DTU Danmarks Tekniske Universitet

Damage Cost Model Tutorial Instructions
Published: 15 April, 2021

The purpose of this user guide is to demonstrate how to utilize the damage cost model developed by DTU. This document contains a step-by-step guide to three different sectors (buildings, health, and traffic) that will use standard input data to illustrate how to obtain and what that output should look like.

The model will be demonstrated using an RCP8.5 scenario for a present day 100-year return period.

For all models, the first three inputs specify the flooding scenario, the water depth column in the flooding data, and minimum water depth. The actual flood data must be in vector format where each polygon has a water depth specified in the attribute table.
All output GIS files should be saved in a geodatabase.

Finally, please note that a new ArcMap project should be opened in between running the models.

Model: Bygninger

Before running the model, ensure that the model is connected to the correct python source script by right-clicking on the model you wish to run -> properties.
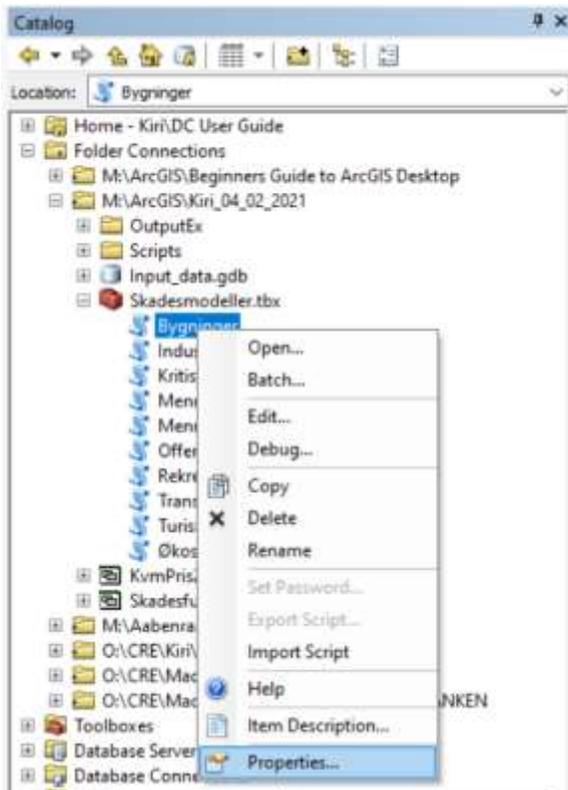
When the properties box opens, check under "Source" that the script file matches the model you are running. If it does not, locate the correct python script from the scripts folder.

Once the model is connected to the appropriate script, double-click on the model you want to run. In this first example case, we're running "bygninger." The following screen will pop up:
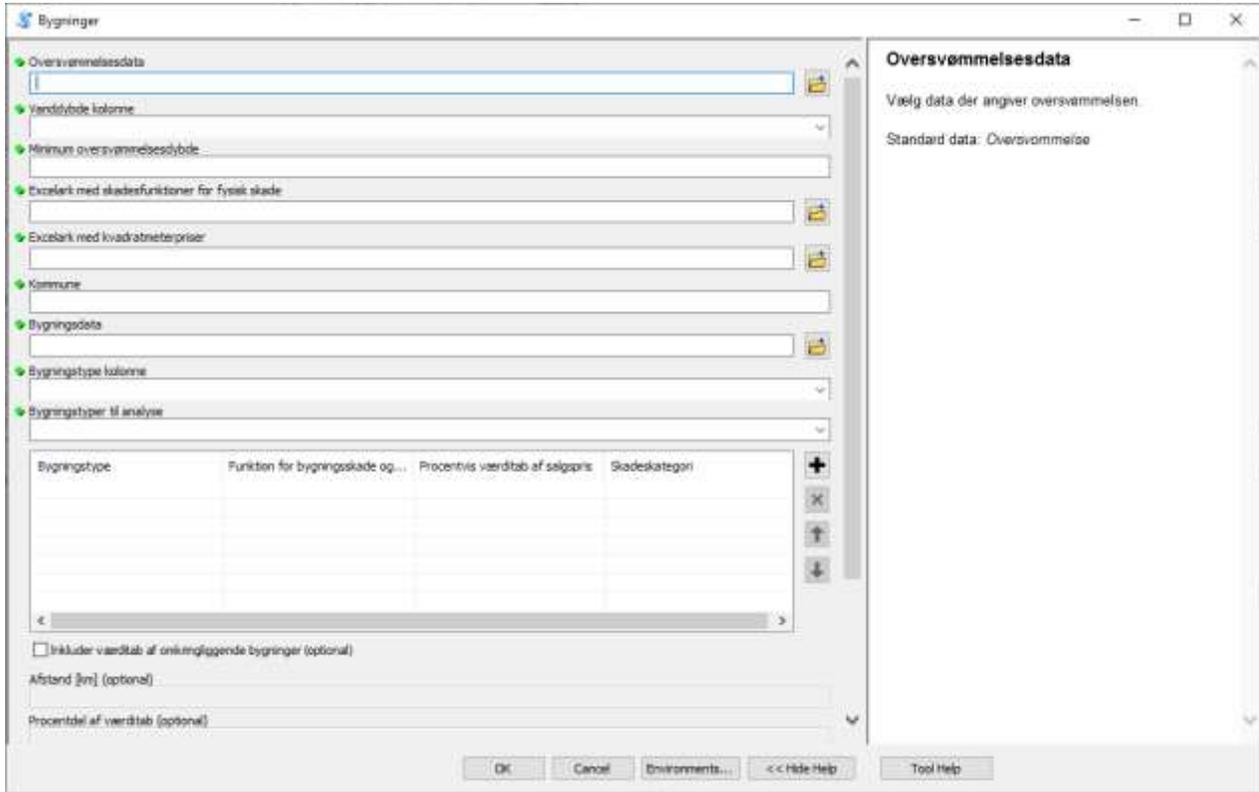
On the left side are all of the input and output variables. Everything marked with a green circle is required for the model to function properly. On the right side is a help column that gives a brief description of each field, as well as recommended values for some standard variables.

The first three rows concern the flooding data itself. First, load your flooding data by clicking on the folder icon to the right to select your input file. Once the flooding data is selected, move to the second row and choose the column from the attribute table that provides water depth. Water depth is measured in meters, so ensure that the column has in the correct measurement (i.e., a vanddybde of 11cm should be listed as 0,11). Then, input the minimum water depth in the third row. Only water depths above this value will be included in the analysis; if you enter 0,10(m), for example, then any flooding less than 10cm will not be included as a damaged area. *NOTE: If you are working with an English dataset, double-check that the decimal separator has been set to comma (0,1 instead of 0.1). Working with periods will not give any obvious errors, but it will heavily distort the output.*

Once the flooding data has been entered, we move onto the damages. In the fourth row, attach the provided excel sheet with damage functions, "Skadesfunktioner." In the fifth, attach the provided excel sheet with prices, "KvmPris2019Alleboligtyper."

Next, choose the municipality you're interested in analyzing. The municipality names are drawn from the KvmPris2019Alleboligtyper excel sheet, so it is possible to combine or modify the options listed. For this example, we'll use a randomly selected area in the Guldborgsund commune.

The next section concerns the building data for your chosen area. In "Bygningsdata," upload the building data. In the next row, choose the column (from the data's attribute table) that lists the building type[1].

One at a time, choose each building type you are interested in from the drop-down column in "Bygningstyper til analyse." After you click on one, it should appear below in the table. This example will use helårsbeboelse, garage, og erhverv.

The other columns in the table should be filled in by clicking in the empty fields. The first column, funktion for bygningsskade og indbo, should be chosen via the drop-down menu according to the building type chosen. The third column should be filled in according to your preferred values, or else recommended values can be seen in the right-hand panel. For this example, we'll use 20% for all. Finally, the skadeskategori relates to how you would like your output grouped – for our example, erhverv will be grouped as "Erhverv," while helårsbeboelse and garager are "Bolig." *NOTE: Do not use æ, ø, or å when typing which skadeskategorier each row belongs to.*

Literature suggests that flooding in a certain area can decrease the property worth of surrounding buildings. To account for this in the model, check the box for "inkluder værditab af omkringliggende bygninger." Then, input the distance around the flooded building that would also be affected, as well as the percentage by which property prices could be expected to decrease. If one wishes to include deductibles, check the "inkluder egenbetaling" and then choose the relevant percentage in the row below.

Finally, the bottom two rows specify where the output will be stored. In the "Output data" field, be sure to specify a geodatabase – the model will not run if a shapefile is specified here. Be sure to choose a folder where the output figures should be saved. The filled out model input should look like this:

---

[1] If your data is missing building type, you can use the bygnings anvendt kode to create a field that contains the type. See "Nationale data: Bygninger" in the model vejledning og dokumentation for more information.

Bygninger

Oversvømmelsesdata
Flood_RP100_PD_Building_Tutorial_multipart_dissolved (1)

Vanddybde kolonne
Vanddybde

Minimum oversvømmelsesdybde
0,1

Excelark med skadesfunktioner for fysisk skade
O:\CRE\Kri\DC User Guide\Other Data\Skadesfunktioner.xlsx

Excelark med kvadratmeterpriser
O:\CRE\Kri\DC User Guide\Other Data\KvmPris2019Alleboligtyper.xlsx

Kommune
Guldborgsund

Bygningsdata
Buildings_tutorial_BBR_simpel_subset

Bygningstype kolonne
Kategori_2

Bygningstyper til analyse

Bygningstype	Funktion for bygningsskade o...	Procentvis værditab af salgspris	Skadeskategori
Helårsbeboelse	Helårsbolig	20	Bolig
Garage mm.	Garager	20	Bolig
Erhverv	Erhverv	20	Erhverv

☑ Inkluder værditab af omkringliggende bygninger (optional)

Afstand [km] (optional)
0,5

Procentdel af værditab (optional)
50

☐ Inkluder egenbetaling (optional)

Egenbetalings procentdel (optional)

Output data
C:\Users\arca\OneDrive - Danmarks Tekniske Universitet\Dokumenter\ArcGIS\Default.gdb\Flood_RP100_PD_Building_Tuto1

Output mappe til figurer
O:\CRE\Kri\DC User Guide\Output

Click on OK, and allow the model some time to execute.

The output will be delivered in two ways. First, in the dialog box where the model is running, a summary of results will be available. It looks like this:

```
Antal oversvoemmede bygninger:
  -Erhverv: 22 (Pct: 31.4)
  -Bolig: 48 (Pct: 68.6)
  -SUM: 70

Forsikret tab af bygnigskategorier:
  -Erhverv: 45.6 Mill. (Pct: 79.7)
  -Bolig: 11.6 Mill. (Pct: 20.3)
  -SUM: 57.3 Mill.

Tab i salgsvaerdi af bygnigskategorier:
  -Erhverv: 23.2 Mill. (Pct: 73.6)
  -Bolig: 8.3 Mill. (Pct: 26.4)
  -SUM: 31.6 Mill.

Total omkostning af oversvoemmede bygningkategorier:
  -Erhverv: 68.9 Mill. (Pct: 77.5)
  -Bolig: 20.0 Mill. (Pct: 22.5)
  -SUM: 88.9 Mill.

Enhedsomkostning af oversvoemmede bygningkategorier 1) med og 2) uden vaerditab:
  -Erhverv: 1) 3.1 Mill. og 2) 2.1 Mill.
  -Bolig: 1) 0.4 Mill. og 2) 0.2 Mill.

Tab i salgsvaerdi af omkringliggende bygninger: 285.3 Mill.

TOTALE SAMLEDE OMKOSTNINGER: 374.1 Mill.
```

The information is presented according to the damage categories you have chosen as well as the sum of damages, and includes antal oversømmede bygninger, forsikret tab af bygningskategorier, tab i salgsværdi af bygningskategorier, total omkostning af oversvømmede bygningkategorier, enhedsomkostning af svømmede bygningkategorier med og uden værditab, og totale samlede omkostninger. Hvis man har inkluderet omkringliggende bygninger, ser man også tab i salgsværdi af omkringliggende bygninger.

Figures, as well as two excel sheets, can be seen in the output folder that one has chosen. The first excel sheet, "AlleOversvømmedeBygninger" gives a list of all flooding buildings, including, among others, their anvendelsekoder, beskrivelse, kategorier, water depth (above InD), insurance and estate loss, and total cost.

The second excel sheet, "Bygningsskade," gives the same information as the initial output shown output, but for all categories. For example, whereas before we could only see "Bolig" as a category, in the excel sheet we can see both "Garage" og "Helårsbolig" as separate categories, with their respective numbers.

The following images are also produced:
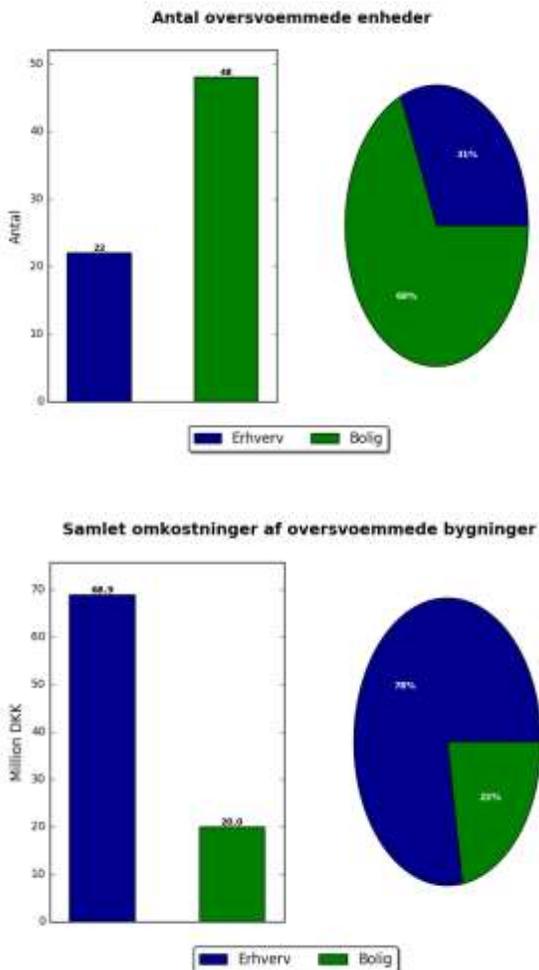
Gennemsnitlige omkostning pr. oversvoemmet enhed
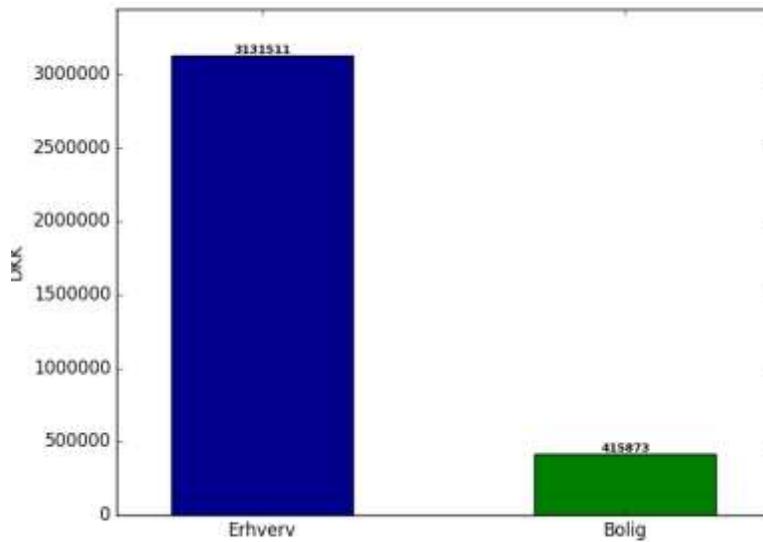
Skadesomkostninger for oversvømmede bygninger

If surrounding areas have been included, this image will also be produced:

Værditab af omkringliggende bygninger

Brugerdefineret afstand:	0,5 km
Indirekte ramte bygninger:	2525
Værditab af salgspris:	285,3 Mill. DKK

Innovationsfonden
COHERENT

In ArcGIS, the model should have produced a layer that will show the flooded buildings. In the following image, the flooded buildings are shown in blue:
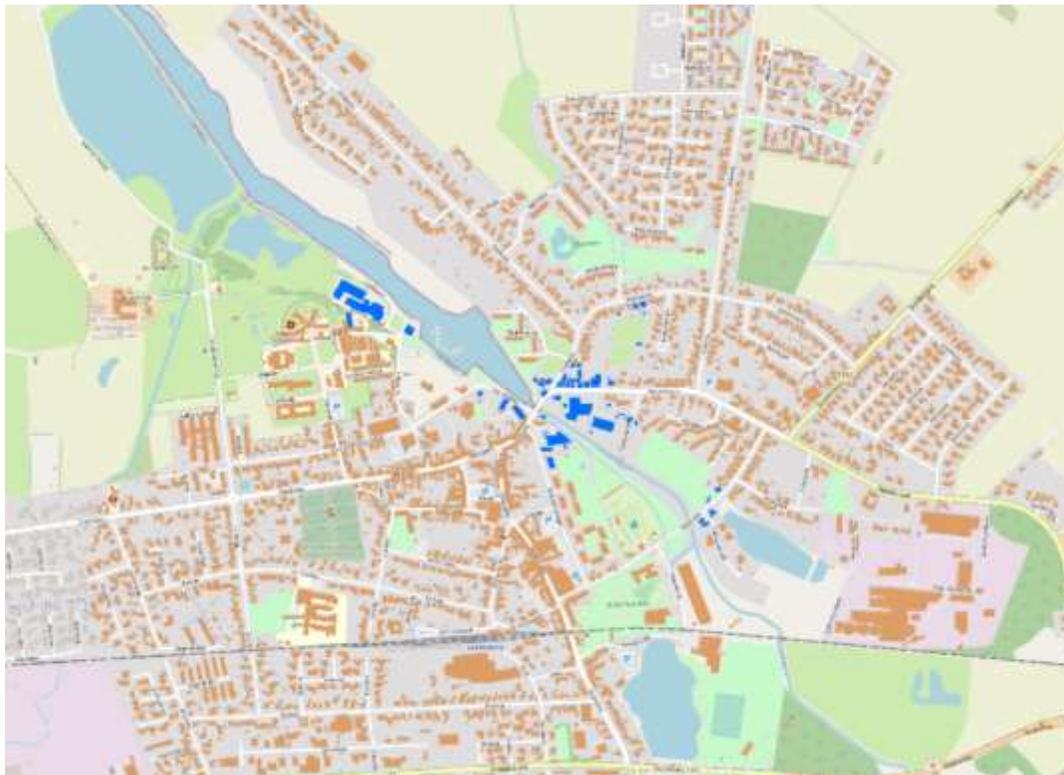
Note: The model can also be used for extreme precipitation rather than storm surges. In order to do this, the user just needs to input the relevant flood data inputs and alter the input parameters for the buildings.

Next, we will run the health module. As this module contains sensitive data, the dataset used in this tutorial is a fake dataset where two persons have been assigned to each residential property, with randomly generated ages between 1 and 100. Reminder: before running the model, connect it with the correct script. Right click the model and choose "properties" and then find the appropriate script.

As previously mentioned, the first three rows in all models are the same. Fill in once again the oversvømmelsesdata, vanddybde kolonne, og minimumoversvømmelsesdybde (m). Remember to double check your data format: the numbers must be in comma format (0,1) instead of punktum (0.1). Then, choose your shapefile that contains information on people living in the municipality.

The data should contain a column that provides people's ages, which should be chosen in the next row.

Next, upload your building data. The 4 options that follow allow you to customize the output of the model. Choose if it should calculate ekstra rejsetid som følge af genhusning, antal sygedage, brugte feriedage, og psykiske følgevirknings.

Finally, choose again the folder where output figures should be placed. Note again that if you change the "output data" row, be sure to specify it as a geodatabase.

The filled in model should like this:

Click "OK" and allow the model some time to run.

When the model is completed, you'll see the following in the dialogue box:

```
Antal oversvoemmede helaarsboligere med beboere: 19
Antal personer beroert af oversvoemmelsen: 38
Samlet omkostning af ekstra rejseomkostninger som foelge af genhusning: 118800
Samlet omkostning af brugte sygedage: 271728
Samlet omkostning af brugte feriedage: 111888
Total omkostninger: 502416
Op til 12 huastande oplever en eller flere psykiske foelgevirkninger (stress, koncentrationsbesvaer, angst, PTSD etc.)
```

This tells you the number of affected houses with citizens, the number of people affected, and the extra four metrics: extra travel costs as a result of rehousing, costs of used sick days, costs of used holiday days, and the number of households with one or several psychological impacts. Finally, the output tells you the summary of the damage costs.

The following two images are produced in your output folder:
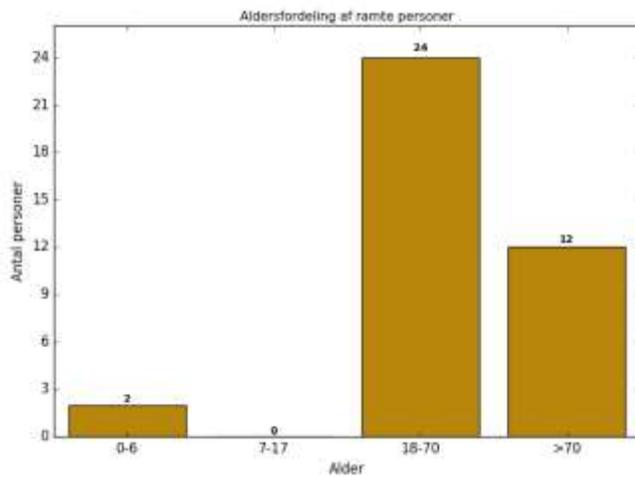
Finally, you'll have a layer in your ArcGIS that displays the households containing people affected by the flooding. In the following image, the houses are in red, and the affected households are in purple:
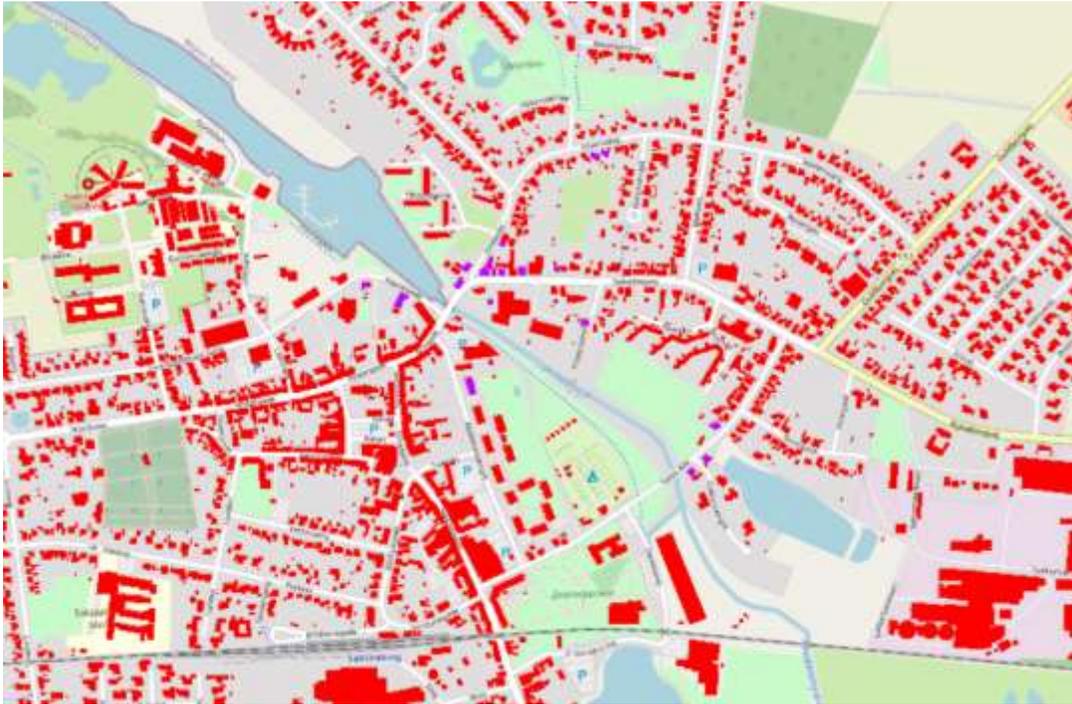
Sector: Transport

The transport module will illustrate traffic losses and road damage for your chosen area. The recommended minimum water depth for flooding buildings is 10cm, but for roads, it is only 7,5cm. Thus, for the transport module, we've included a second example flooding dataset that includes observations between 0,075 and 0,10.

Again, before running, double-check that the model is connected to the correct script, and then double click on the model. You'll see the following screen:
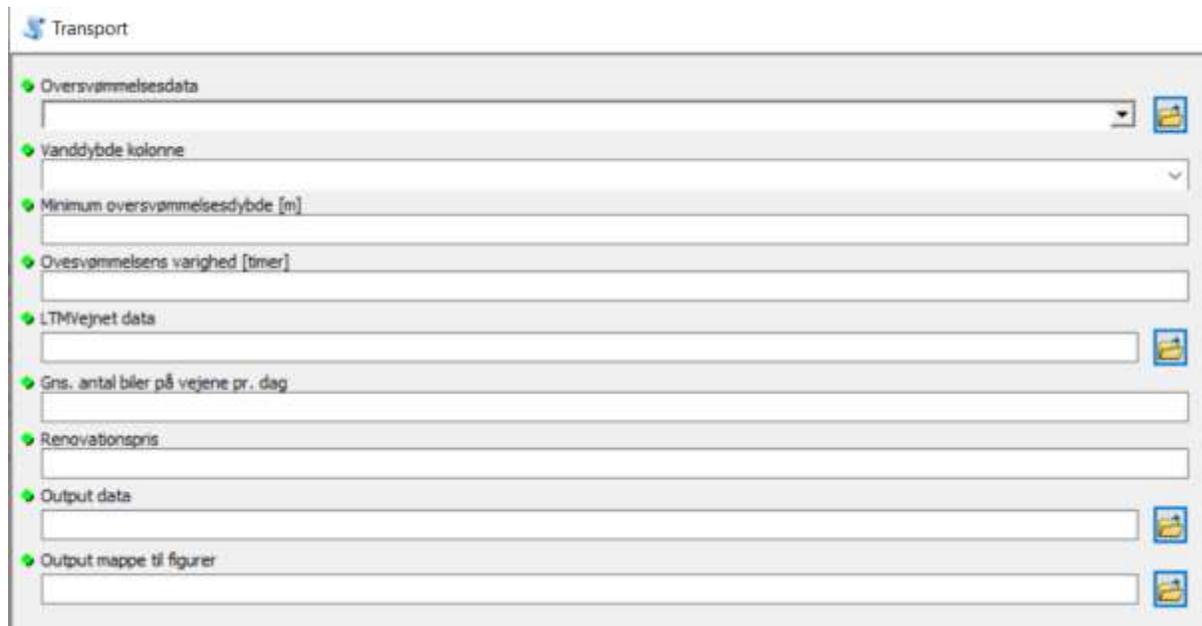
The first three inputs are the same as the previous two modules: flooding data, water depth column, and minimum flooding depth in meters.

Then, input the number of hours that the road network is expected to be affected by the flooding event. For this tutorial, we'll use a standard 24 hours.

The next field is for the input of road network data itself. Then, enter the average number of cars that use the road every day. The renovation price is the cost of renovating a single meter of road in your chosen area. This tutorial will use a standard price of 20kr per meter.

The final two rows are the same as in the other two modules – again, ensure that the output data is saved to a geodatabase, and specify a folder where the output figures should be saved.

The filled in input should look like this:

Press "OK" and allow the model some time to run.

When the script is completed, you'll see the following output:

```
Transport omkostninger: 578170
Renovations omkostninger: 210419
Total: 788589
Completed script TransportCost...
```

The new layer in ArcGIS will display the affected roads, shown here in red:

Finally, in the output folder, you'll find an image that displays (i) which roads will be closed, (ii) which will have reduced speed, and (iii) which will be unaffected:

Transport og vejnet

Lukket	Transport:	**578170 DKK**
Nedsat hastighed	Renovation:	**210419 DKK**
Ikke oversvømmet	Total:	**788589 DKK**

COHERENT