RELOCATION SOCIAL INSURANCE PROGRAM

Storslysia Case Study

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Executive Summary

With climate-related catastrophes increasing over time in Storslysia, its residents face the imminent threat of displacement, and the economy faces a decline due to the costs of supporting impacted individuals. The team has been tasked with alleviating the adverse financial impacts of climate change by designing and implementing a long-term social insurance program. This report will outline the program's design and the method for pricing under two climate scenarios.

The final program to be utilised offers two solutions to minimise cost and maximise results. The first is to incentivize residents in high-risk areas to voluntarily relocate which will mitigate larger costs later, and the other is to help impacted individuals who are permanently displaced because of a catastrophe. To incentivise relocation, the program offers a 20% above-market price buy-back scheme to households considered to be high-risk; this is capped at 2000 houses per year to avoid excessive claims. For those involuntarily displaced, a lumpsum payment will be distributed, calculated based on the property damage value per household, as well as income support and accommodation expenses for those applicable. The values we have calculated are a result of strenuous testing and comparisons to obtain an optimal solution.

Our proposed program restricts the cost associated with relocation (voluntary or climate-induced) to 10% of Storslysia's GDP every year. This is significantly lower than without the program and shields the economy from negative financial ramifications. We recommend that both streams of the program be run simultaneously as promoting voluntary relocation will greatly reduce larger costs down the line resulting from forced displacement.

Objectives

Climate events are extremely detrimental to Storslysia's economy due to its high level of uncertainty and the severity of pay-out values when those events do occur. To shield the economy from suffering the worst, this report focuses on mitigating household impact costs. Our objective is to design a social insurance program to manage Storslysia's exposure to displacement risk; we address both voluntary and forced displacement and focus secondarily on lowering geographic risk and avoiding large disparities in the socio-economic status. There is a strong need to include incentives for voluntary displacement as it harbours much lower costs than if an involuntary claim is made. Climate incidences are often long occurring and to derive a program that is sustainable, we have factored in the community's needs. Our solution incorporates community consultation and feedback to tailor and adapt the program through both qualitative and quantitative metrics.

Key metrics

This program is a long-term solution that consists of multiple stages. The following table illustrates the key metrics to be analysed throughout and the rationale behind them.

Table 1 – Key metrics used to monitor the program.

Metric	Frequency	Reason
Total pay-outs as a percentage of GDP	Annually	Confirms Storslysia is on track to remain financially sound with costs not exceeding 10% of the year's GDP.
Projected costs	At the end of each buyback cycle	Ensures that the future costs continue to remain under 10% of the year's GDP using up-to-date data for accurate reprojection results. A review

	and annually after 2029	to check opportunities to reduce costs can be conducted and implemented to adapt.
Natural disaster occurrence	Annually	Allows for adjustments for better model accuracy and adjustment to application criteria if risk zone information changes.
Sum of involuntary displacement payments	Annually until 2029 then every 5 years after that	Monitor and expect to see a decrease in future due to the implementation of the program. Revise and adjust the program as needed.
Number of applications	At the end of each buyback cycle	Monitor demand for buyback and adjust the program accordingly.
Community satisfaction	At the end of each buyback cycle	Incorporate the community's feedback and opinions into the program.

Program Design

The proposed program provides financial support for households in high-risk areas to voluntarily relocate or to recover after being affected by a catastrophic event. Households are encouraged to voluntarily relocate through a buyback scheme which provides financial assistance to encourage residents in vulnerable areas to voluntarily relocate to a lower-risk area, therefore minimising costs from the involuntary scheme. Properties bought back will become government-owned and deemed unhabitable after the buyback.

Voluntary Scheme	
Eligibility to claim	Citizens over 18 years old are eligible to apply for the buyback scheme if they are an owner of a property in a high-risk region. Only one owner per property can apply. Applications are submitted every two years and reviewed on a case-by-case basis and the top 2000 properties most at risk of property damage from a catastrophic event are selected. Successful applicants must relocate to a low-risk region. The number of eligible properties is determined by ensuring that the objectives are met and adjusted according to the target voluntary relocation proportions in Table 2.
Coverage	**Home buyback** – Claimants receive a lump sum valued at 20% above the market price of the property they currently own. The additional 20% of the lump sum above the market price serves as a financial incentive for households in high-risk areas to relocate to lower areas. Furthermore, this ensures that they can afford homes in lower-risk areas as the market prices in such areas are expected to be more costly. It also accounts for the temporary loss of income due to frictional unemployment. **Moving costs** – Claimants can reimburse up to a maximum of ₱1000 in moving costs incurred. If a household has multiple owners, a single payment is made to the applicant and the distribution of funds is up to their discretion.
Other features and requirements	**Application review** – Properties eligible for the buyback scheme will be selected based on factors such as whether the property had been damaged due to a catastrophic event in the past and the likelihood of a severe catastrophic event in the future. Furthermore, the applicant must have owned a home in the vulnerable region for a sufficient length of time. **Low/High-risk regions** – Low-risk regions include regions 1 and 3. High-risk regions include regions 2, 4 and 5. These will be reviewed every year.

	The risk rating of regions is determined through past experience, including the frequency of catastrophic events and total property damage incurred.
Additional incentives	**Government land acquisition** – To support the buyback scheme, Storslysia's government will acquire land in low-risk areas and begin development. Suitable areas will be discussed in community consultations with relevant stakeholders. According to King et al., some households may be resistant to voluntarily relocating due to longevity of residence in the community, reduced incomes of retirees and lack of time available to restart elsewhere. Successful applicants can choose to move to any lower-risk region or relocate to a property on land acquired by the government. The latter option provides an opportunity for high-risk regions to maintain a sense of community after relocating and reduce the burden of searching for a home.

Involuntary Scheme	
Eligibility to claim	Citizens over 18 years old are eligible to apply if their property was damaged or they were forced to cease work due to a catastrophic event. The address of the covered property must be the claimant's main residence address.
Coverage	**Home and property damage** – Affected households are entitled to small claims lower than ₱500, while the reimbursement of additional costs will require manual review. Triaging claims aims to minimise costs associated with claims investigation. Home and property damage claims include the replacement of household items and housing repairs. **Loss of income payments** – If affected residents are temporarily unable to work after the catastrophic event, they are eligible to receive 75% of their income for 8 weeks, capped at Storslysia's median income. **Accommodation expenses** – If the property becomes uninhabitable following the catastrophic event, residents are eligible to be compensated for accommodation expenses for 2 weeks. If the property at risk was rented to a tenant, the landlord is entitled to home and property damage coverage while the tenant may receive loss of income and accommodation expenses if eligible.

The timeline in Figure 1 details timeframes for the implementation of the program. There are three cycles of the scheme each being two years in length. The program aims to prioritise individuals most vulnerable to natural disasters within the community and scale to cover proportionally more households over time. Towards the second half of each cycle, there are opportunities for review both internal and external. Community members are consulted for feedback which is evaluated by the committee alongside statistical information to streamline the process. These review cycles identify points of optimisation within the program to improve both implementation efficiency and cost, allowing for the scheme to effectively help those in need in subsequent iterations.

Metrics for both voluntary and involuntary schemes detailed in Objectives will be re-evaluated and claim amounts and the number of eligible households will be adjusted accordingly.

Ultimately, the goal of the scheme is to reduce the proportion of involuntary displacement. Taking the amount of involuntary displacement before the implementation of the scheme as 100%, the scheme aims to decrease the need for displacement by 15%, 25% and 35% through three cycles respectively. These figures are summarised below in Table 2.

Figure 1 – Home Buy-Back Scheme Implementation Timeline.

Table 2 – Target Voluntary Relocation Figures for Home Buy-Back Scheme

		Target Proportion EOY	
Year	Cycle Number	Voluntary Relocation	Involuntary Displacement
2023 and before	0	0%	100%
2024 – 2025	1	15%	85%
2026 – 2027	2	40%	60%
2028 – 2029 +	3	75%	25%

Pricing/Costs

Without the program

In both short-term and long-term timeframes, the frequency and severity of extreme weather events will vary under a range of future greenhouse gas emission scenarios (IPCC, 2021), which will affect the frequency of natural hazards, GDP, and household income. Based on historical weather-related hazard data, the economic costs without the program were estimated under a low and high emissions scenario, as summarised in Table 3.

Table 3 – IPCC SSP Emission Scenarios

Emission Scenario	**RCP and likely SSP**
Low	RCP2.6 (SSP1 – Sustainability[1])
High	RCP4.5 (SSP5 – Fossil-Fuelled Development[2])
1 – Assumes a gradual but persuasive shift towards sustainable development (IPCC, 2021). 2 – Assumes rapid economic growth and energy-intensive lifestyles, powered by a strong reliance on fossil fuel energy (IPCC, 2021).	

These two scenarios represent the lowest and highest Representative Concentration Pathways (RCPs) considered by IPCC, as provided in the Shared Socioeconomic Pathways (SSPs) scenario data. However, it is worth noting that they do not represent the absolute maximum and minimum future emissions.

2 major cost components were considered:

- Loss of income payments depending on the region of residence and severity of the natural hazard(s), and
- Cost of involuntary relocation, driven by property damage due to natural hazards.

Cost of involuntary relocation

A Generalized Linear Model with Gamma distribution and Log link was used to model the severity of property damage due to natural hazards. The base values inputted into the frequency projection model were determined through a weighted average of the annual event frequency from 1990, with larger weights assigned to more recent years to reflect up-to-date trends.

The overall property damage was estimated over a short-term timeframe of 10 years to 2030, and a long-term timeframe to 2100. Coastal and drought-related costs were excluded in the projections to reflect recent hazard-related experiences, as the latest occurrences of these events were in 1989 and 1993 respectively. This exclusion is immaterial to the overall projection, as they represent less than 3% of total historical costs across all regions.

Figure 2 – Expected changes to property damage costs compared to current 10-year average.

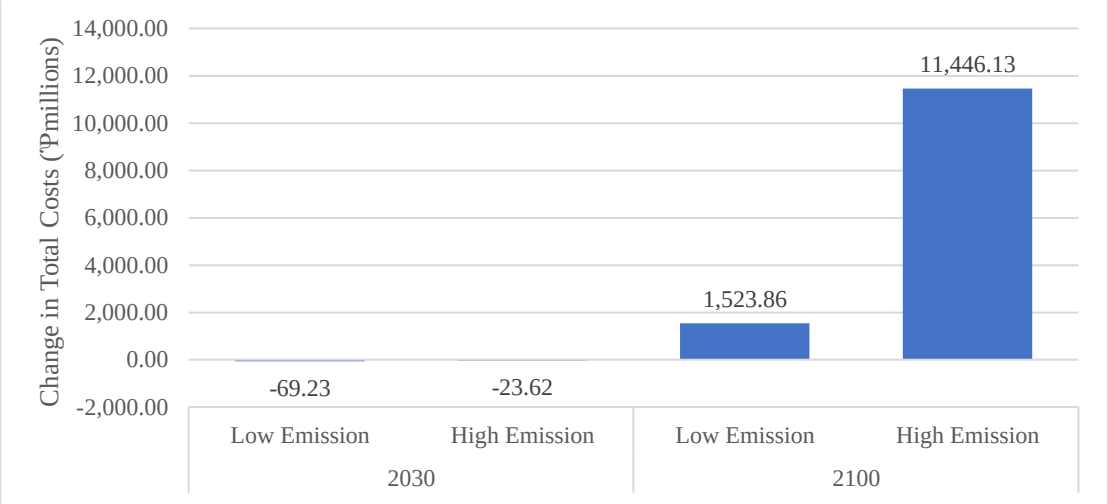


Figure 2 shows the expected changes to costs of hazards by 2030 and 2100 respectively, under both low and high-emission scenarios. While there are minor decreases in 2030 under both scenarios, by 2100, total costs under both scenarios are expected to increase significantly relative to the current 10-year average. Overall, costs related to Flooding, Hurricane and Other hazards are expected to increase materially, with region 2 being the most susceptible to these natural hazards.

Loss of income

Storslysia's median household income and population were projected by applying the IPCC's GDP and worldwide population projections (IPCC, 2021) over current census figures, under low and high emission scenarios. Key assumptions were established to estimate the total loss of income costs:

- The proportion of individuals whose income is affected equals the proportion of projected property damage within each region.
- Affected individuals are eligible to receive an income stream payment of 75% of the median household income in their region of residence for up to 8 weeks.

Figure 3 – Expected loss of income payments under both timeframes and scenarios.

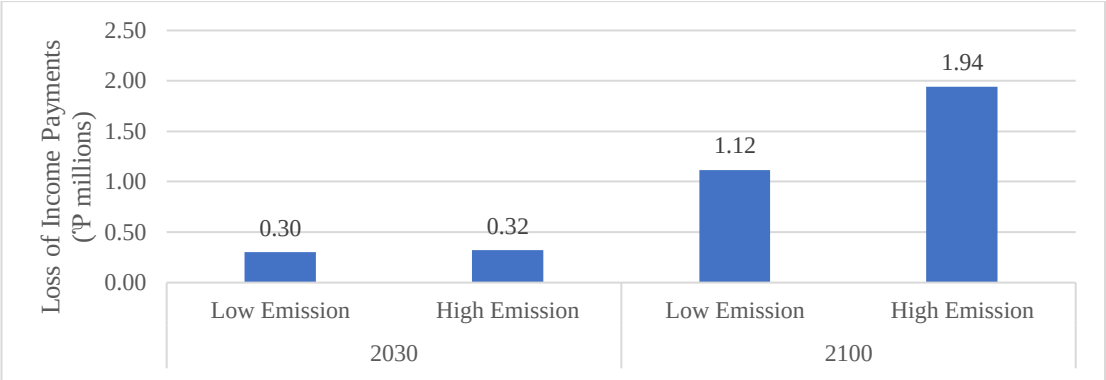


Figure 3 displays a similar trend to Figure 2, with loss of income payments increasing significantly in 2100 in both scenarios. This is primarily driven by the significant increase in both natural hazard frequency and severity in the future, with no effective mechanisms, such as voluntary relocation, to mitigate the climate risks.

Overall costs compared to GDP

Table 4 – Total projected costs expressed as a percentage of projected GDP.

	Low Emission Scenario		High Emission Scenario	
Year	2030	2100	2030	2100
Costs (% of GDP)	14.66%	26.17%	15.95%	89.98%

As observed from Table 4, without the Program's proposed voluntary schemes, the costs of natural hazards far exceed the target cost of 10% of Storslysia's GDP. Most notably, under the high emission scenario, costs more than double the projected GDP by 2100, driven primarily by the significant increase in property damage costs.

These estimated figures provide a benchmark for assessing the economic impact of the proposed program, which will be discussed in the following sub-section.

With the program

The proposed program consists of both an involuntary scheme and a voluntary scheme, with the involuntary scheme behaving largely the same as described above. Table 5 summarises the average annual property damage divided by the total housing units in each region expressed as a proportion. From the analysis:

- Regions 2 and 5 account for more than two-thirds of total proportional property damage.
- Regions 4 and 6 are moderately affected by natural disasters.
- Regions 1 and 3 experience very little proportional damage from natural disasters.

Hence, our analysis shows that the voluntary scheme aims to relocate households in high-risk areas of regions 2, 4 and 5 to lower-risk regions 1 and 3. Region 6, which has a moderate risk of natural disasters, is neither eligible for voluntary relocation support nor considered a target for relocation. The decision to include or exclude certain regions from being targeted will depend on the application and climate risk trends in each area, which will be regularly reviewed.

Table 5 –Property Damage Per Region as a Proportion of Housing Units.

Region	1	2	3	4	5	6
Proportion	2%	33%	4%	14%	38%	8%

Property damage is used as the basis to calculate totals for voluntary relocation. Two thresholds are introduced being:

- Damage factor: defined as the average proportion of total property value that is damaged during natural disasters (10%).
- Time between incidents: defined as the number of years between incidents for a household at risk (30 years).

Factoring both thresholds, parameters are set for the scheme being that all households with a risk of damage higher than 10% of their total property value every 30 years would be relocated. Combined with the incentive of ₱1000 moving costs per household, the results from Table 6 are derived.

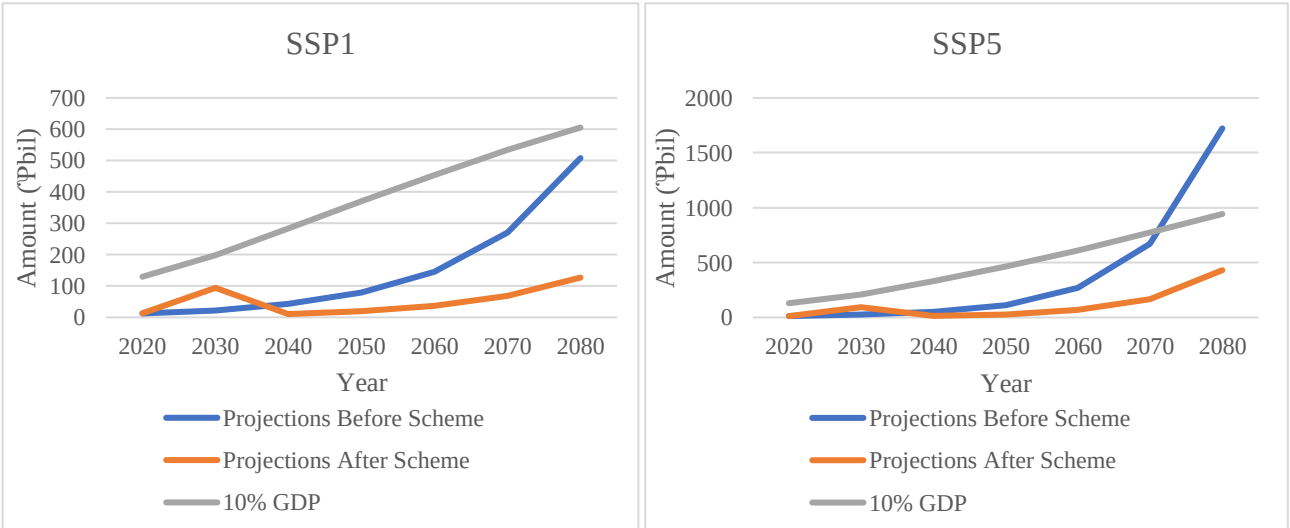
Table 6 – Voluntary Relocation Costs for Home Buy-Back Scheme

Year	Cycle Number	Voluntary Relocation	Cost
2023 and before	0	0%	₱0
2024 – 2025	1	15%	₱17,638,087,278
2026 – 2027	2	40%	₱47,034,899,408
2028 – 2029 +	3	75%	₱88,190,436,391

The remaining 25% of at-risk households not covered by the home buy-back scheme include households with property damage risk lower than the 10% of damage every 30 years. Analysis has concluded that below this threshold voluntary relocation of households would be more expensive than involuntary displacement support, should the event arise.

Modelling these factors over time, the upfront investment in voluntary relocation will significantly reduce associated involuntary displacement costs. Projecting with 25% voluntary relocation and 75% involuntary displacement we arrive at figure four below. In reference to budget constraints of 10% of annual GDP, projections show that annual spending on damages from climate-related catastrophes approach the budget cap under SSP1 development and exceed the cap in the early 2070s under SSP5 development. With the program in place, an initial spike in costs is observed but over time the effects of these disasters are successfully controlled for the foreseeable future in both future scenario extremes to within the 10% annual budget.

Figure 4 – Scheme Cost Projections Across SSP Scenarios



Assumptions

The IPCC's SSPs importantly highlight projections on population growth, economic growth, and Green House Gas (GHG) emissions. In calculating income projections, present-day figures are indexed in line with GDP growth as outlined by the four major SSP scenarios. These scenarios provide estimates for future GDP, but it is important to note that figures vary significantly between scenarios, affecting forecasts on Involuntary Displacement related income support.

Our calculations adjust for the effects of inflation, meaning all projected values can be directly compared in dollar amounts today. Where specified in the IPCC data, this adjustment is already performed so no further adjustment for inflation is considered. In all other scenarios, it was assumed that projected figures did not account for inflation. Annual future inflation figures were randomly sampled from the past 40 years of Storslysia inflation data and future figures were subsequently adjusted to the present day using these sampled rates.

To project the economic impact of the involuntary scheme, these key assumptions were made:

- Property damage estimates below a threshold of ₱250 were assumed to be ₱0 to account for the possibility that hazard events result in no property damage.
- Historical property damage included replacement of household items and housing repairs.

To project the economic impact of the voluntary scheme, these key assumptions were made:

- The median value of owner-occupied housing units reflects the median value of all housing units within each respective region.
- The median value of housing units will grow in line with inflationary expectations.
- The risk associated with a region is based on averages of past property damage totals.
- Lower-risk regions 1 and 3 have unlimited capacity to support new residents.

Lastly, the voluntary relocation model assumes households relocating to lower-risk regions are no longer part of the regional risk pool, with total costs behaving differently to its original households. Once sufficient data is collected after initial cycles of buybacks, this assumption will be revised to provide a more realistic cost estimate of the voluntary scheme.

Data and Data Limitations

Where inflation adjustments were made, the magnitude of future figures are significantly impacted by the sampling of past inflation data. If there were high initial inflation figures specifically, future amounts would be valued as substantially lower. These factors caused a degree of inconsistency within the results.

Additionally, the inflation and interest rate datasets given indicated very volatile experiences in the past, where inflation and the 1-year risk-free rate variance between a 20-year bracket of 2001 to 2021 was 3.76% and 5.41% respectively combined with alternating rise and fall experiences in inflation and interest rate between consecutive years. This presented difficulties in forecasting future interest and inflation rates correctly and thus a moving average of the past 10 years was chosen as this allows short-term economic fluctuations to be smoothed out and a more stable long-term trend to be projected. Where errors and inconsistencies in the dataset

were identified for example inflation rate of -999% in 2003, this was replaced by the average of the previous 10 years to prevent inaccurate projections.

Furthermore, it was challenging to predict future income, housing and population data with the limited data given. With data from only two previous years, this brought limitations to our projections such as difficulties capturing all possible future outcomes, assessing long-term trends and patterns accurately and considering unforeseen events. When projecting future income, housing and population data, trends were identified from the inflation and interest rate data given and used as a basis to make informed assumptions about the future.

Risk and Risk Mitigation Considerations

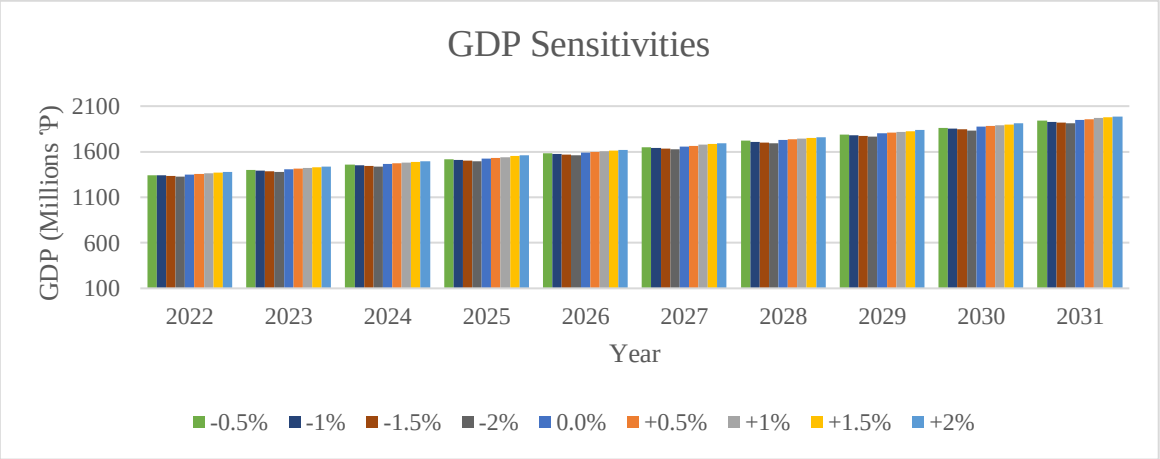
Below are potential key risks resulting from the social insurance program.

Description	Explanation/Mitigations
Incorrect model Impact: 5 Likelihood: 3	The highly uncertain nature of catastrophic events and the lack of sufficient data in Storslysia present modelling difficulties in projecting the future frequency and severity of future catastrophic events. Some of the parameters subject to fluctuations which could impact the scheme include: • Higher than expected inflation rates. • Faster growth in population density in risk-prone locations. • More severe catastrophic risk than expected. • More demand in the housing market, driving an inorganic growth in property prices. **Mitigations –** perform stress tests to ensure adverse scenarios are considered and assess Storslyia's risk profile in such events. The government can also consider acquiring vacant land to expand the housing market and infrastructure in response to housing shortages in a demanding housing market.
Moral hazard Impact: 5 Likelihood: 3	Some of Storslysia's citizens may be more likely to engage in risky behaviours with the implementation of the program. For example, individuals may be more inclined to report fraudulent data to receive payments from the scheme. **Mitigation –** implement constraints within the program such that people over a certain level of income are unable to claim from the program and for people who are claiming, the benefit would only be paid for a defined period.
Inadequate benefits Impact: 4 Likelihood: 2	Individuals in risk-prone regions face the risk of insufficient benefits to meet their needs during involuntary displacement. For example, due to the implementation of a maximum payout which is lower than the individual's salary in the income support scheme, individuals who are earning a below median salary might experience difficulties in supporting their needs in times of involuntary displacement. Considering this, inadequate benefits may exacerbate the number of individuals unable to recover from a catastrophic event despite receiving an income from the program. **Mitigation –** public-private partnerships could be established to utilise the resources and expertise in both the public and private sectors. For example, companies can be encouraged to provide monetary support to individuals who experience displacement due to catastrophic risks which is partially funded by the government.

Culture of dependence Impact: 4 Likelihood: 2	Individuals receiving income support can develop a culture of dependence on the program, where government assistance is relied upon rather than taking responsibility for their own financial wellbeing. **Mitigation** – to prevent a culture of dependence, the program will only be paid for a defined benefit period, which is aimed at encouraging displaced individuals to regain their financial independence within a set period.
Political Change Impact: 3 Likelihood: 3	The program may be terminated prematurely due to changes in political decisions. As such, individuals may experience a change in the level or availability of financial assistance in times of catastrophic events. **Mitigation** – adequate funding needs to be maintained to maintain the stability and longevity of this program, overall reducing political interference.

A sensitivity analysis was performed for inflation rates, to address the first risk of having an incorrect model and its subsequent impact on GDP as shown in Figure 5.

Figure 5 – GDP Projection Sensitivity Analysis



Holding all other variables constant, negative changes in inflation has a larger impact on GDP than a positive rise in inflation as seen in the graph, where a -2% change in inflation gives a ₱38.9mil change to GDP while a 2% change in inflation gives a ₱27.0mil change in GDP across all years. In turn, the less sensitive nature of GDP to higher inflation rates as compared to lower inflation rates suggests that Storslysia is more resilient to inflationary pressures, which is a favourable outcome in projecting future scheme payments compared to a less volatile GDP.

Recommendation

The devised program is strongly recommended within the suggested timeframe as it will ultimately reduce increasing future costs resulting from catastrophic climate occurrences to Storslysia's economy. The strong results were determined using GLM modelling and other projections under two climate scenarios. As displayed, the social insurance program incentivises voluntary relocation to achieve the target of restricting costs to 10% of Storsylia's yearly GDP, thus it is effective in obtaining the set-out objectives. We would also advise following the given metrics and frequencies to continuously monitor changes in the real world that could result in updates or adaptions in the program statistics.

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