Lab 4: House Elevation NPV Analysis

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using CSV  
using DataFrames  
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Plots.default(; margin=6Plots.mm)  
  
include("depthdamage.jl")

# 1. Depth-damage function

# 2. Single Year Function

house\_area = 8000u"ft^2" #   
house\_value = 140\_000  
  
haz\_fl\_dept = CSV.read("data/haz\_fl\_dept.csv", DataFrame) # read in the file  
desc = "Average hotel/motel, Contents (Equipment/Inventory)"  
row = @rsubset(haz\_fl\_dept, :Description == desc)[1, :] # select the row I want  
dd = DepthDamageData(row) # extract the depth-damage data  
  
 # get the depth-damage function  
 damage\_fn = get\_depth\_damage\_function(dd.depths, dd.damages)   
  
 #Flood distribution from GEV  
 gauge\_dist = GeneralizedExtremeValue(8, 1.5, 0.1) # This is same hypothetical gauge distribution used for lab 3  
 offset = 5.35 # hypothetical height from house to gauge  
 flood\_dist = GeneralizedExtremeValue(gauge\_dist.μ - offset, gauge\_dist.σ, gauge\_dist.ξ)  
  
 #calculating expected damage in percentage  
 samples = rand(flood\_dist, 100\_000) .\* 1u"ft"  
 damages = damage\_fn.(samples)  
 expected\_damages\_pct = mean(damages)  
 elevation\_cost = get\_elevation\_cost\_function()  
   
function single\_year\_cost\_benefit(flood\_dist, damage\_fn, elevation\_cost, house\_area, house\_value, Δh)  
  
 # calculate the expected damages  
 c\_dmg = house\_value \* expected\_damages\_pct/100  
  
 # calculate the cost of elevating  
 elevation\_cost = get\_elevation\_cost\_function()  
 c\_constr = elevation\_cost.(Δh, house\_area)  
   
 # return the total cost and benefit  
 return -c\_constr - c\_dmg  
end

single\_year\_cost\_benefit (generic function with 1 method)

# 3. NPV Function

function npv\_cost\_benefit(flood\_dist, damage\_fn, elevation\_cost, house\_area, house\_value, Δh, T, discount\_rate)  
  
 T= 10  
   
 annual\_dmg = single\_year\_cost\_benefit(flood\_dist, damage\_fn, elevation\_cost, house\_area, house\_value, Δh)  
   
 # calculate the costs and benefits for each year, and then discount  
 #npv = sum(annual\_dmg .\* (1 - discount\_rate) .^ (0:9))  
 npv2 = sum([annual\_dmg \* (1 - discount\_rate)^(i - 1) for i in 1:10])  
  
 return npv2  
 end

npv\_cost\_benefit (generic function with 1 method)

# 4. One SOW, several actions (Δh [0ft, 2ft, 4ft, 6ft, 7ft])

Δh\_values = [0u"ft", 1u"ft", 2u"ft", 3u"ft", 4u"ft", 5u"ft", 6u"ft", 7u"ft", 8u"ft"]  
  
 discount\_rate = 0.5  
 T= 10  
  
for Δh in Δh\_values  
  
 npv\_result = npv\_cost\_benefit(flood\_dist, damage\_fn, elevation\_cost, house\_area, house\_value, Δh, T, discount\_rate)  
  
 println(npv\_result)  
  
 end

-76652.44608554798  
-1.4094476160074228e6  
-1.4162889285074233e6  
-1.4231302410074228e6  
-1.4299715535074228e6  
-1.4368128660074228e6  
-1.4539389820788514e6  
-1.4710650981502803e6  
-1.4881912142217087e6

* The NPV varies significantly based on the (Δh) chosen.
* The Δh = 0ft is the less negative npv among other Δh explored and is relatively most cost-effective option among options Δh explore.

# 5. Sensitivity test

Δh = 0u"ft"  
T = 10  
  
  
# Generate random discount rates using a normal distribution  
discount\_rates = rand(Normal(4, 2), 100\_000)  
  
# Calculate NPV for each discount rate in the Monte Carlo simulation  
  
npv\_sim = [npv\_cost\_benefit(flood\_dist, damage\_fn, elevation\_cost, house\_area, house\_value, Δh, T, rate) for rate in discount\_rates]  
  
# Calculate the mean of the NPV results  
npv\_mean = mean(npv\_sim)  
  
# Print or analyze the results as needed  
npv\_mean

1.5837073068535507e11

# 6. Discussion

## 6.1 1.

NPV for different actions are different which means different collective of actions under a certain scenario will give different expectations.

## 6.2 2.

* The sensitivity test considers uncertainty discount rates using distribution of discounts rates.
* The npv varies between the range 1.5x^11 to 1.6X10^11

## 6.3 3.

* We considered only one SOW, we assume constant parameters over time i.e elevation cost, flood distribution, upfront value etc.
* These limitations could add up to the uncertainty in our npv values.
* To address thise limitations additional sensitivity analyses should be conducted e.g., sensitivity to house value, construction costs, house maintainance, depth-damage function to find out how our npv values will response to these factors.
* exploring npv sensitivity over different time frames like T=20 years to capture long-term implications.