# No flood insurance – Single objective: cost – Ignoring uncertainty

In cases where the homeowner decides not to participate in the NFIP or purchase private flood insurance. In the majority of such houses, not raising the house is the cost-optimal policy. We calculated the cost-optimal elevation for a local community of 10,000 houses in the vicinity of the USGS gauge in this study and compared the results with FEMA’s one-foot-above-BFE (OFAB) policy. Figure 1 compares the obtained optimal elevation in this study with FEMA’s recommendation. Each dot in this figure represents a house close to the target USGS gage. Houses are assumed to vary in size, value, departure from the FEMA’s base flood elevation. The optimal policy for all the houses has a lower total cost than the OFAB policy. The optimal raises of these policies are compared in figure 2 where the histogram of the difference in our optimal height and OFAB is compared. It is noted that in the majority of the houses, the optimal raise is less than OFAB. This is mainly because for those houses elevating a house is not cost effective.



Figure 1: Cost comparison of the cost-effective policy with FEMA’s one-foot-above-BFE policy. Dots represent hypothetical houses in the vicinity of the USGS gage at Sunbery, PA



Figure 2: Histogram of difference the cost-effective policy and FEMA’s one-foot-above-BFE policy. Negative values indicate that OFAB’s policy suggest higher level of heightening the house and positive values indicate that the cost-optimal policy recommends higher house heightening

Expected damages, construction cost, and total costs are shown in the following. Three houses that are located 9, 6, and 4 feet below the base flood elevation are chosen for demonstration of cost-benefit analysis through figures 3, 4, and 5, respectively. In these figures, the cost optimal policy is shown by a blue dot and FEMA’s recommendation is shown by a dashed line. For the house that is 9 feet below the base flood elevation, the expected damages are relatively high and therefore, elevating the house is cost-optimal. For this specific house, both approaches suggest the same level of heightening. The second sample house reside 6 feet below FEMA’s base flood elevation. Similarly, for this house, elevating is recommended; however, the cost optimal policy suggests raising the house to s higher elevation that FEMA’s OBAF. In this case, the homeowner can invest more money in elevating the house now and save more money by preventing future floods. Finally, for the third house that is located 4 feet below the BFE, elevating is not a cost optimal policy as expected flood damages are not anticipated to be higher than cost of elevating. These three houses are good examples to showcase that the elevating a house to one-foot-above-BFE is not always cost optimal. While for certain houses it might be cost-effective, it is not the case for other houses.

and Total costs of three sample houses are shown in figure 3.



Figure 3: expected damages, construction costs, and total cost of various heightening policies ranging from 0 to 14 feet for a house that is located 4 feet below the base flood elevation.



Figure 4: Same as figure 3 but for a house that is located 9 feet below the base flood elevation.



Figure 5: Same as figure 3 but for a house that is located 4 feet below the base flood elevation.

# No flood insurance – Single objective: cost – Considering uncertainty

Some parameters that are involved in this cost-benefit analysis are uncertain including the extreme value distribution parameters, discount rate and the house lifespan. Uncertainty of these parameters result in uncertainty of the expected present value of expected damages which could ultimately reverse the decision of elevating a house or not. Figures 6, 7, and 8 show the cost-benefit analysis of same sample houses when the expected damages are uncertain. While accounting for uncertainties in the first and third house does not make a considerable change in the optimal policy, it entirely reverses the decision if the house should be elevated or not in the second house. For this house, that is 6 feet below the BFE, elevating the house is not recommended if a more scientifically sound method is used to calculate the expected damages. This highlights the significance of considering uncertainties in flood adaptation policy making since uncertainties could make a considerable change in the chosen policy.



Figure 6: Uncertain expected damages, current cost of construction, and total costs of various elevating policies for a house that is 9 feet below FEMA’s base flood elevation.



Figure 7: Similar to figure 6 but for a house that is 6 feet below the base flood elevation.



Figure 8: Similar to figure 6 but for a house that is 4 feet below the base flood elevation.

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|  | *Would you abandon?* | | *Would you consider demolishing and rebuilding?* | |
|  | *No way* | *I might* | *No way* | *I might* |
| *No insurance - certainty - cost objective* |  |  |  |  |
| *No insurance - certainty - cost and reliability objective* |  |  |  |  |
| *No insurance - uncertainty - cost objective* |  |  |  |  |
| *No insurance - uncertainty - cost and reliability objectives* |  |  |  |  |
| *With insurance - certainty - cost objective* |  |  |  |  |
| *With insurance - certainty - cost and reliability objective* |  |  |  |  |
| *With insurance - uncertainty - cost objective* |  |  |  |  |
| *With insurance - uncertainty - cost and reliability objectives* |  |  |  |  |