2020-21 Example Scenario
Flooding & Preventative Measures
Instructor Guide

A program of The Actuarial Foundation

Modeling The Future Challenge

Introduction

Each year, billions of dollars are lost due to flooding across the United States. In 2019 alone, $3.75 billion was lost; however, this is far from the largest annual loss the US has suffered from flooding. That title goes to 2017, when severe storms, excess precipitation, and hurricanes cost over $60 billion in damage!

These losses come in many forms, most notably perhaps are property losses. Floods, like most natural disasters, do not discriminate on the type of buildings they damage; from farms to strip-malls, to family homes and everything in-between, floods can cause untold damage to anyone. For individual homeowners, flooding can be one of the most destructive risks of owning a home. However, there are many factors that can lower the risk of loss for homeowners.

Information on the elevation of the property, whether the property has a basement, or other under-ground assets, the size of the property, and whether it has preventative measures to help protect against flooding are all factors that can be used to model the risk of loss for each property in the event that a flood occurs.

In this scenario, you have been provided data about 7,000 households across the Midwest with 1-year term policies that cover water damage to the structure. The data is all from one insurance company, Sphinx Insurance, which is reinsured by the National Flood Insurance Program (NFIP) under the Federal Emergency Management Agency. Sphinx is interested in understanding how to better price their insurance products and help protect families in the flood-prone states of the Midwest. Sphinx currently insures home-owners in the states of Iowa, Illinois, Missouri, Kansas, and Nebraska.

Data summary:

Sphinx has provided you with data on 7,000 of their losses from written policies in the last year, cleaning the data from any policyholders who did not have a claim. All households are located within Iowa, Illinois, Missouri, Kansas, or Nebraska, and policies were written uniformly across each state (1400 each). Households are classified by their policy ID number, the elevation of their home (in feet), as well as by indication if they have preventative measures against flooding (i.e. sump pumps, or drainage ditches).

Use the data in the attached spreadsheet to answer the questions provided and help the Sphinx Flood Insurance CEO make decisions about how to update or add to their insurance policies.

Questions from this part of the scenario build upon Part 1 of the Actuarial Process. It may be valuable to review this section of the Actuarial Process Guide before answering the questions below.

1. Identify at least two factors other than those mentioned in the spreadsheet provided (i.e. elevation and preventative countermeasures) might be valuable in helping to separate the level of risk into more specific possible likelihoods and severities?

2. Describe in no more than a few sentences how insurance helps homeowners mitigate the risks of flooding.

3. Which type of risk mitigation strategy would the installation of a sump-pump, or other type of preventative counter-measure be (hint: reference the three types of risk mitigation strategies from the Actuarial Process Guide, Section 1.3)?

4. Provide examples of two other groups (beyond homeowners) who could be at risk due to flooding of communities in the midwestern states discussed in this scenario. Identify who they are and describe the risk in written terms.

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Questions from this part of the scenario build upon Part 2 of the Actuarial Process. It may be valuable to review this section of the Actuarial Process Guide before answering the questions below.

5. What critical series of information is NOT included in your spreadsheet that would be required to determine the frequency of the losses in this scenario?

6. What is one way that the dataset provided needs to be "cleaned?"

7. How does having more information such as the elevation of the property and whether it includes preventative counter measures or not, help in characterizing the potential risk for loss?

8. Beyond refining the possible severity or frequency of potential losses, what other information could be valuable to this scenario that is not provided? (Hint: see Actuarial Process Guide Section 2.1 for general types of valuable data).

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Questions from this part of the scenario build upon Part 2 of the Actuarial Process. It may be valuable to review this section of the Actuarial Process Guide before answering the questions below.

8. Of those with a claim, what is the average claim amount for policyholders in each state?

9. If a Nebraska policyholder did not have preventative measures installed in their home, what is the probability that they had a claim over $14,000 last year, given they had a loss?

10. In Illinois, what is the difference between the expected loss of a policyholder who has preventative protection installed and the expected loss of a policyholder who does not have any preventative measures installed?

11. What is the variance of elevation in each state? (Hint: You have all of the claims data, so use the population variance)

12. What percentage of claims were paid out to policyholders in states bordering the Mississippi River?

13. Create a histogram of the claim amounts for nonzero claims. Describe the distribution. Sphynx is especially interested in reducing the occurrence of large claims, what might be called outliers. You may have experience with the 1.5 IQR rule or with using Mean ± 2SD for identifying outliers in a distribution. Based on the shape the claim amount histogram, do you think either of these are reasonable methods?

14. Sphynx management decides that it would like to try to reduce the number of claims that are greater than $50,000. Does it appear that claims less than or equal to $50,000 are more likely to have taken preventative measures than those that are greater $50,000?

15. With which variables can you identify a correlation coefficient with the size of the claims? Calculate the correlation coefficient between claims and these variables. What can you say about the strength of these correlations? Are there any issues in using correlation coefficients to identify relationships in your available data?

16. Plot the distribution of elevation and explain some potential reasons of its shape.

17. Use elevation only to predict the expected loss of a policyholder living at an elevation of exactly 2,000 feet. Is this a good way to predict future claim sizes?

Questions from this part of the scenario build upon Part 4 of the Actuarial Process. It may be valuable to review this section of the Actuarial Process Guide before answering the questions below.

Additionally, the following questions reference information about insurance not previously discussed. For insurance companies there are several ways of making sure they will be able to cover all expected losses in a given year. The "premium" is the base amount a policyholder must pay (either annually or monthly). A loading charge is an additional percentage increase in a base premium designed to cover overhead expenses for the insurance company. A yearly fee is another method of recovering expenses which adds a standard fee for each policy. Companies may also consider having a co-pay for any claim – meaning the policyholder must pay a certain percentage of the claim. Companies also include deductibles which are dollar amounts that must be met before the insurance will pay the rest of the claim.

18. Assuming 35% of Nebraska policyholders had a loss last year, if all premiums are the same, what is the minimum premium that should be charged per month in the state to cover the expected losses if that is the only fee the insurance company gathers from the policy holder?

19. What is the minimum premium required if there is also a 10% annual charge on the expected losses in Nebraska and $200 yearly fee on every policy?

20. If all other variables stayed the same and the likelihood of severe storms were to increase 10% throughout the region, in written, general terms, what would you expect to happen to:
1. **The average claim value:**

2. **The number of claims:**

3. **The average premium Sphinx would need to charge to break-even.**

21. Suppose Sphynx wants to start selling flood insurance in Idaho. Should they use their data on losses in the Midwest to determine the new rates? Why or why not? Use data to justify your answer.

22. What bias may be present in a model based on this data alone? Explain your reasoning.

23. Sphynx is considering writing more policies. Does it make more sense to write them in states where they already write policies, or expanding their business into new states? Why? If they were to write more policies in Iowa, Illinois, Missouri, Kansas, or Nebraska, which state should they choose and why?

24. Based on this data, do you think it's more profitable to use a rate based on elevation instead of a flat rate for each state? What are the limitations of using a rate based on elevation alone?

25. An average sump pump costs a policyholder $500 to purchase and install. Sphynx wants to implement a nationwide discount program that reimburses policyholders for installing a pump. If 72.5% of policies did not have a loss last year and Sphynx charges a $220 flat annual fee and a 12% yearly loading charge for each policy. If the company is willing to reduce the loading charge by 8% for six months if a policyholder installs a pump and reduce the annual fee by $20 for the next six years, what percentage of the pump cost will policyholders ultimately have to pay?