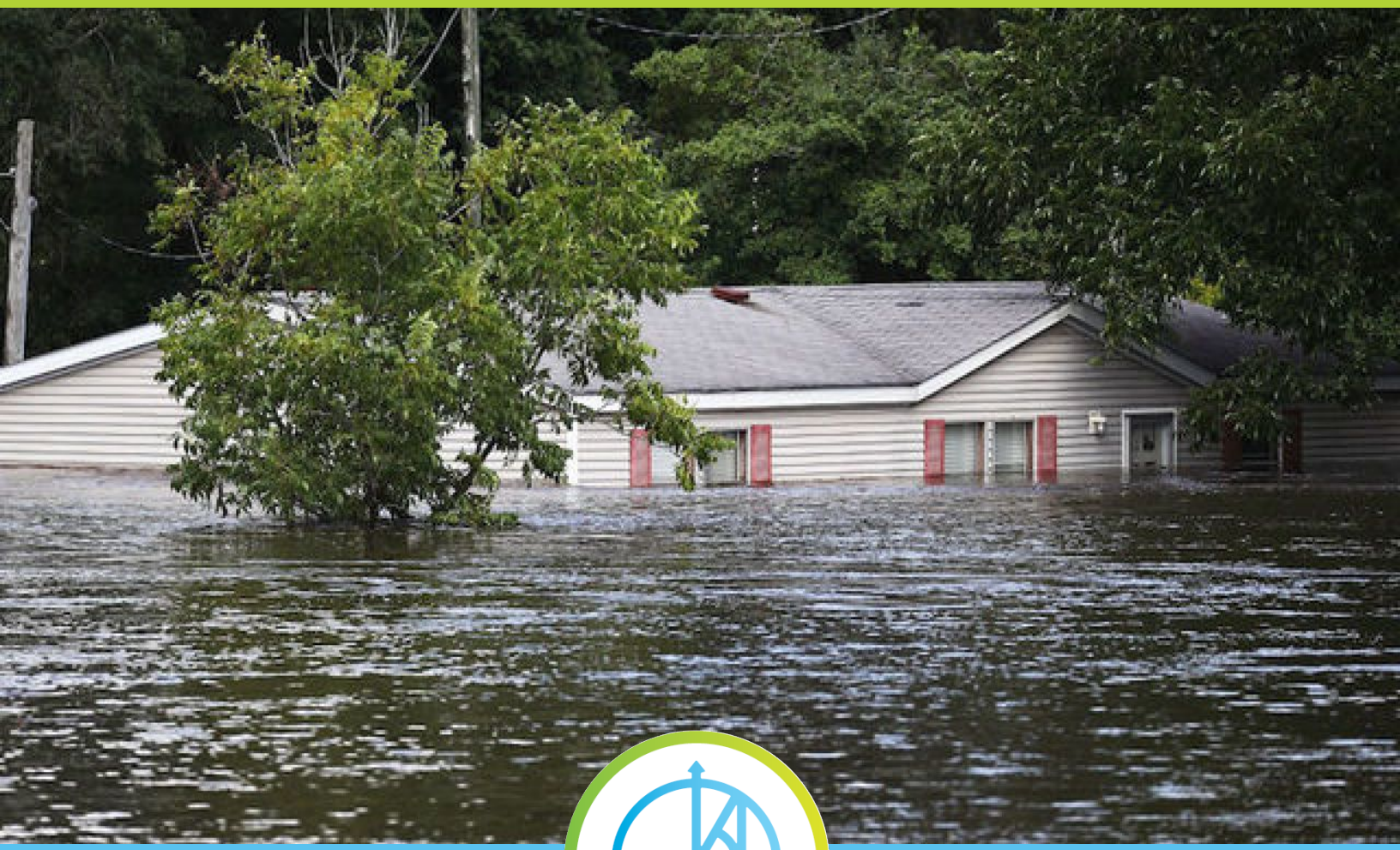
# 2019-20 Scenario

## National Flood Insurance Program

### STUDENT WORKBOOK



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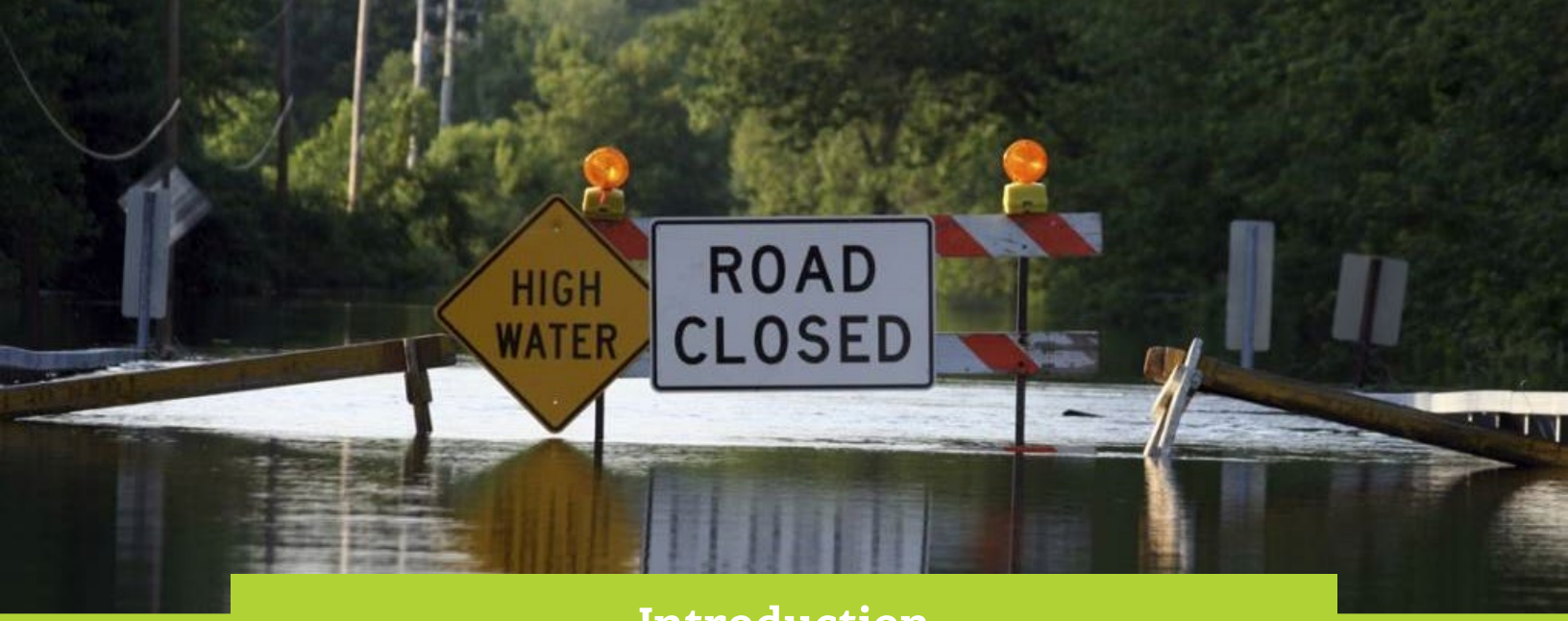
# Modeling The Future Challenge




# Introduction

Each year, millions of dollars are lost due to floods. Losses are seen in all types of property including farms, homes, commercial real estate, and to the contents and valuables lost inside properties as well. Flooding occurs from many different natural and man-made phenomena including hurricanes, severe storms, dam and levee failure, and much more. In 1968 the federal government created the National Flood Insurance Program (NFIP) to provide flood insurance to property owners across the country. NFIP is now managed by the Federal Emergency Management Agency. Between 1989 and 2019, NFIP paid claims on 65,723 policies in North Carolina, Missouri, and Michigan.

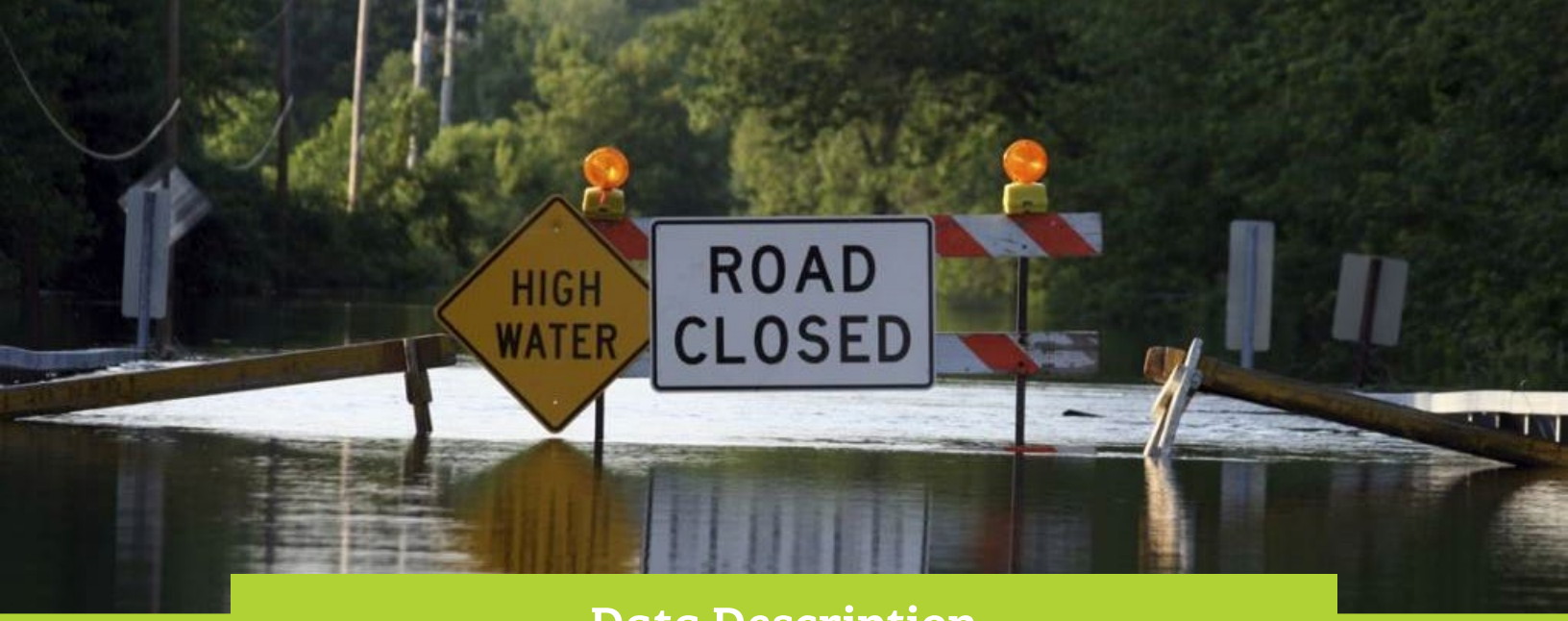
You have been hired by Homeward Insurance Co., a small insurance company looking to expand their flood insurance policy offerings into these states. Your team has provided you with a spreadsheet of annual summaries of the policies with a loss from the NFIP claims in North Carolina, Missouri, and Michigan. These data are only policies that HAD a claim each year, not all NFIP policies.

In addition, your team members have provided you with information they researched from the National Oceanic and Atmospheric Administration (NOAA) about the total precipitation values in each state over the years. This information may be useful in calculating some correlations in for your insurance analysis. Your team has included the data as a separate tab in the spreadsheet attached.

The CEO of Homeward has asked you to review this data to help them analyze if they should enter the market and determine how to best price their insurance policies so they can be beneficial to the policy holders while still making a profit for the company and minimizing risks. Examine the data spreadsheet attached to this scenario to answer the questions on the following pages.

**Relation to MTFC Project Phase:**

All data in this scenario is real. Although this NFIP data is not directly connected to this year's theme, it is very similar in the structure of the data to what will be used. Additionally, the type of questions provided in this scenario may help provide ideas for your MTFC project.




# Data Description

Your team at Homeward Insurance has provided you with a spreadsheet of historical residential insurance claims from the National Flood Insurance Program (NFIP) in three states (Michigan, Missouri, and North Carolina) in from 1996 to 2016. The data includes four columns of information:

- **State:** the state in which the claim occurred.
- **Year:** the year in which the claim occurred.
- **Claims**: the number of claims that were paid.
- **Loss**: the dollar amount that was paid for all the claims in the row.
- **Precipitation Anomaly:** The difference that the annual amount of precipitation in the state was off from the 1901-2000 mean in inches.

Additionally, Homeward Insurance has compiled a list of severe "100-year" storms and hurricanes that occurred in these states during those years. The hurricanes included are only those that made landfall in the state. The storms are only those that caused wide-spread flooding of rivers that crested beyond their flood stage for more than 1 week. This list is provided on the second tab of the spreadsheet.

# Level 1 Questions:
# Basic Statistics & Probability

1. **What is the average annual loss for each state?**

2. **What is the Standard Deviation for the average annual loss for each state?**

3. **Interpret the difference in standard deviations you see. Why might one state be significantly higher than the others?**

4. **What is the likelihood that each state had a loss of over $25,000,000?**

# Level 1 Questions:
# Basic Statistics & Probability

**Your interns at Homeward Insurance have consulted the National Oceanic and Atmospheric Administration (NOAA) to provide you with a list of hurricanes and severe non-winter "100-year storms" that have occurred in each state over the past 30 years. Here is what they found:**

**1996 – Hurricanes Bertha and Fran both hit NC in 1996.**
**1999 – Hurricanes Dennis and Floyd both hit NC.**
**2003 – Hurricane Isabel hit the outer banks of NC.**
**2008 – Storm over central US caused Meramec river to flood in MO.**
**2011 – Hurricane Irene made landfall near cape lookout, NC.**
**2011 – Storms cause Missouri river basin to flood in MO.**
**2014 – Storms cause widespread flooding in MI.**
**2015 – Storm over central US caused levees to fail due to historic rain in MO.**
**2016 – Hurricane Matthew made landfall in southeast NC.**

5. **What is the probability of having a hurricane landfall in north Carolina between 1996 and 2016? What is the probability of a severe storm in Missouri or Michigan? Compare this to the years where each state had a loss greater than $25,000,000.**

6. **Compare the average loss and standard deviations for the annual loss in the hurricane or storm years versus the annual loss and standard deviations in NON hurricane or storm years for each state. Complete the chart below and explain what this tells us about losses in each state?**

| | Michigan | Missouri | North Carolina |
|---|---|---|---|
| Average loss in NON hurricane or storm years for the state. | | | |
| Average loss in hurricane or storm years for the state. | | | |
| Standard deviation of loss in NON hurricane or storm years for the state. | | | |
| Standard deviation of loss in hurricane or storm years for the state. | | | |

# Level 2 Questions: Trends and Relationships

7. **Conduct a linear regression analysis of the annual loss in Missouri for all years. What is the correlation coefficient?**

8. **Is a linear regression model on this data a good way to project the future values of loss in Missouri?**

9. **Graph the loss (dollars) per claim in Missouri over the years? Compare the loss per claim from 1996 to 2005 with the loss per claim from 2006 to 2016. Explain what you believe the cause for this difference could be.**

# Level 2 Questions:
# Trends and Relationships

10. **What is a 95% confidence interval for NC annual losses in years that do NOT have a hurricane.**

11. **How well do annual MO claims and NC claims correlate to the Precipitation Anomaly in their state? Explain logically why one state might have a stronger correlation with precipitation values than the other.**

# Level 2 Questions: Trends and Relationships

12. **Between 1996 and 2016, what is the likelihood of having a Precipitation anomaly >=5.0 in Missouri?**

13. **Compare the likelihood of having a loss of greater than $25,000,000 and having a Precipitation anomaly of >= 5.0 with the likelihood of having a loss of greater than $25,000,000 and having a Precipitation anomaly of < 5.0 in Missouri.**

14. **How could this information help Homeward Insurance better predict or plan for future losses due to flooding?**

# Level 3 Questions: Risk Analysis

15. If the likelihood of having a 100-year storm in Missouri went from .15 1996 to 0.167 in 2016 and the trend is expected to continue, what is the probability of having a 100-year storm in 2036?

16. What is the expected value of annual loss from 100-year storms in Missouri in 2036?

17. What is the overall expected value of annual loss in Missouri in 2036 given the same annual loss values calculated from #6 and the likelihood of having a "100-year" storm calculated above.

# Level 3 Questions: Risk Analysis

18. **Explain logically what the "expected value" for an annual loss in the future means to the NFIP?**

**The Loss Ratio is defined as the amount of loss divided by the amount of the premium received from the policy holder. If you have a loss ratio of 1 you are breaking even on how much you pay out in losses compared to how much you take in from the policy premium.**

19. **If the NFIP had a loss ratio of 4.0 in 2016 from their policies in Missouri that had a claim, on average, how much would their annual flood insurance premiums be for these policies?**

20. **What other important information from the NFIP is NOT included in your spreadsheet that is critical to understanding the full structure of their costs and income from their insurance policies?**

# Level 4 Questions: Recommendations

21. If 25% of the NFIP policies in NC had a loss each year, and the NFIP broke even , how much would they have had to charge for their annual premiums on average?

22. If the NFIP wanted to improve its premium pricing in NC what other information could it use to help differentiate prices that is not included in your spreadsheet?

23. The CEO of Homeward Insurance has decided to start offering new insurance policies to either North Carolina or Missouri. The CEO also wants to keep the company annual losses to less than $50,000,000, which state would you recommend and why?

24. Can you guarantee to your CEO that if the company launches its flood insurance policies in that state that you will meet these requirements?

25. How could an insurance company protect itself against having large losses it has to pay out in a year?

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