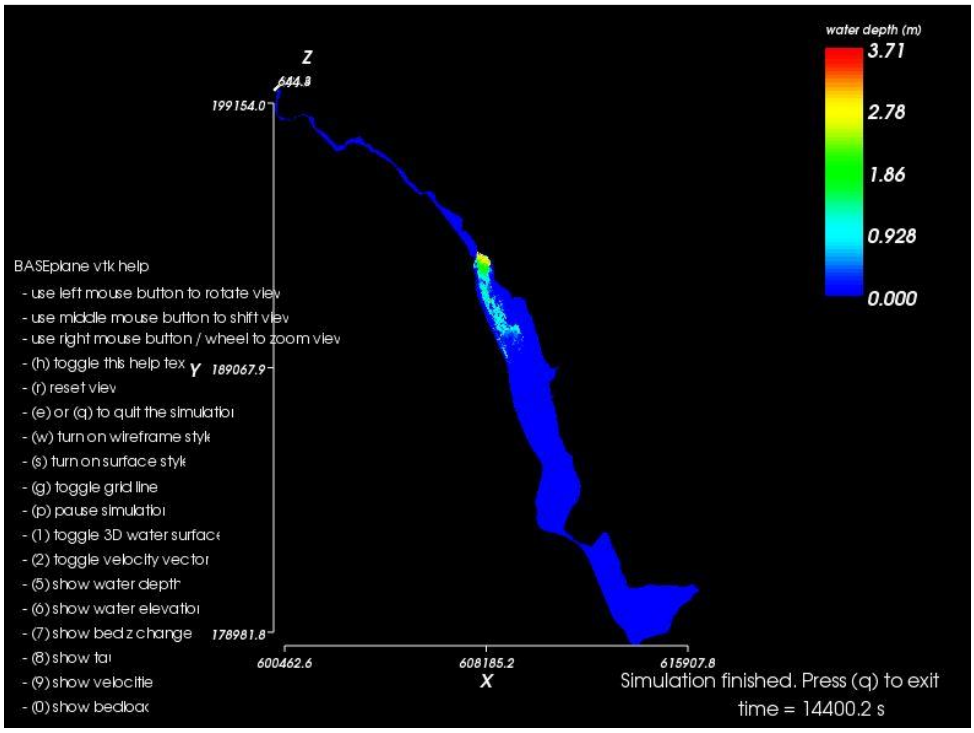
University of Berne

Institute of Geography

Geodata analysis and modelling

Modelling flooded houses on the right-hand side of the Aare



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Introduction

During the last decades, distinct technological achievements and progresses led to our current period of «big data» - a time where more and more data is generated and collected and thus need to be processed and analysed. Especially in the field of geography, processing, modelling and analyses of these data gained more and more a substantial importance to understand or at least get an idea of the complex systems and their functional chains.

In the framework of the seminar, we got in touch with these thematic areas through theoretical inputs and practical exercises. In order to get the most learning outcome, we also had to design and execute our own modelling and analysing project.

Project

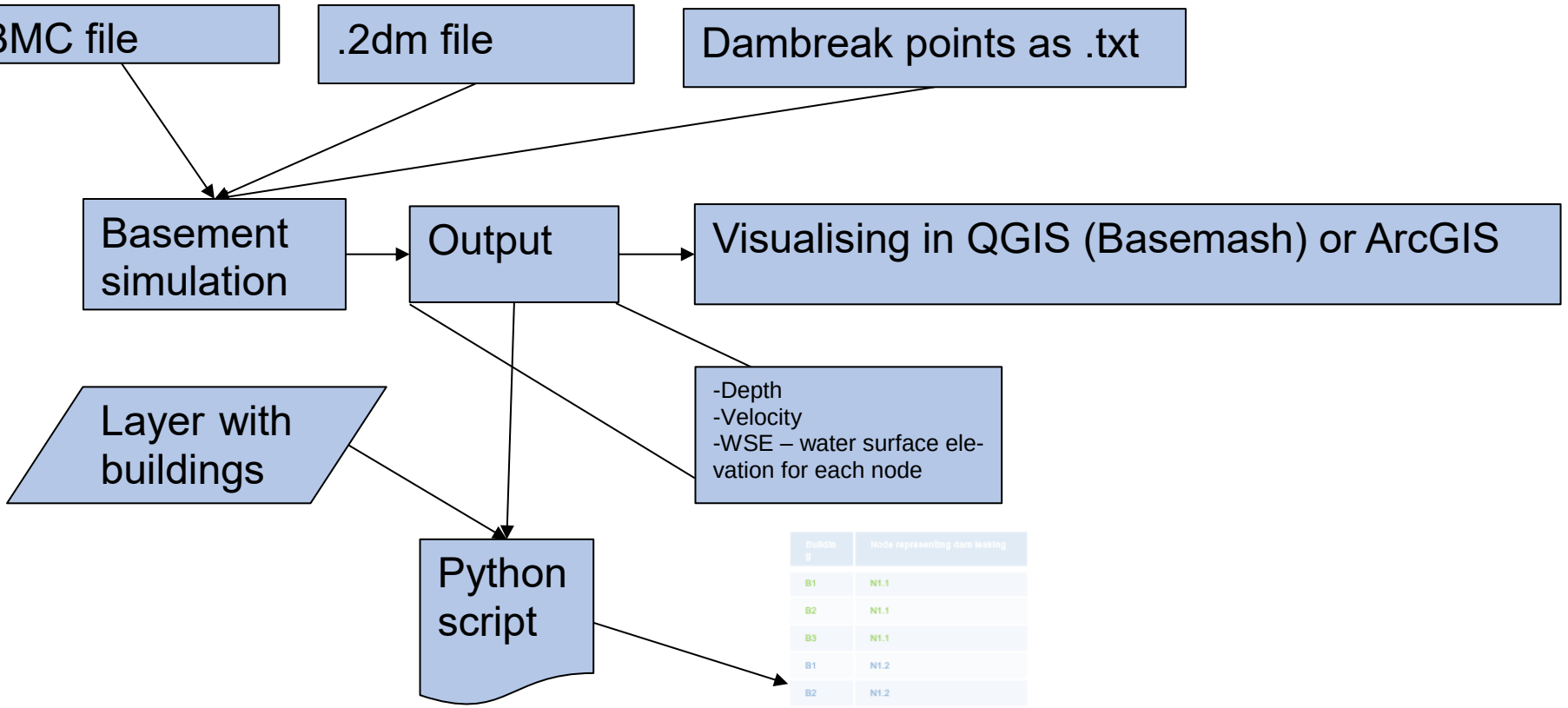
Our own group project comprises a flood-modulation of the right-hand side of the Aare from Thun to Bern. The aim is to target all houses that are affected by a flood of a dam break at point x. Through the developed script, various numbers of dam breaks can be modelled and analysed which will be used for further research questions (see «Outlook»).

The used flood model is one from the ETH-Zürich, called Basement. Input data are provided by Andreas Zischg, head of the seminar. The inputs data will be modified, so that each selected «dambreak-points» will execute a different flood simulation with the associated input parameters.

The output of each simulation will contain two csv-files: One containing all houses put into the simulation and their corresponding water depth at each of the 25 timesteps. The other csv is a sub selection of the first one; only containing the houses which will be affected by the simulated flood (water depth > 0.0m).

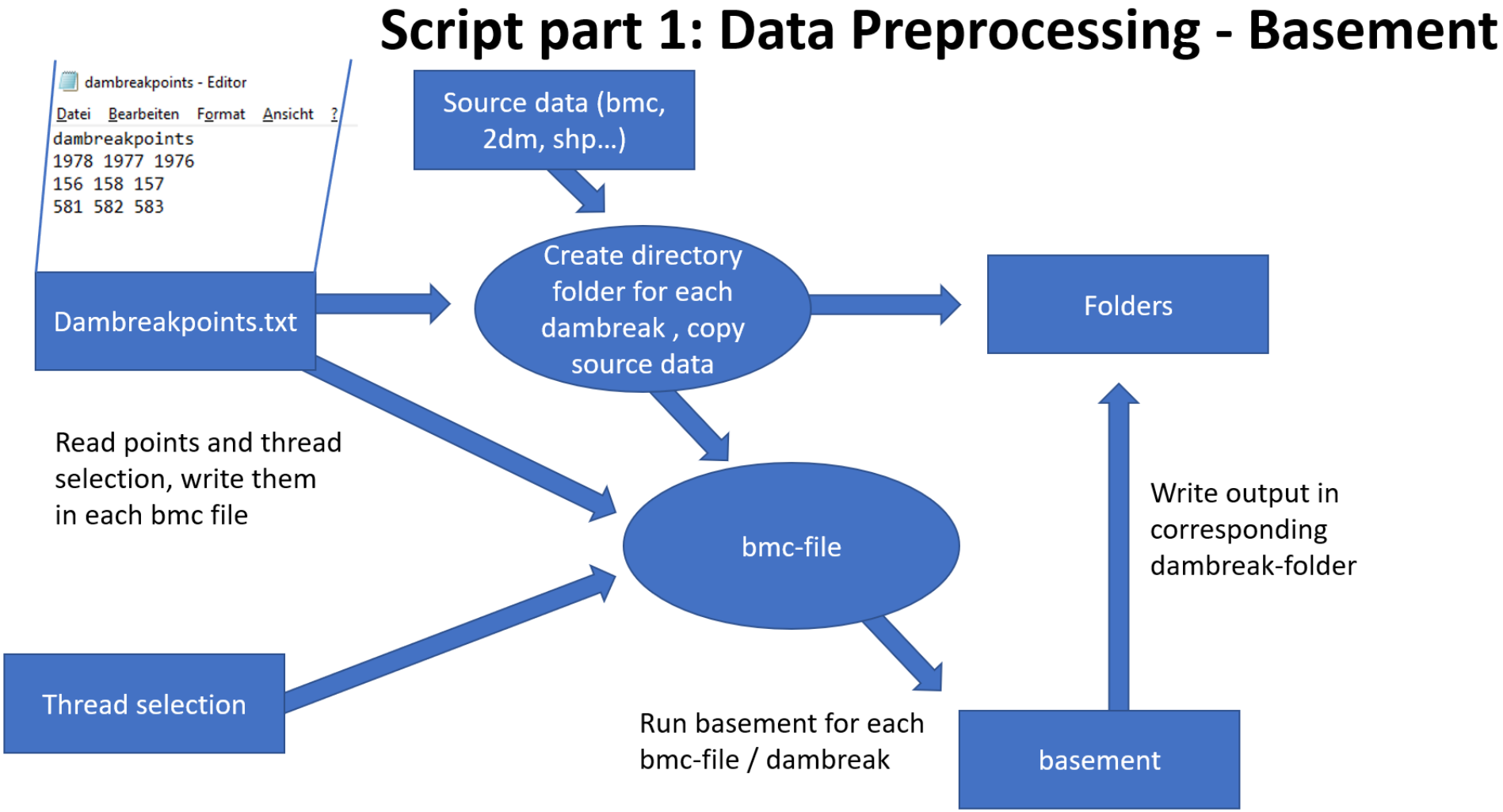
These two csv-files can be imported to Microsoft Excel or any other software to gain a better idea of the situation. The values displayed for each time steps are computed automatically and cannot provide the accuracy given in the csv-file (some values contain up to 6 decimal places which would equivalate to an accuracy up to a micrometre). Therefore, the authors suggest rounding the values to two decimal places; centimetres are more than enough for the purpose of this model. Any accuracy beyond that cannot be guaranteed.

Conceptual model diagram

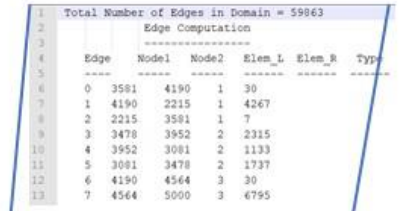


Buildin g	Node representing dam leaking
B1	N1.1
B2	N1.1
B3	N1.1
B1	N1.2
B2	N1.2
B3	N1.2
B2	N1.3
B3	N1.3
B4	N1.3

Flow chart of inputs, processes and outputs



Script part 2: Creating basic graph with nodes



```
Total Number of Edges in Domain = 59863
                Edge Computation
                ----------------
  Edge    Node1   Node2   Elem_L  Elem_R   Type
  ----    -----   -----   ------  ------   ------
     0     3581    4190        1      30
     1     4190    2215        1    4267
     2     2215    3581        1       7
     3     3478    3952        2    2315
     4     3952    3081        2    1133
     5     3081    3478        2    1737
     6     4190    4564        3      30
     7     4564    5000        3    6795
```

Aare.edg-file

aareV10rechtsGrob_Quality_nodes

	FID	Shape	NODE_ID	X	Y	Z
	0	Point	1	600575	199151	503.016998
▸	1	Point	2	600592.8288	199148.0641	504.153015
	2	Point	2675	600557.4485	199139.1751	502.782013

aareV10rechtGrob_Quality_nodes.shp

Extract Node Ids as integers, Replace NA data with -9999

Manually add X-Y and Z-Coodinates to shp (via ArcGIS) and extract those Coordinates to join them with the extracted nodes from the .edg file

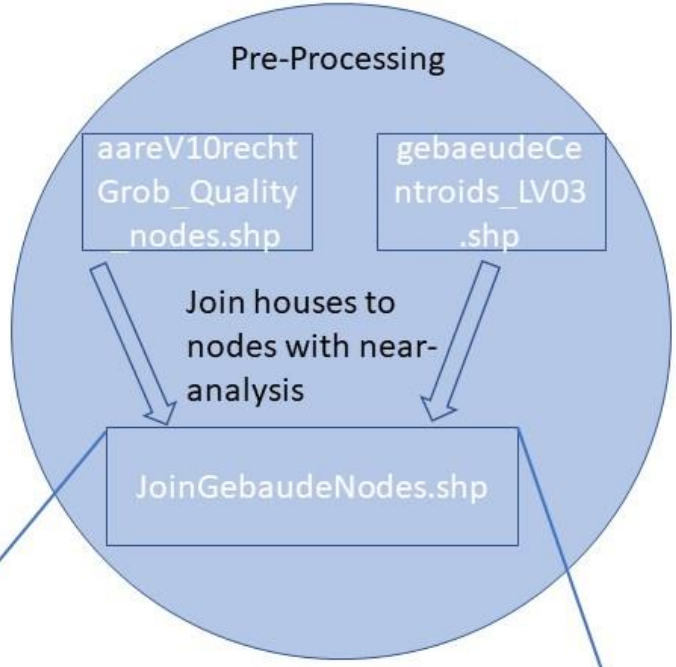
Create network based on location of nodes

Script part 3+4: Adding water depth and house ID as attributes to the network

Extracting waterdepth for 21'133 nodes for 25 time steps and adding them as attributes to the network

Add waterdepth to network

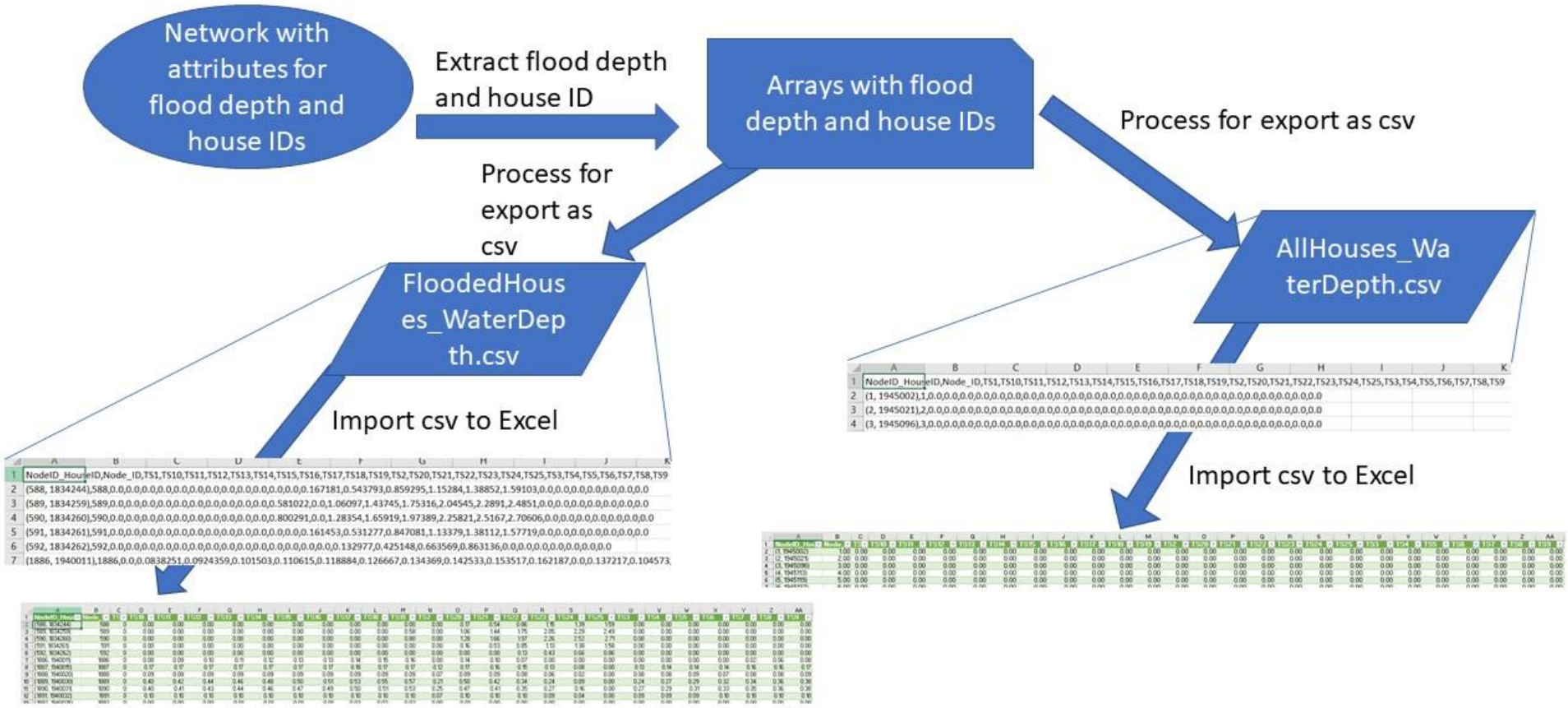
Export as table and convert to dictionary to be able to add the House ID as a second attribute to the network



JoinGebaudeNodes

NODE_ID	X	Y	Z	idper_2d	NEAR_DIST
1	600575	199151	503.016998	1945002	6.558822
2	600592.8288	199148.0641	504.153015	1945021	13.467994
2675	600557.4485	199139.1751	502.782013	1944137	8.170188
2676	600559.4679	199153.9837	502.949005	1944169	6.435686

Script part 5+6: Filter and export to csv



Key literature

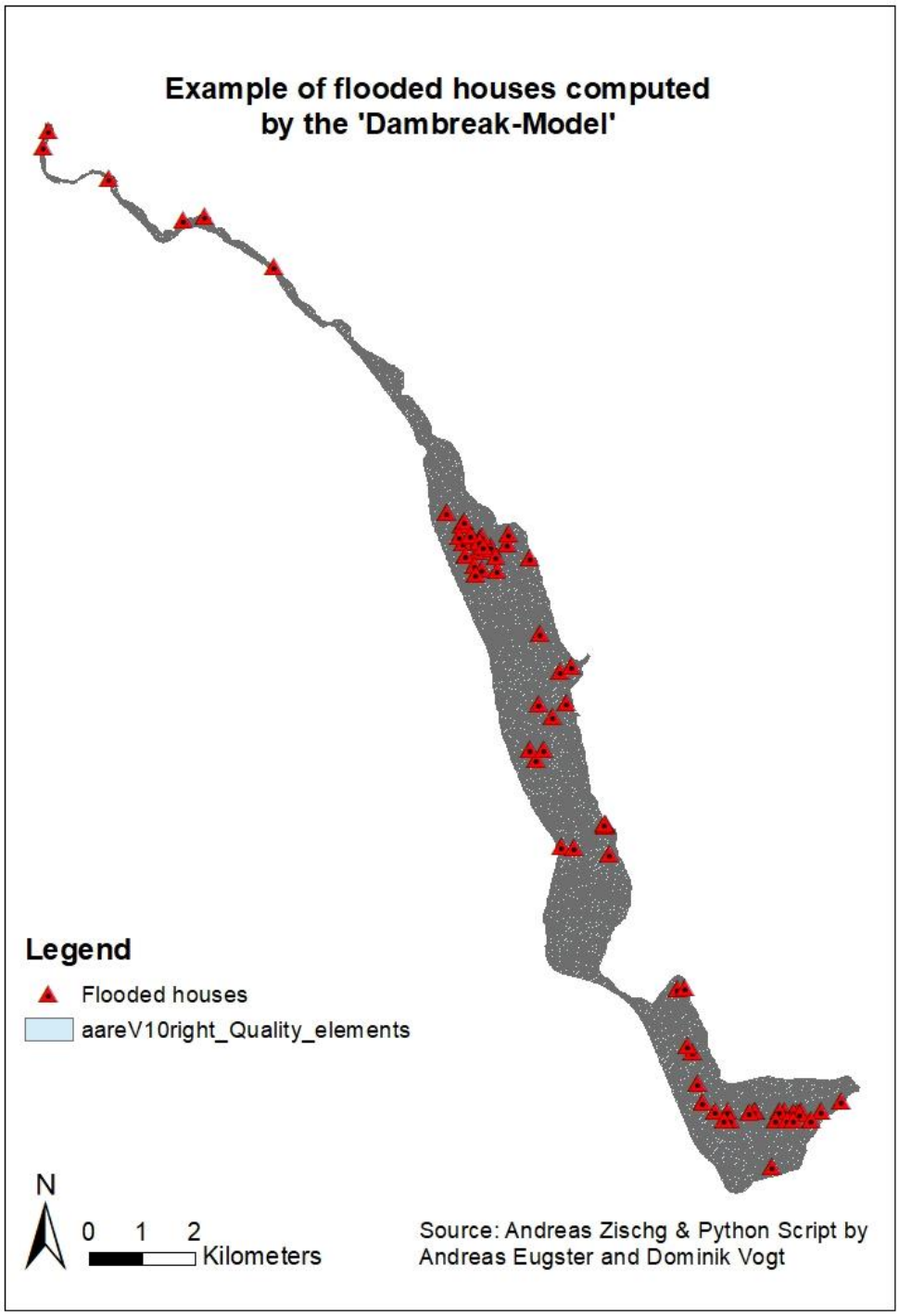
- Mainly googling (stackoverflow, networkx on github etc)
- Andreas Zischg and Pascale Horton

Results

The resulting csv files can be imported to Excel and displayed as a table. An extract of a possible depiction is shown below for the csv of the flooded houses where the first column represents a tuple with the node ID of the network where the water flows and the corresponding house ID which will be flooded. The thereafter following columns represents the waterdepth [m] at each timestep TS1 to TS25.

NodeID_HouseID	. TS1	TS10	TS11	TS12	TS13	TS14	TS15	TS16	TS17	TS18	TS19	TS2	TS20	TS21
(588, 1834244)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.54
(589, 1834259)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58	0.00	1.06	1.44
(590, 1834260)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.00	1.28	1.66
(591, 1834261)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.53
(592, 1834262)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(1886, 1940011)	0.00	0.08	0.09	0.10	0.11	0.12	0.13	0.13	0.14	0.15	0.16	0.00	0.14	0.10
(1887, 1940015)	0.00	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.18	0.17	0.17	0.12	0.17	0.16
(1888, 1940020)	0.00	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.07	0.09	0.09
(1889, 1940030)	0.00	0.40	0.42	0.44	0.46	0.48	0.50	0.51	0.53	0.55	0.57	0.21	0.50	0.42
(1890, 1940031)	0.00	0.40	0.41	0.43	0.44	0.46	0.47	0.49	0.50	0.51	0.53	0.25	0.47	0.41
(1891, 1940032)	0.00	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.07	0.10	0.10
(1892, 1940035)	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.00	0.01	0.00
(1893, 1940040)	0.00	0.03	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.06	0.00	0.05	0.04
(1896, 1940072)	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.00	0.05	0.00
(1911, 1940153)	0.00	0.03	0.03	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.00	0.05	0.04
(1912, 1940159)	0.00	0.04	0.04	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.00	0.07	0.06
(1913, 1940166)	0.00	0.04	0.04	0.04	0.05	0.06	0.05	0.06	0.06	0.06	0.07	0.00	0.07	0.05
(2051, 1940736)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

The map below displays an example run of the python script with a total model run time of 14’400 seconds (4 hours) and a maximum outflow of 200m^3/s after 3 hours. After the script ran successfully, the .csv was manually processed to build a definition querry in ArcGIS where only the 72 houses which are flooded in the example run were displayed as red triangles. To visualise the right side of the Aare basement the base-nodes handed-out at the beginning of the seminar were used.



Outlook

The work done in this seminar will be used for the master thesis of Dominik and therefore provides an important foundation for the project of modelling the flood dynamic of the Aare between Thun and Berne. For a better performance a revision of the script is planned to do in autumn term 2018. The feedback given by the lecturers will provide valuable information for a more effective, memory-saving script running and some basic programming skills as this is the first script written by the two students.