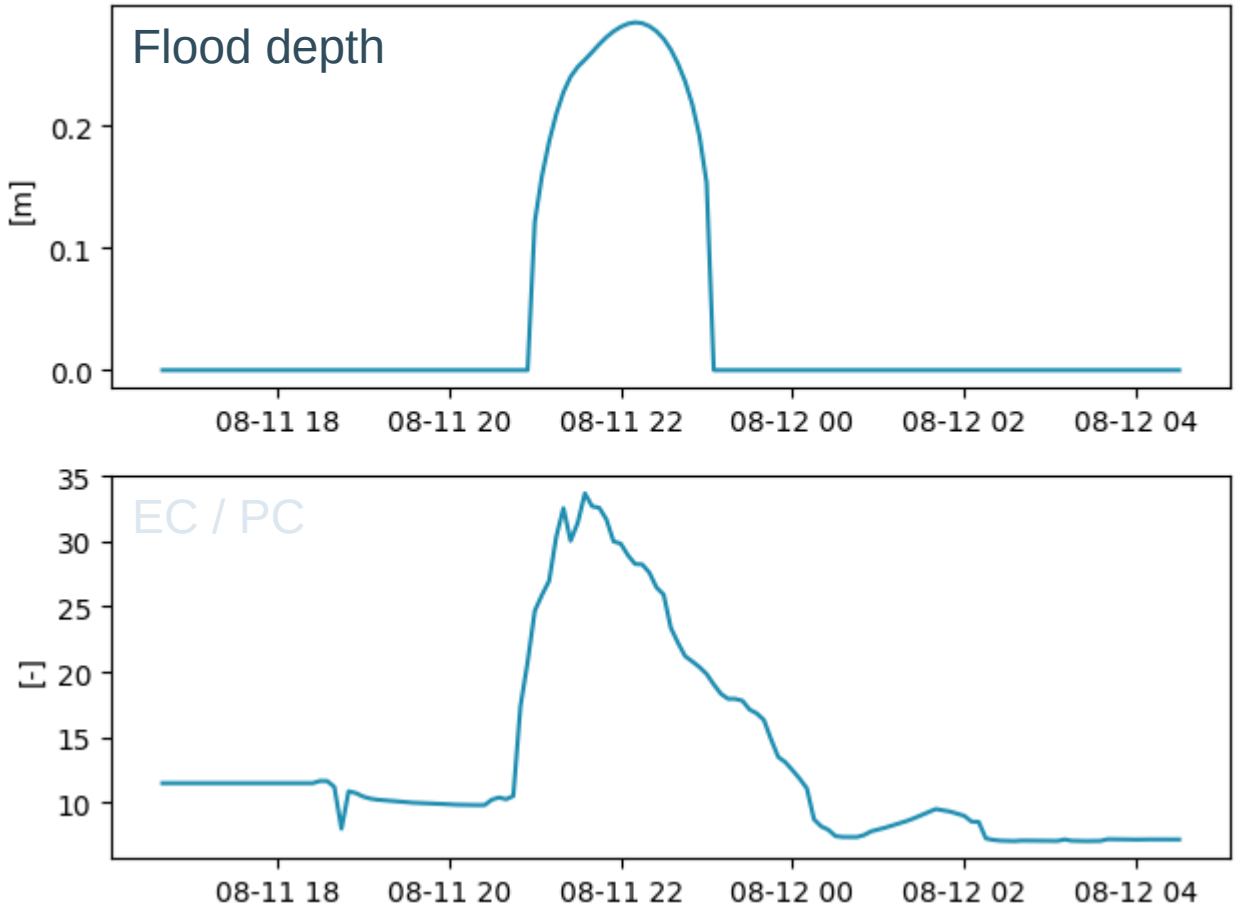
Fast flood model hybrid model

Data-driven model

Gaussian Process

Dimensionality reduction

EOF / PCA

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Fast flood model hybrid model

Data-driven model

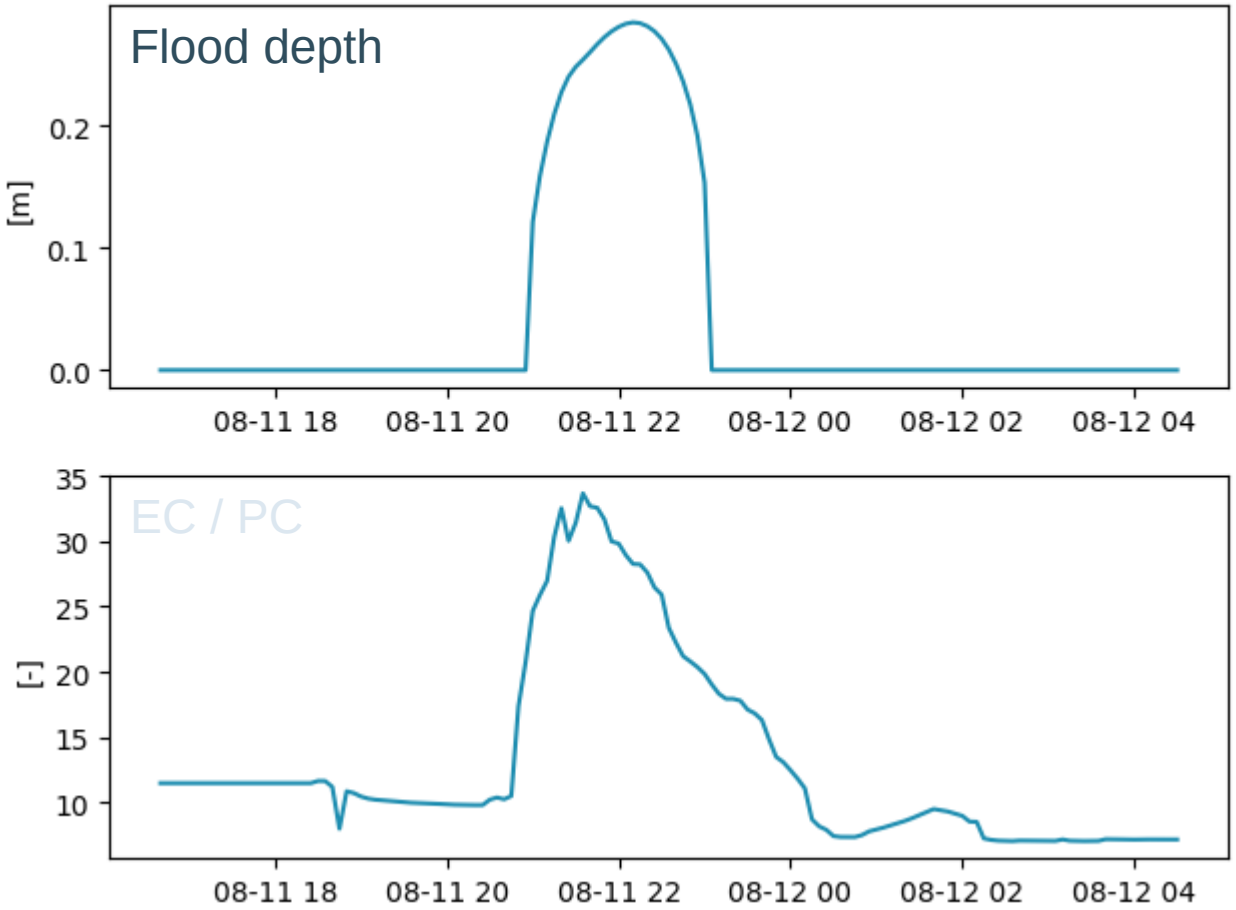
Gaussian Process

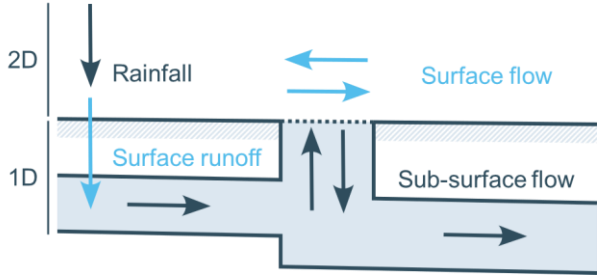
Dimensionality reduction

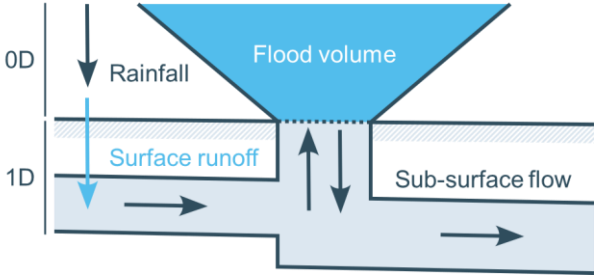
EOF / PCA

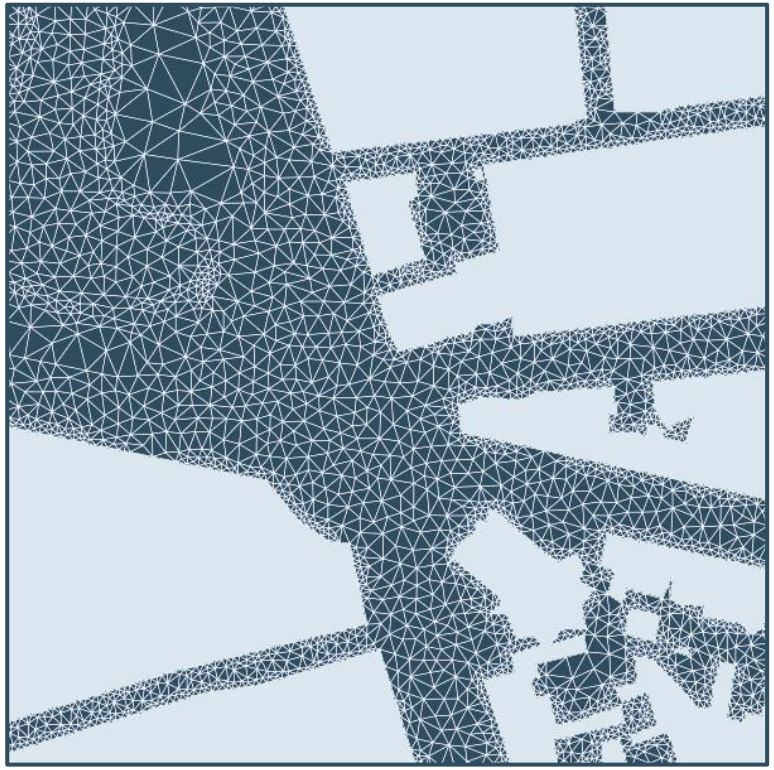
Simplified flood model

Physically-based

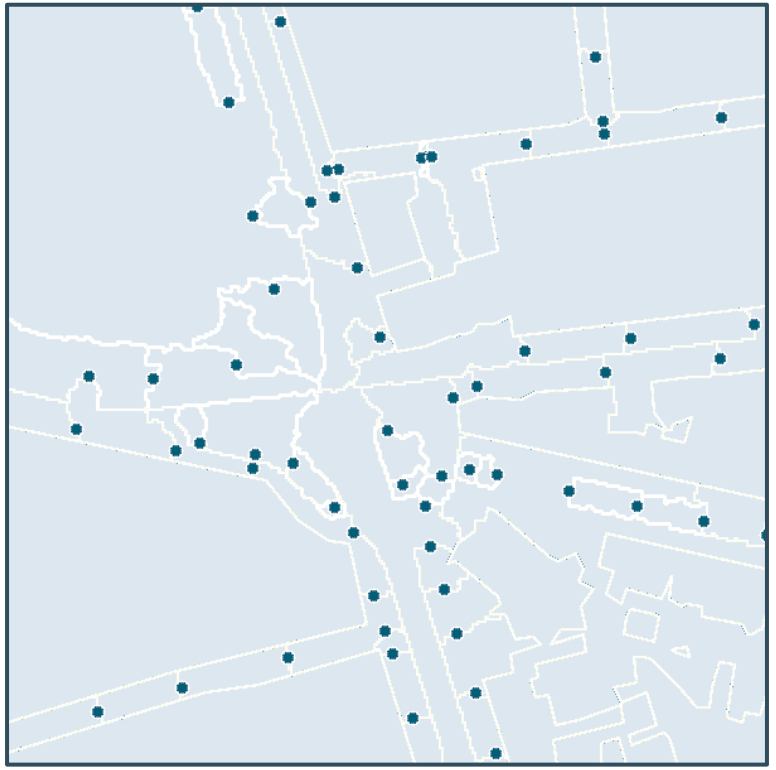




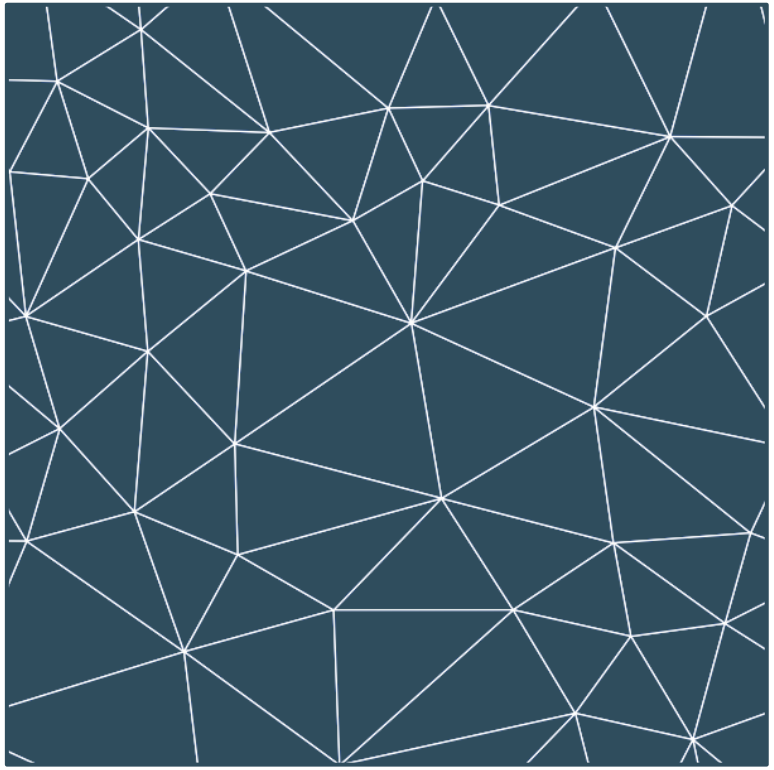




Original (1D2D)

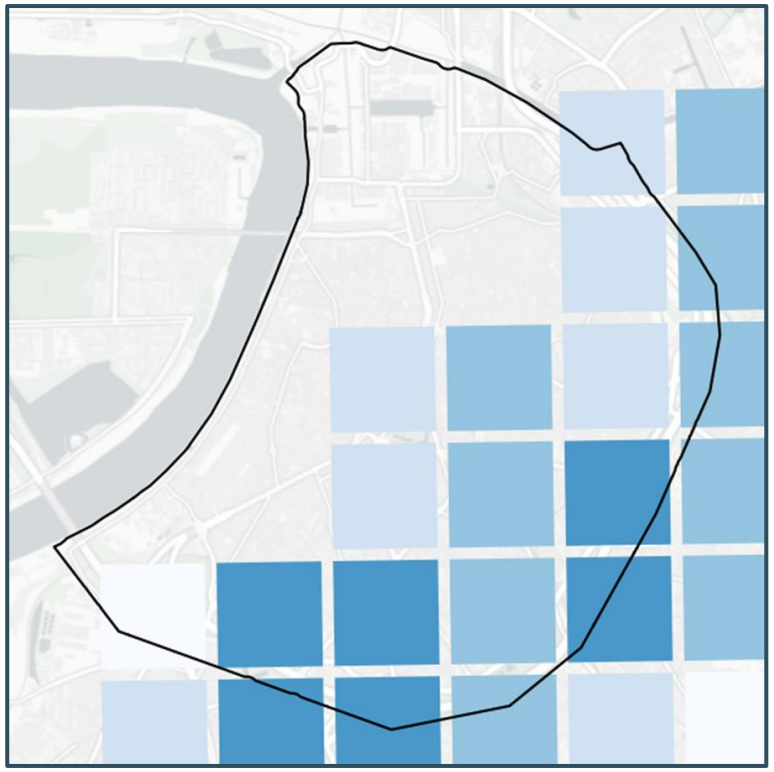


Simplified (1D0D)

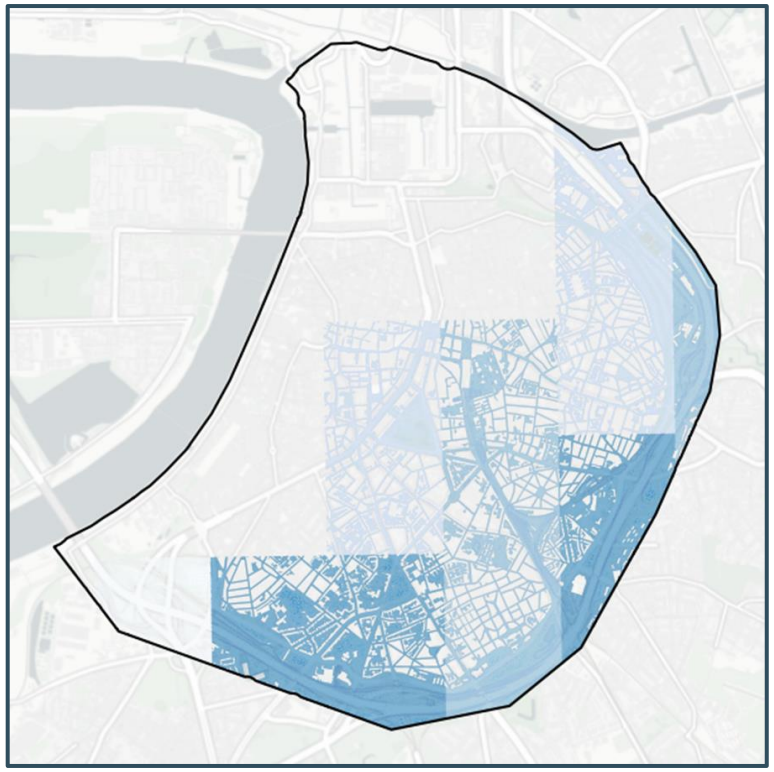


Simplified (2D)

Rainfall no flood model



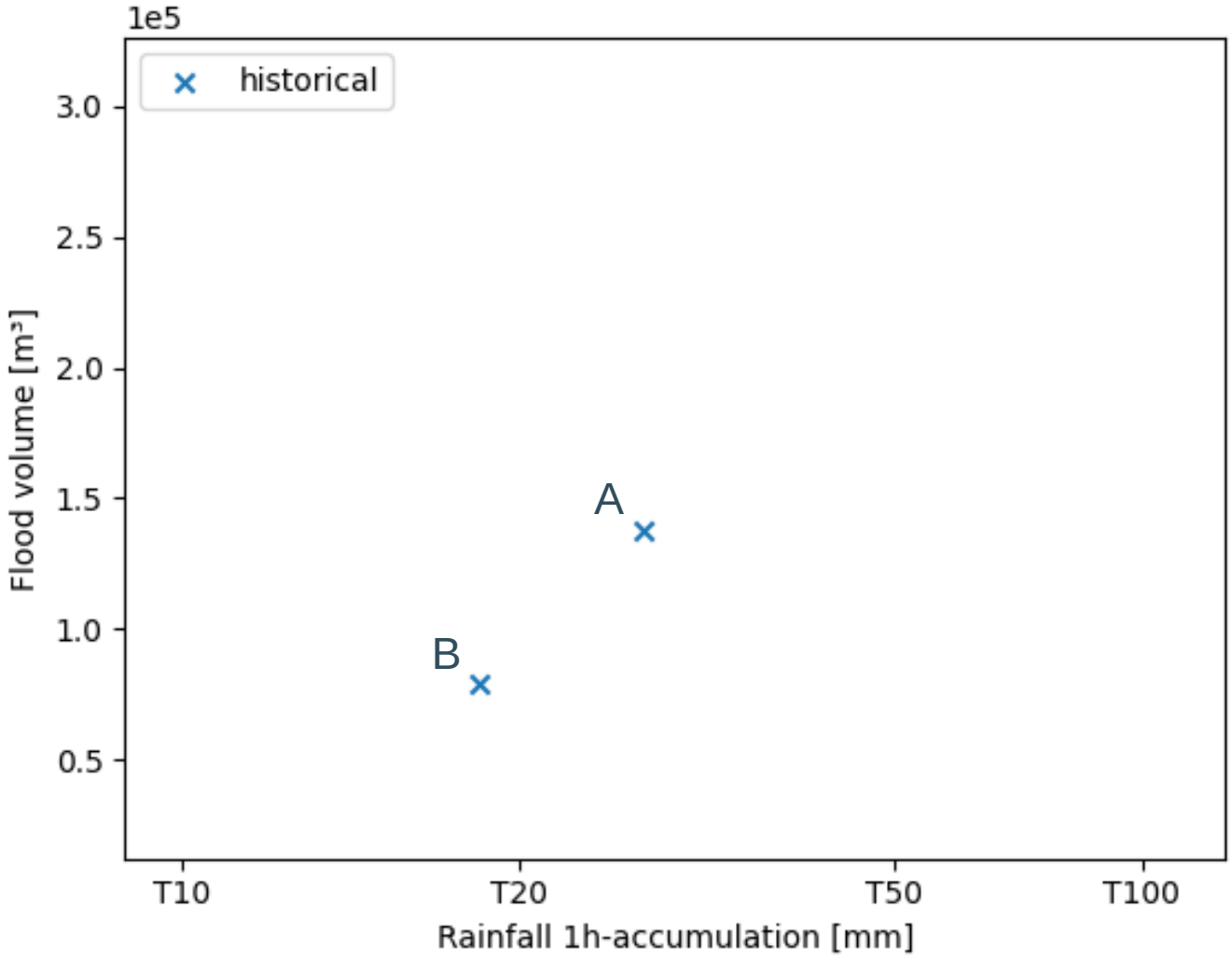
Accumulated rainfall



Original mesh

Dataset

QPE (2017-2023)



Dataset

QPE (2017-2023)

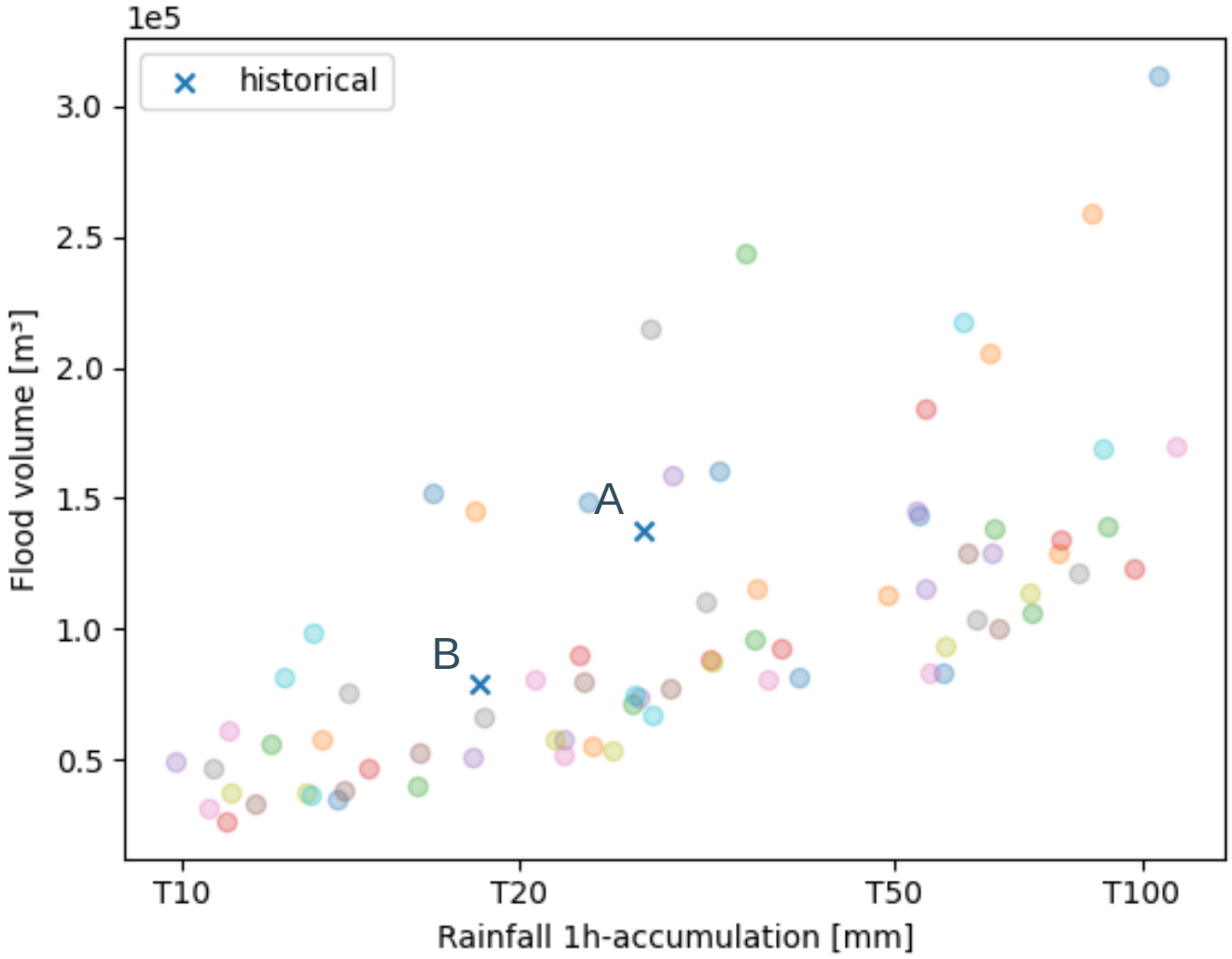
Training data

Spatial transposition

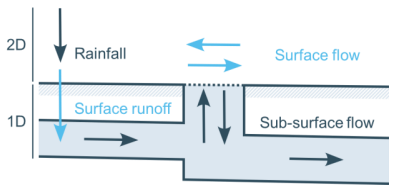
Cross-validation

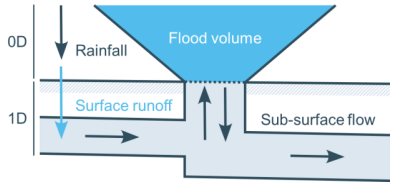
Stratified sampling

Rainfall over 2D zone



Results cross validation



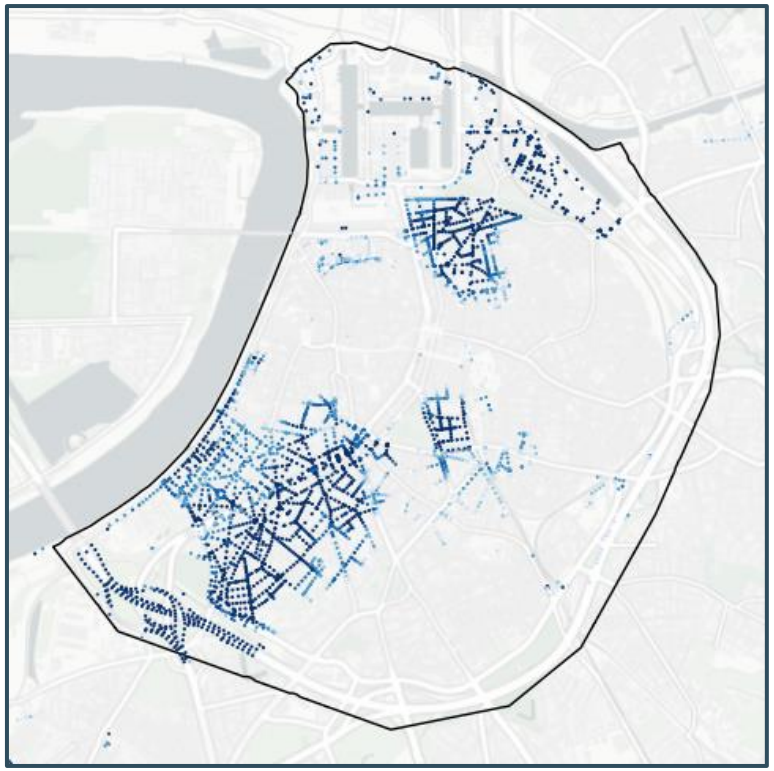


Original Hybrid Hybrid Hybrid

μ_{CV} (σ_{CV})		1D2D	1D0D	2D	Rainfall
Dimensions	[#]	877k	23k	5.7k	86
Time / h_{sim}	[s]	188.8 (10.9)	11.7 (0.2)	2.5 (0.1)	**0**
CSI	[-]	-	**0.69** (0.03)	0.62 (0.05)	0.32 (0.08)
R^2_{peak}	[m]	-	0.81 (0.06)	**0.87** (0.06)	0.53 (0.14)
Δ_{peak}	[m]	-	**0.01** (0.01)	0.03 (0.01)	0.07 (0.01)
RMSE	[m]	-	0.09 (0.01)	**0.07** (0.01)	0.14 (0.01)

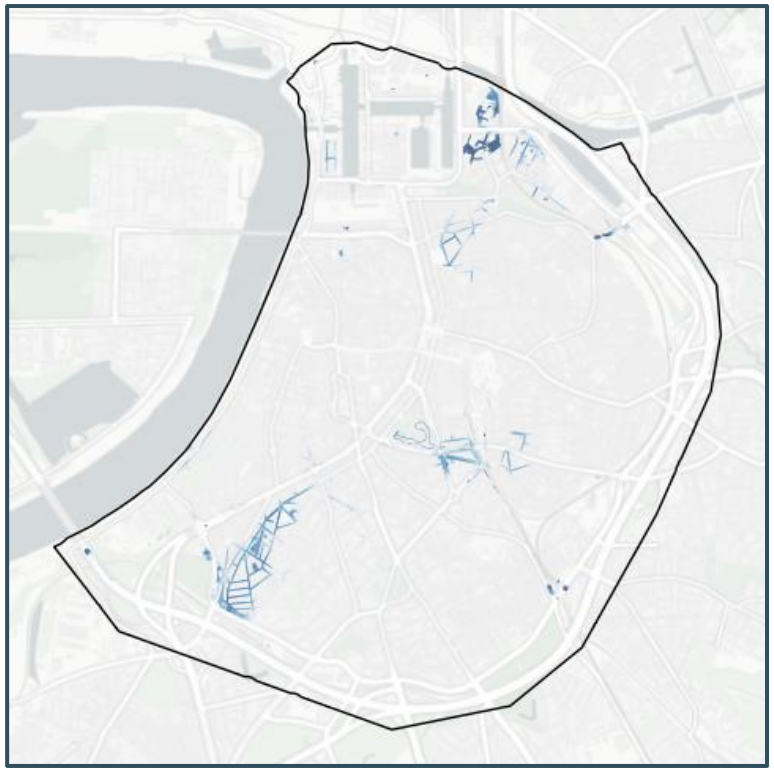
Results storm A

CSI	[-]	0.57
RMSE	[m]	0.14
R^2_{peak}	[m]	0.78
Δ_{peak}	[m]	0.029



Simplified (1D0D)

Hybrid model (1D0D)



Original (1D2D)

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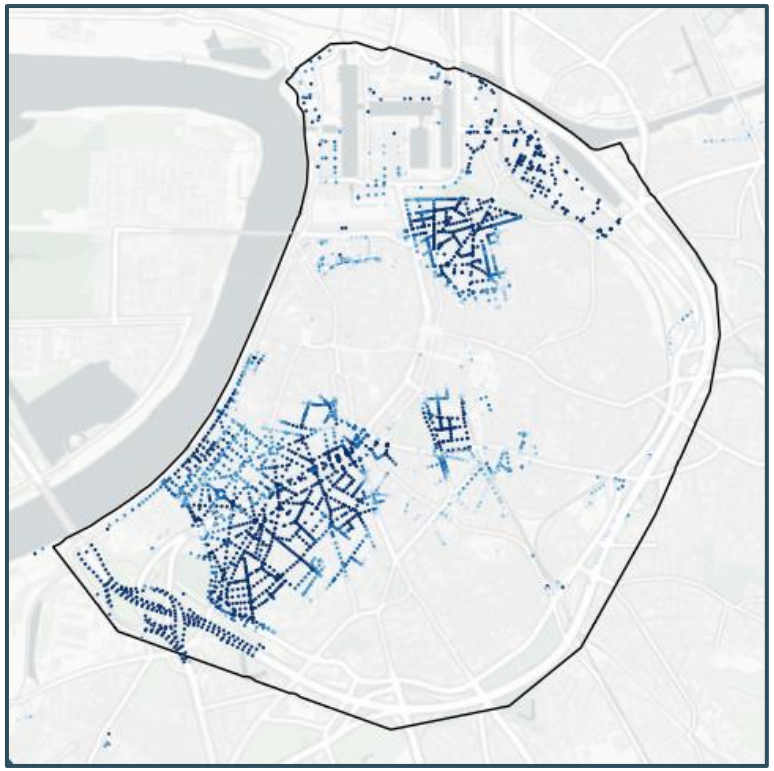
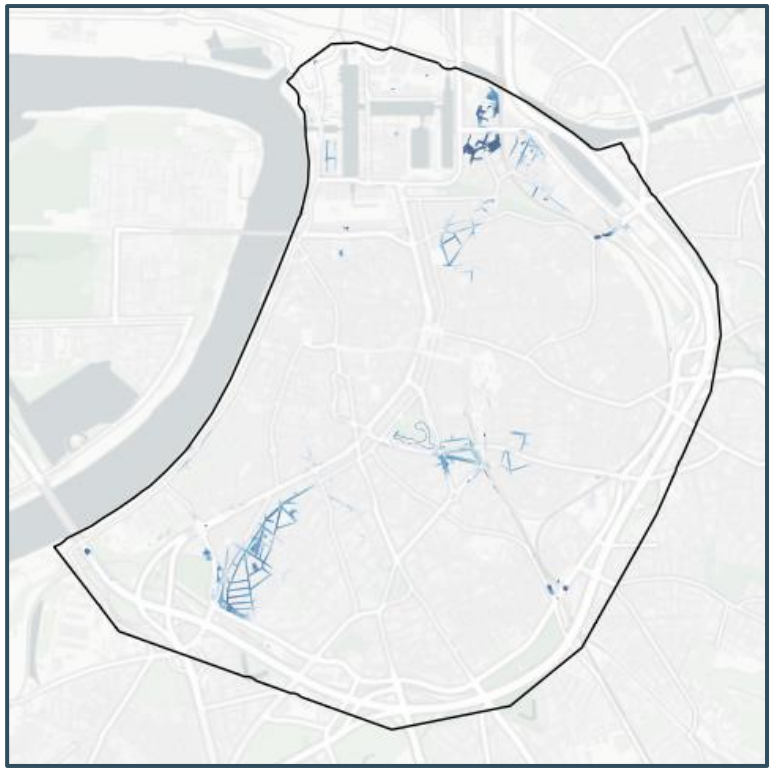


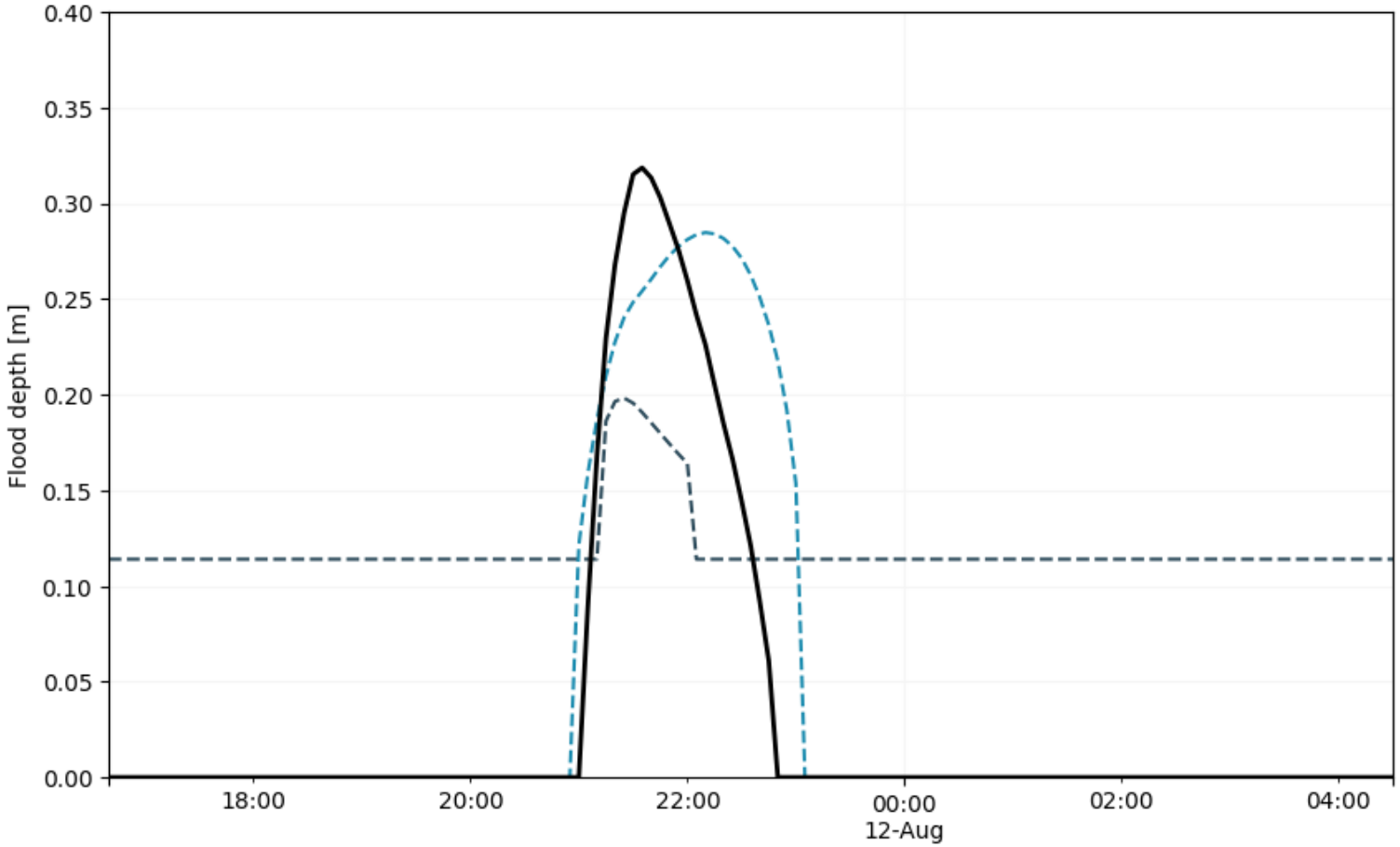
Simplified (1D0D)

Hybrid model (1D0D)



Original (1D2D)

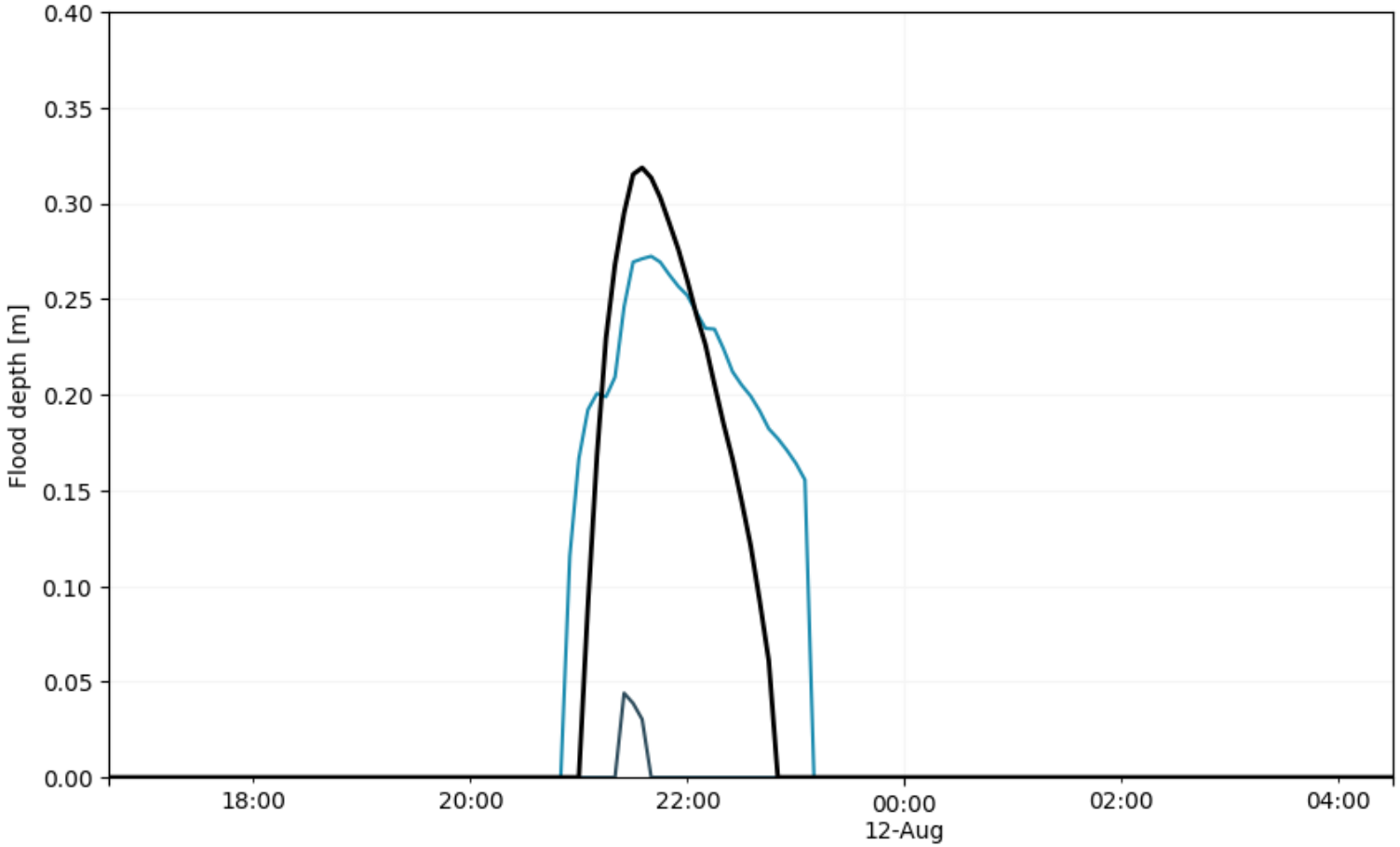
Results storm A



1D0D

2D

Results storm A

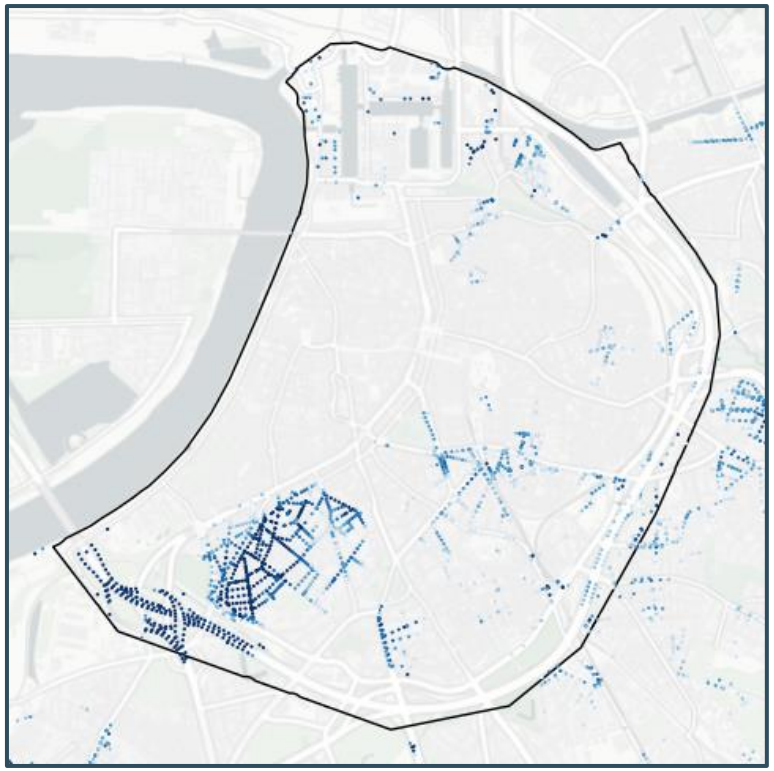


Hybrid (1D0D)

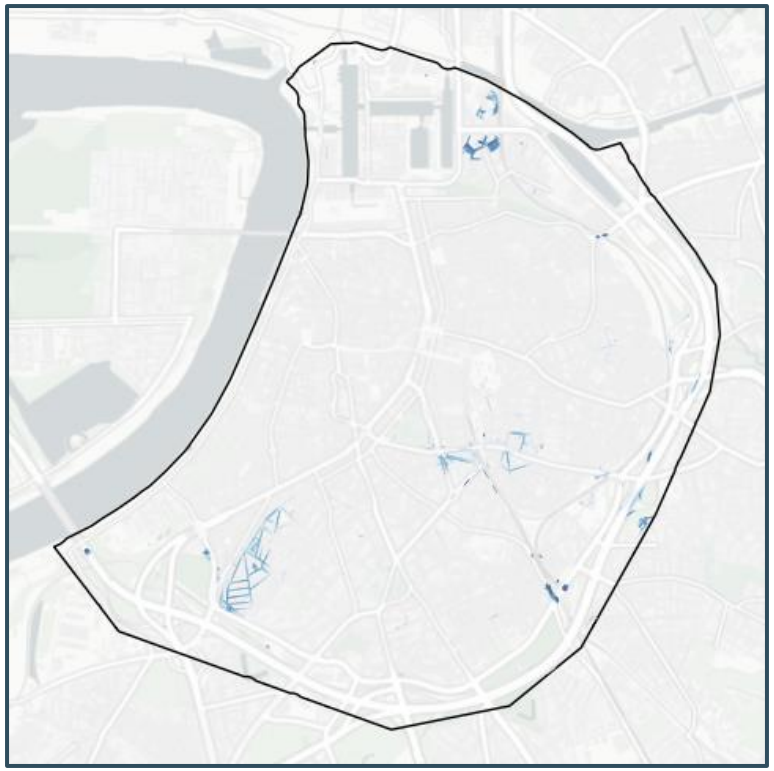
Hybrid (2D)

Results storm B

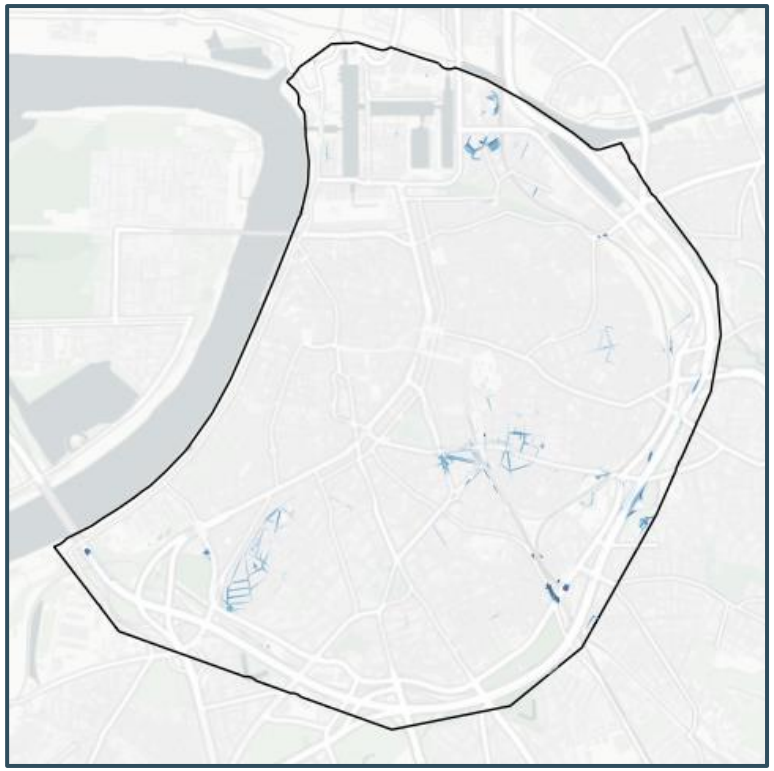
CSI	[-]	0.70
RMSE	[m]	0.05
R^2_{peak}	[m]	0.87
Δ_{peak}	[m]	-0.002



Simplified (1D0D)

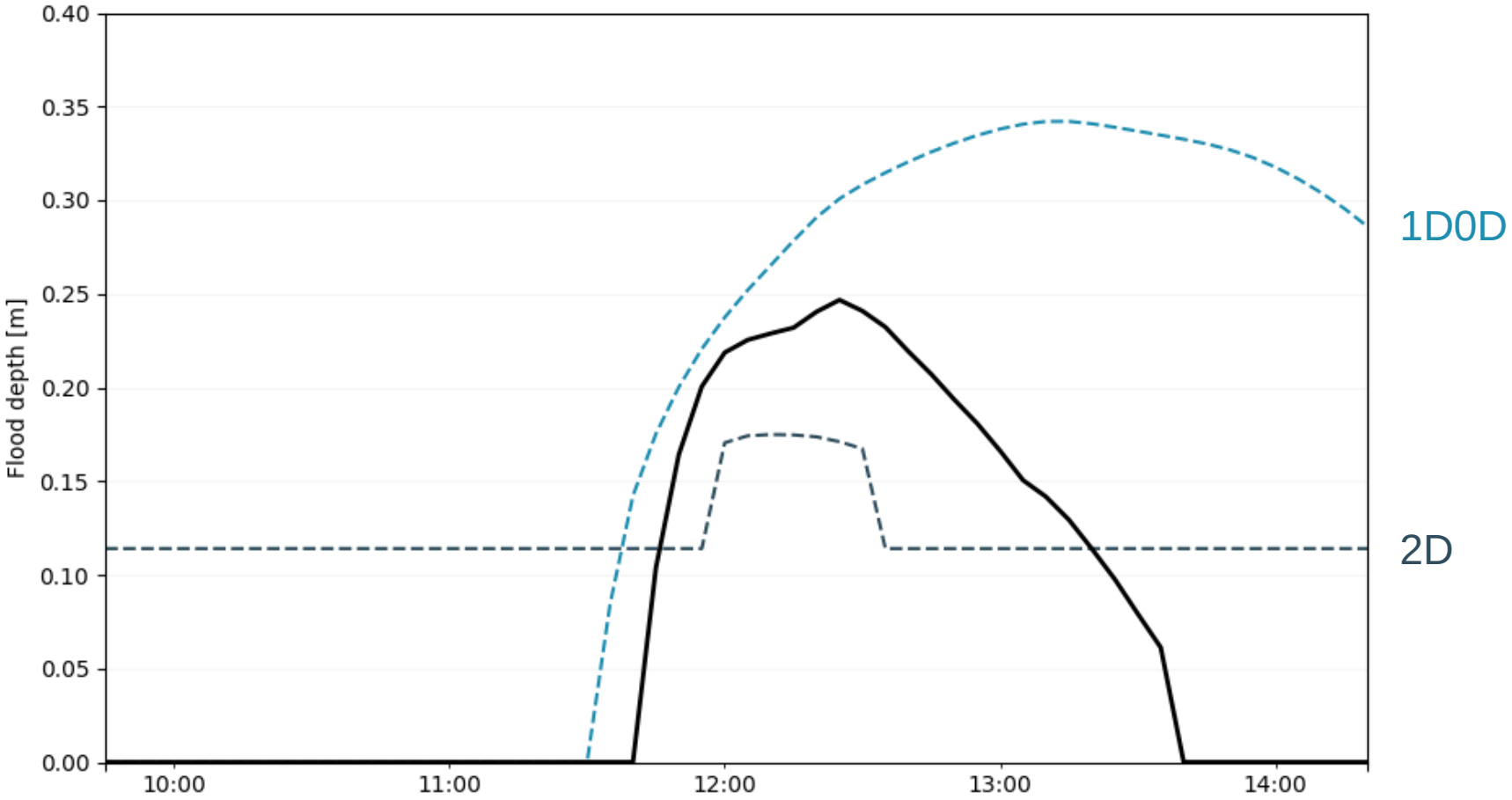


Hybrid (1D0D)

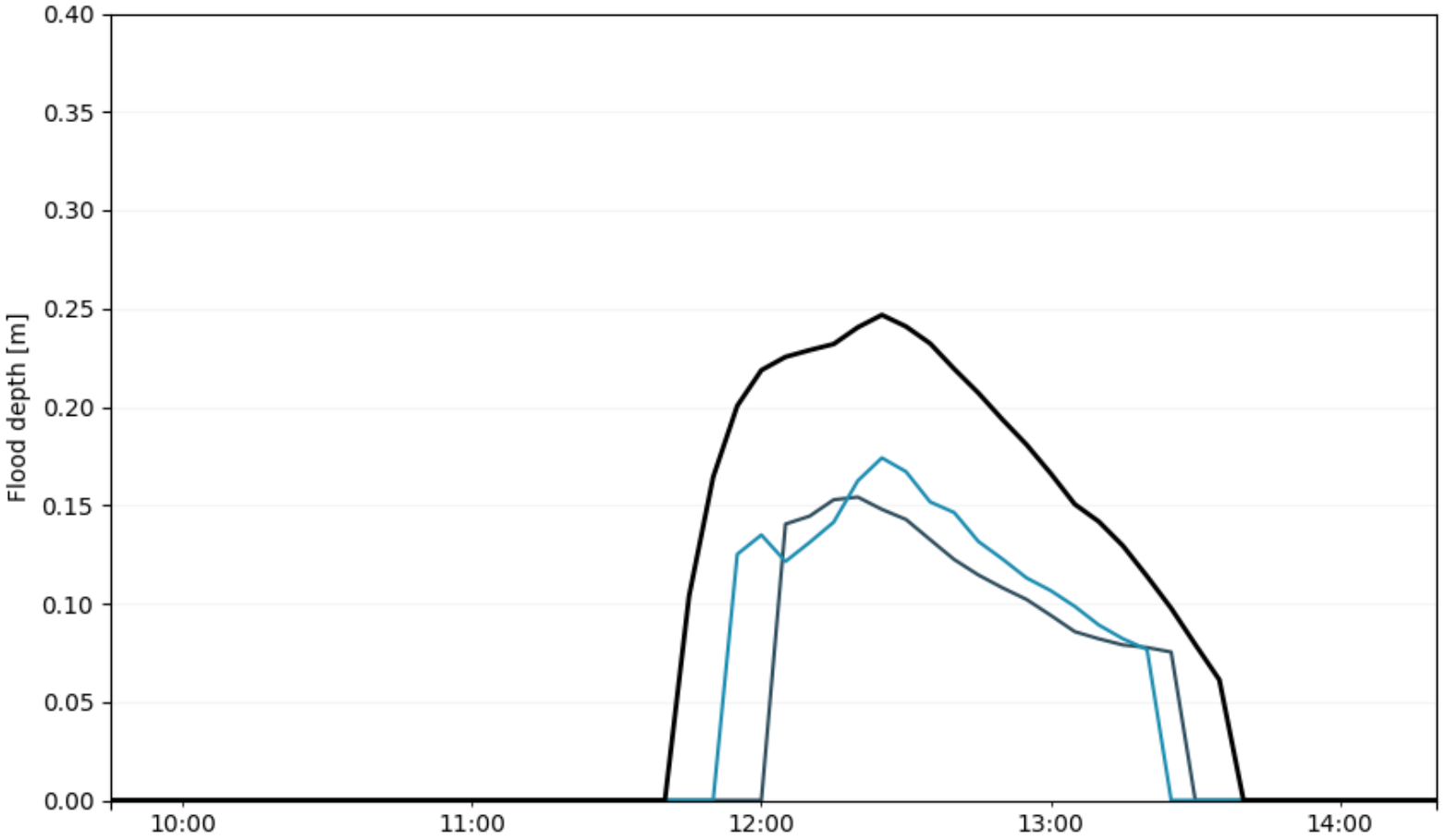


Original (1D2D)

Results storm B



Results storm B



Hybrid (1D0D)

Hybrid (2D)

Urban pluvial flood

Hybrid model

- Dimensionality reduction
- Data-driven model
- Simplified model

► **Informative warnings**

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