

# Exercise 5a. Generating vulnerability curves - Answers

## Step A: Extract vulnerability parameters from PGIS survey.

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Q: Write below for each relevant column the type of domain (Class, Identifier, Boolean, Value):

- 1) Landuse: Class Domain
- 2) Building\_type: Class Domain
- 3) Nr\_floors Value Domain
- 4) Remember\_flood\_1998: Group Domain
- 5) Flood\_damage: Value Domain

Q: Water\_heights: the domain is related to flood depth, How can you identify intervals corresponding to the different levels? Write them below.

A: The intervals can be found in the Water\_Height domain: double click on the domain and copy the correct intervals values.

- 1) Ankle: from 0 to 0.2 meters.
- 2) Knee: from 0.2 to 0.5 meters.
- 3) Hip: from 0.5 to 1.0 meters.
- 4) Breast: from 1.0 to 1.5 meters.
- 5) Head: from 1.5 to 2.5 meters.
- 6) First floor flooded: from 2.5 to 3.5 meters.
- 7) Second floor flooded: more than 3.5 meters.

Q: The buildings present in the 1997 map but not in the polygon map have been totally destroyed or irreparably damaged hence abandoned. Approximately how many buildings have been destroyed by the 1998 flood disaster? How can we extract this information?

The buildings present in the building map from 2007 that are no more visible in the building map 2008 have been destroyed by two events: the 1998 flood event and the landslide occurred in the same period. The total number of buildings is approximately 87. The easiest method is to visually detect them by overlapping the the Building map 1997 on the Building map 1998.

## Step B: Calculate the stage damage function for all the buildings.

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Calculate the average of damage for each water height interval. Click the "Function" (blue circle) and chose "average". Fill the table:

Interval	Water height (m)	Centriod of the interval	Average Damage
Ankle	0 – 0.2	0.1	5.5
Knee	0.2 – 0.5	0.35	10.0
Hip	0.5 – 1.0	0.75	24.2
Breast	1.0 – 1.5	1.25	34.0
Head	1.5 – 2.5	2.0	57.0
First floor fl	2.5 – 3.5	3.0	76.9
Second floor fl	> 3.5	5	82.0

Interval	centroid	Av damage
No Flood	0	0%
Anke	0.1	5.5
Knee	0.35	10.0
Hip	0.75	24.2
Breast	1.25	34.0
Head	2	57.0
First floor flooded	3	76.9
Second floor floded (>3.5m)	5	82.0
7 or more meters	7	90

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**Advanced Task I**

Q: Open the new table, go to Columns / Aggregation, chose the column: Flood\_100y, function: Average, group by: Building\_map\_1998, weight by: Area. Call the new column Water\_Height. What does it represent? Why did the operation calculate?

A: For each building the cross table shows the areas of the buildings with different water heights (check the building ID in the primary column). The operation we performed calculates for each building the average of the water depths weighted on the basis of the flooded building areas.

Q: Check the column Damage\_Buildings, especially the highest values; are they correct according to the meaning of the column? What is the cause of the inaccuracies? How would you avoid them?

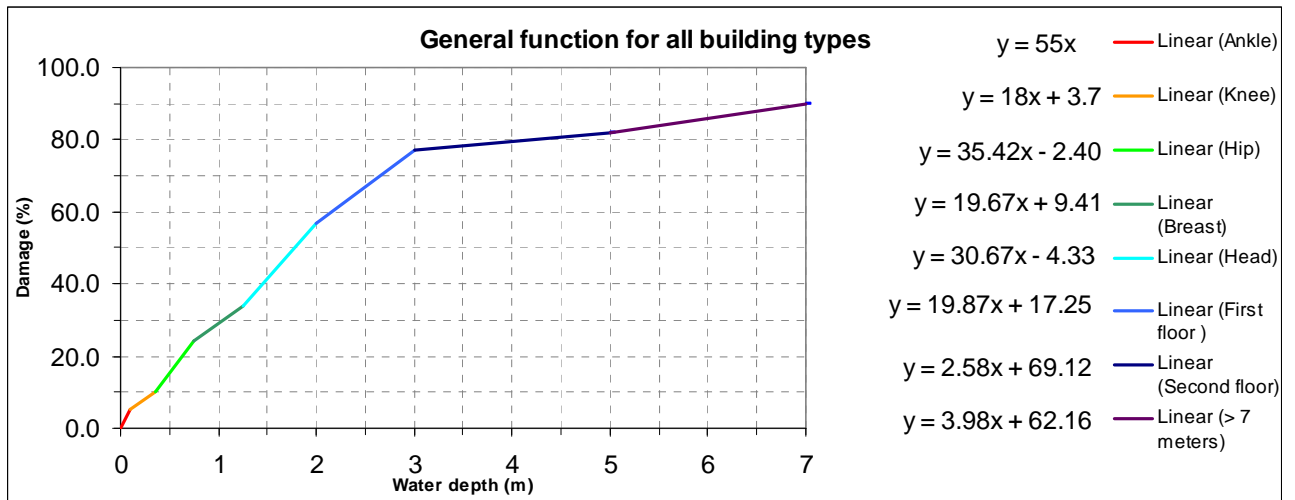
A: The column includes values higher than 100 (the records **B\_16882** and **B\_19320**); this column should represent the degree of damage for each building expressed in percentage (0 – 100%). The values higher than 100 are related to locations where the water height is much higher than 7m (9.64m and 9.84m); the depth damage functions we created have their last value at 7m. The water heights values upper than 7m are extrapolated using the last equation of the model; this can produce damage values higher than 100%. We can avoid this fact by creating another column with an IFF statement like the following:

$$\text{Damage\_Buildings\_Corr} := \text{IFF}(\text{Damage\_Buildings} > 100, 100, \text{Damage\_Buildings})$$

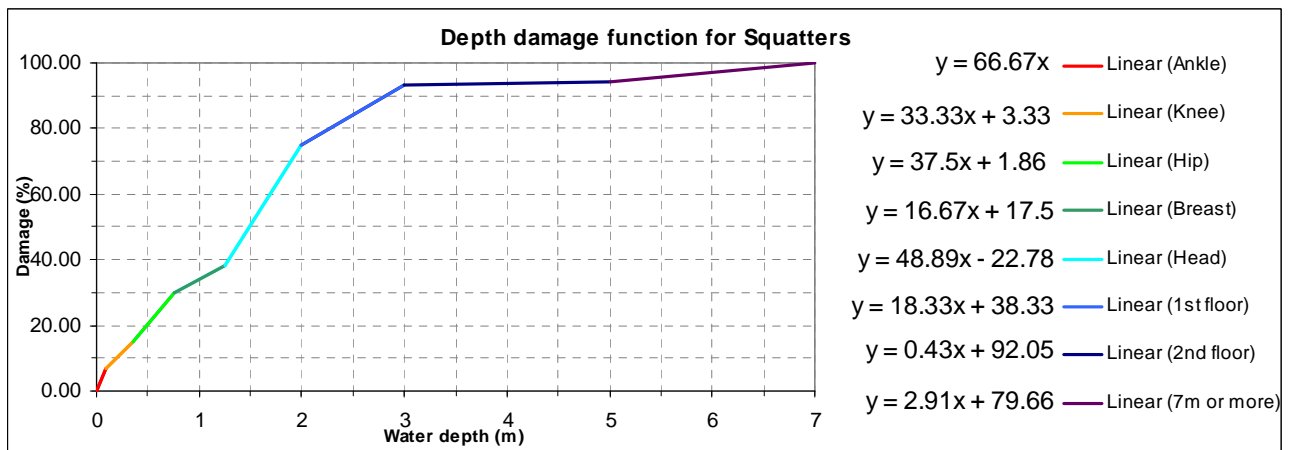
The expression creates another column where the values higher than 100 are changed into the value 100.

Q: Compare the two graphics and comment them. Do they differ from each others? Why?

A: The graphics related to A) all building types and B) Squatters are shown below with the equations as they appear in the Excel sheet Stage-Damage Curves.



**Graphic A:** general depth-damage function for all the building types.



**Graphic B:** depth-damage function for squatters only.

The graphic B is steeper than the other and it reaches values close to 80% of damage at a water depth of 2m. This is due to the higher vulnerability of the squatters than the overall average. The interval between 0.75m and 1.25 shows strange results: the squatters seem to have lower damage rates with this water depth than the average of the building types. This inconsistency is caused by the small amount of records that the statistics are based on.

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Q: Extract the water height in the table **Building\_map\_1998** from the column Water\_height only for the squatters, and apply the ILWIS expression you created. Store the result in a column called **Damage\_Squatters**. Compare the two columns Damage\_buildings and Damage\_Squatters; what can you conclude?

A: According to the explanation provided for the previous answer, the values of the column Damage\_Squatters are higher than the ones of the column Damage\_Buildings.

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The two expressions to apply the depth-damage functions in ILWIS: Check the values in the expressions and the equations in the corresponding graphics.

Damage\_Buildings:=IFF(Water\_Height<=0.1,Water\_Height\*55,  
IFF(Water\_Height<=0.35,Water\_Height\*18+3.7,  
IFF(Water\_Height<=0.75,Water\_Height\*35.42-2.40,  
IFF(Water\_Height<=1.25,Water\_Height\*19.67+9.41,  
IFF(Water\_Height<=2,Water\_Height\*30.67-4.33,  
IFF(Water\_Height<=3,Water\_Height\*19.87+17.15,  
IFF(Water\_Height<=5,Water\_Height\*2.58+69.12,Water\_Height\*3.98+62.16))))))

Damage\_Squatters:=IFF(W\_H\_Squatter<=0.1,W\_H\_Squatter\*66.67,  
IFF(W\_H\_Squatter<=0.35,W\_H\_Squatter\*33.33+3.33,  
IFF(W\_H\_Squatter<=0.75,W\_H\_Squatter\*37.5+1.86,  
IFF(W\_H\_Squatter<=1.25,W\_H\_Squatter\*16.67+17.15,  
IFF(W\_H\_Squatter<=2,W\_H\_Squatter\*48.89-22.78,  
IFF(W\_H\_Squatter<=3,W\_H\_Squatter\*18.33+38.33,  
IFF(W\_H\_Squatter<=5,W\_H\_Squatter\*0.43+92.05,W\_H\_Squatter\*2.91+79.66))))))