MTFC Project Proposal 2024-25

Team Name	Less Than Three
Team ID #	19717

Part 1: Project Definition *(Soil Erosion)*

#1: Identify the topic

- **Response:** Soil erosion, although it seems like an insignificant issue on the surface, causes significant risks in many different ways. Soil erosion threatens crop yields and food production by decreasing soil fertility. Additionally, it may cause pile ups of large amounts of sediment, which may cause flooding Also, if it happens once, it's more likely to happen again. It's become especially relevant in the global effort to reduce climate change. PennState Extension found that this threat is still increasing despite current efforts to save the industry, thanks to accelerated precipitation caused by climate change. It causes a nearly $12.75 billion dollar loss to farmers each year.

#2: Identify potential risks

- **Response:** Because soil erosion increases the risk of natural disasters, there are several parties at risk of soil erosion, which include the government, farmers, insurance companies that insure the farmers, and all consumers that rely on this food.

#3: Identify a behavior change risk mitigation strategy

- **Response:** Behaviour changes to mitigate these risks include intercropping–an effective process involving growing trees and crops simultaneously to reduce erosion and create habitats –and reducing deforestation. Soil erosion could also be prevented through campaigns that promote anti-deforestation, reforestation, or sourcing materials from reputable non-lumber sources. On an individual scale, going vegan or simply being more conscious of this issue and where your wood may be sourced from can help mitigate soil erosion.

#4: Identify a modifying outcomes risk mitigation strategy

- **Response:** One modifying outcome risk mitigation strategy would be to immediately plant new crops after cutting down all of the trees in the region. Although these plants won't necessarily start growing immediately, the soil would still be fertile enough where these plants could germinate and start placing roots down before the soil dries out. Placing mulch down over these patches would also help to keep the soil from blowing away. This would mean that that soil has a layer of something to cover it, which would allow for it to stay moist and fertile, preventing it from blowing away.

#5: Identify an insurance risk mitigation strategy

- **Response:** A potential risk mitigation strategy for the insurance company could be purchasing crop insurance. FCIP is a federal program that compensates farmers for crop loss, and covers 60% of farmer's premium. Farmers could also look into getting insured from private insurance companies. This helps mitigate the risk of loss of revenue from crops for farmers, and affects parties such as the government, farmers, and insurance companies.

#6: Identify driving research questions for your topic

- **Response:** Some research questions include:

- What is the most effective pattern and schedule of intercropping or planting new crops immediately after uprootal to yield the greatest reduction in soil erosion?
- Is it more valuable for farmers to obtain private or governmental insurance to insure their crops?
- How effective is promoting the reduction of deforestation in decreasing soil erosion over time?

Part 2: Data Identification & Assessment *(Soil Erosion)*

#7: Identifying the type of data you hope to find

- **Response**: The ideal dataset would include information such as:
    - Dates of when crops were planted
    - Order of crops
    - Genus/type of crop
    - Volume of soil eroded
    - Coordinate location of crops grown (to identify geometric patterns)
    - Insurance premiums for government insurance programs, as well as claims made through them
    - Insurance premiums for a private crop insurance company, as well as claims made through them
    - Number of anti-deforestation campaigns
    - Number of people that attended the campaign/viewed the social media post/saw the flyer
    - Number of people that stated they were affected by the campaign/their actions will change (from survey responses)
    - Number of people aware of soil erosion (from survey responses)
    - Percentage change in the number of campaigns per year across decades in a specific region
    - Volume of soil eroded per year across decades in the same region

#8: Identify potential data sources for your topic

- **Response:** https://catalog.data.gov/dataset?tags=soil-erosion
    - Global Soil Erosion Modeling | Land & Water | Food and Agriculture Organization of the United Nations → This data set is provided by the United Nations and it defines historical frequency. It shows a global soil erosion map from the years 2001- 2012. Using this dataset, we would be able to study the areas with the most soil erosion and further investigate any preventative measures that were implemented afterwards. This could help us make informed decisions about which areas are most susceptible to soil erosion and whether any preventative measures taken in recent years were more effective than others.
    - United States Deforestation Rates & Statistics | GFW → This dataset, provided by the Global Forest Watch, defines historical frequency. It provides information on forests around the US over the past twenty years. Using this data, we can study which types of forests are more susceptible to deforestation over time, and we can compare this dataset with another dataset that measures soil erosion to see the extent to which deforestation actually affects soil erosion.
    - https://www-statista-com.ezpv7-web-p-u01.wpi.edu/statistics/723049/value-of-crop-insurance-premiums-usa-by-crop/ This dataset, provided by statista.com, provides information on crop insurance premiums for different crops. While not necessarily comparing private vs. government insurance, it may suggest that it may be more effective for farmers to obtain insurance depending on the crop they grow.

Part 3: Mathematical Modeling *(Soil Erosion)*

#9: Modeling research on your topic

- **Response:** The online searches yielded results of research articles and papers describing existing models of soil erosion.
- This paper talks about developing a model to try and create a soil erosion map. This can help determine the distribution of soil erosion across the world, and can help find what areas are more likely susceptible to soil erosion. This may help us find areas to focus on in our research. Modeling and Assessing Potential Soil Erosion Hazards Using USLE and Wind Erosion Models in Integration with GIS Techniques: Dakhla Oasis, Egypt.
- This article analyzes previous models for determining soil erosion and the locations they were applied to worldwide. Scientists also sought to try and find areas where the models were not used and why this was done, and then put together a database. This may help us find methods that are in place already to reduce soil erosion in some areas and how we can apply them in our model . Soil erosion modeling: A global review and statistical analysis - ScienceDirect
- This article develops a model that can be used to predict soil erosion in an area at any given time based on several factors, including rainfall detachment, sediment deposition, soil entrainment, the slope of the land, and rainfall rates. This could help us determine which factors of a landscape are most likely to cause soil erosion in a region, and if this is dependent on the factors in the region. https://acsess.onlinelibrary.wiley.com/doi/abs/10.2136/sssaj1983.03615995004700050030x

#10: Goals of a mathematical model in the project phase

- **Response:** There are several avenues for math models that our group could pursue, but the primary models necessary for exploring soil erosion would be ones to characterize the risk and predict the effectiveness of a risk mitigation strategy. Ideally, the model would be able to estimate the severity of soil erosion, predict the likelihood of severe soil erosion in the future, model the changes in the volume of soil across a time period, and estimate the impact of a risk mitigation strategy, such as intercropping, reforestation, or farmers's insurance, on the volume of soil eroded in an area. For these topics, we would likely need to employ mathematical analysis tools that identify a trend and continue the pattern to predict a variable's future value.

#11: Assumption development

Response:

- The appropriate future time period for our analysis would be around 5 years into the future. This is because soil erosion, and climate change as a whole, can suddenly and rapidly change as governments and scientists try to reverse it. This means that while we might be able to predict what would occur in the next couple years, it would be especially difficult to predict what steps might be taken to mitigate the risk of climate change (and thus soil erosion) in the next couple decades.
- The rate of change would be different from the historical rate of change. This is because in the past there were little to no changes implemented to decrease soil erosion, but as people are becoming more aware of the problem, more calls to action are being made to mitigate the risk of long-term soil erosion and its consequences.

Part 4: Risk Analysis *(Soil Erosion)*

#12: Goals for mitigation strategy

- **Response:** Some potential outcomes if no risk mitigation strategies are executed include exhausting our top soil layer. Currently, soil is eroding 100 times quicker than it is forming (Sulaeman & Westhoff, 2020), and if this pattern continues, about 582 million people around the world will be severely malnourished by 2030 due to the decrease in farmland (FAO et al., 2023). Eroded soil could take several years to replenish, and until then, the world could also experience increased natural disasters, water pollution, and declines in fish and other marine species. The goal of the risk mitigation strategies would be to decrease the effects of soil erosion on the general public by decreasing the risk of world hunger.

Part 5: Recommendations *(Soil Erosion)*

#13: Recommendation differences between mitigation strategies

- **Response:** We would prioritise effectiveness of our risk mitigation strategy because we want to achieve the best results possible with the lowest cost and energy required. We would also consider the cost because this is essential to the purpose and effectiveness of the risk mitigation strategy- if the strategy is too expensive, it can not be deemed a feasible solution. One other factor we would consider is ethics, since some solutions are more ethical than others (ex. some don't favor certain groups of individuals, some do).

#14: Audience for recommendations

- **Response:** It would be based on the government and the community as a whole to enact those changes. The government would be able to provide the financial aid necessary to carry out large scale solutions like campaigning, insuring farmers, and enacting laws, while the community as a whole would be in charge of accepting the laws and campaigns that the government puts out and adjusting their habits to decrease the risk of soil erosion in their areas.

#15: Goals for situation improvement

- **Response:** The optimal outcome of our recommendations would be an improved state of soil erosion. Ideally, the government, community, and farmers will follow our recommendations and the volume of soil eroded annually will reduce. This will slow the onset of the global hunger crisis and the greenhouse gas effect.

References

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