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# A Study of the 2004 Indonesian Tsunami: The Effects on GDP Growth and Tourism Post-Disaster

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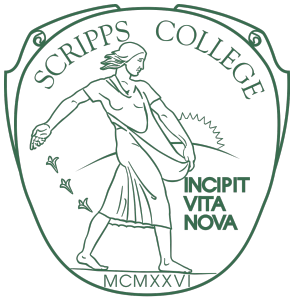
**by**

**VASUDHA JALAN**




**SUBMITTED TO SCRIPPS COLLEGE IN PARTIAL FULFILMENT OF THE DEGREE OF BACHELOR OF ARTS**

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**Abstract**

The 2004 Indian Ocean Tsunami caused 225,000 deaths and economic damages of a little bit less than $10 billion. In this paper, I look at the differences in resilience between the countries affected by this natural disaster and those that were not. By adopting a difference-in-differences regression model and looking at GDP growth rates and the amount of international tourism before and after this disaster, I find that there were no effects on GDP growth rates, while international tourism increased post disaster in countries affected by the earthquake. These results are interesting as previous literature finds negative impacts on GDP growth post-disaster. Increases in tourism can also be explained by the ideas of disaster tourism, dark tourism, and blue tourism; and these findings show us how increases in tourism can be used to boost economic activity post-disaster.

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# I. Introduction

The Indian Ocean Tsunami of 2004 was caused by an undersea earthquake of magnitude 9.1 that hit the coast of the Indonesian Island of Sumatra. There were more than 225,000 deaths recorded, and the countries primarily affected were Indonesia, Sri Lanka, India, the Maldives, and Thailand (Indian Ocean Tsunami of 2004, Encyclopedia Britannica). The earthquake caused the nearby ocean floor to rise by 40 meters, triggering a massive tsunami. Within 20 minutes of the earthquake, a 100-foot wave hit the shoreline of Banda Aceh and killed more than 100,000 people as a result. In succession, the tsunami waves moved towards the coastlines in Thailand, India, and Sri Lanka, killing and displacing even more people. The Tsunami moved 5,000 miles from its epicenter in Asia and reached coastal areas in South Africa (Reid, *2004* Indian Ocean Earthquake AND Tsunami: Facts, FAQs, and How to Help). This makes the 2004 Indian Ocean Tsunami one of the deadliest disasters in modern history.

The economic damage caused by a natural disaster varies depending on the intensity of the disaster, and the location at which the disaster occurs. Capital assets and infrastructure are affected as housing, schools, factories, and roads are damaged; and human capital is depleted due to the loss of life, workers, and the destruction of education infrastructure that disrupts schooling. There are also large costs associated with rebuilding the economy and the infrastructure that was damaged.

In this paper, I hope to answer the question of how different economies recovered at different rates after the 2004 natural disaster. In order to do this, I compare the Gross Domestic Product (GDP) growth rates and the international tourism receipts (in millions of $ U.S.) of the countries affected by the tsunami in order to analyze the economic resilience of these countries to the natural disaster. I aim to compare the countries affected by the tsunami to those that were not affected; and use the countries that were not affected as a control group to analyze the economic effects of the natural disaster.

The estimated cost of the damage from the 2004 tsunami was just under $10 billion (Indian Ocean Tsunami: Then and Now, BBC News), showing us the large economic impact that resulted from the disaster. There were economic damages (such as the destruction of assets) worth $5.597 billion and losses (due to changes in economic flows due to the disaster) worth $4.333 billion (Rego, Social and Economic Impact of December 2004 Tsunami) as a result of the tsunami across Indonesia, Thailand, India, Sri Lanka, and Maldives. After the 2004 tsunami, the

World Bank established the Study of the Tsunami Aftermath and Recovery (STAR) to examine how individuals, communities, and families were affected by and responded to the disaster in the short and medium term (Resilience and Recovery Ten Years after the 2004 Indian Ocean Tsunami: A Summary of Results from the Star Project). The study was designed to provide information on the short-term costs and longer-term recovery for people in very badly damaged communities in comparison to communities where the disaster had little direct impact. At Aceh, the epicenter of the earthquake, the economic recovery was a result of nearly $7 billion in contributions from the Indonesian government and international donors (Indonesia: A Reconstruction Chapter Ends Eight Years after the Tsunami).

In this paper, I define economic resilience as the ability and speed of an economic system to recover from a disaster shock (Taylor and Francis, Is tourism development a catalyst of economic recovery following natural disaster? An analysis of economic resilience and spatial variability). A country would be said to have "recovered" from the natural disaster when they reach the same rate of GDP growth and international tourism is as before the incident. Through the course of this paper I perform two econometric regressions to analyze the effect of the earthquake on GDP growth and international tourism. This paper aims to assess the causal impact of the tsunami on GDP growth and international tourism by using a difference-in-differences approach. In order to add to the broader literature in this field, this paper tries to classify this natural disaster as either one that aided economic growth by increasing GDP growth and tourism, or one that caused an economic decline.

The main findings of this research show that the tsunami had no effect on the GDP growth rates of the countries affected by the disaster, while international tourism receipts for the countries affected increased post disaster. These increases in tourism post disaster can be linked to the concepts of disaster and dark tourism, which refers to the act of visiting locations at which an environmental disaster has occurred. Benefits to an increase in visitation to these sites includes raising awareness of the disaster to the rest of the world and stimulating the economy. These factors can also be used by policy makers in the countries affected by the disaster to increase economic growth. By knowing that a natural disaster could increase the amount tourists spend in the country, governments can implement policies that boost the tourism sector post disaster in order to aid the country's recovery process.

# II. Literature Review

## a. Studies measuring the impact of a natural disaster

Natural disasters may result in serious consequences as they have an impact on human lives and wellbeing, cause the destruction of physical capital, and result in a loss of financial resources. Therefore, there are numerous ways of quantifying the impact of a natural disaster and its outcomes. A disaster with direct damages at the microeconomic level, such as the loss of life and property, can lead to cumulated damages on a macroeconomic level, such as lower economic output and production which can affect a country's economic growth long term (Panwar and Subir, 2019).

Natural disasters can result in an impact on the economic conditions of countries (Panwar and Subir, 2019; Padli et al., 2010). Padli et al. demonstrate that income plays a significant role in the economic impact of a natural disaster, and that wealthy nations and their citizens are more prepared, and therefore left better off, after a natural disaster compared to countries with lower levels of income.

Other studies have looked at economic effects of natural disasters by looking at income inequality (Keerthiratne and Tol, 2018), poverty incidence (Warr et al., 2019), and stock markets (Wang and Kutan, 2013). Keerthiratne and Tol study the impact of natural disasters on income inequality in Sri Lanka under the assumption that natural disasters disproportionately affect the poor. Their findings exhibit how natural disasters decrease household income inequality, and demonstrate how the rich are affected more by a natural disaster as their income is mainly derived from non-agricultural and non-seasonal agricultural activities. However, they also find that natural disasters do not affect household expenditure inequality. Their explanation for these results lies in the possibility that government handouts after a disaster caused the poorest to benefit the most, and result in them being disproportionately employed in the post disaster recovery effort. Warr et al. also study the impact of a natural disaster on income inequality and poverty. By comparing the household expenditures in Myanmar from 2005 to 2010, they are able to conclude that the 2008 cyclone that hit Myanmar reduced the poverty incidence in the country even though the average real consumption expenditures scarcely changed. Their study finds that the Gini coefficient of inequality declined from 0.265 to 0.220, and that the reduction in

inequality at the national level accounted for a large component of the decline in poverty incidence.

Wang and Kutan also analyze the economic effects of natural disasters, but do so by investigating the insurance sector and composite stock market of Japan and the United States (two countries that, due to their geographic location, have endured a large number of natural disasters in history). Their results find that there are no significant wealth effects in the U.S. and Japan composite stock markets, which indicates that these markets are able to diversify away from the impact of natural disasters on their stock returns. However, their results also find that there are significant wealth effects in the U.S. and Japan insurance sectors. In Japan, investors in the insurance sectors gain after a natural disaster, while in the U.S. the investors lose. These results are important as due to geography, investors in Japan and the U.S. face a high probability of experiencing a natural disaster; but the results from this study suggest that as impact is diversified away at the market level in both Japan and the US, investors do not need to panic in the event of a natural disaster. The results also show us that the insurance sector in Japan gains after a natural disaster while the U.S. insurance sector suffers.

Other studies that measure the impact of a natural disaster look at effects on migration, psychology, and domestic violence. Drabo and Mbaye find that there is a positive relationship between the occurrence of natural disasters and migration rates. By observing how the effect of natural disasters on migration rates in developing countries varies based on the level of education, they are also able to conclude that natural disasters only have an effect on the migration of people with a high level of education. Other literature explores how natural disasters can affect psychological distress and suicide rates. As populations affected by natural disasters develop mental health conditions at a faster rate than those not impacted (Horney et al., 2021), it is important to study the effects between natural disasters and mental health. Freedy et al. explore how resource loss after a natural disaster is positively related to distress and constitutes a risk for developing clinically significant psychological distress due to increased emotion and disengagement endured, and Horney et al. investigate the positive association of being exposed to a natural disaster with suicide rates in the United States. Exposure to natural disasters can also be seen to have a positive impact on the rates of interpersonal violence (Gearhart et al., 2018). The loss of safe housing resulting from a natural disaster and long-lasting

exposure to natural disaster was associated with an increase in simple assault reports in the state of Florida.

Previous literature also shows us how natural disasters can have conflicting effects on countries and their economies. Some effects of natural disasters could be beneficial to the economy by leading to positive growth effects (Loayza et al., 2009, Fomby et al., 2011), better capital stock, the adaptation of new technologies (Cuaresma, et al., 2008), and increases in tourism (Tucker et al., 2016, Lin et al., 2018). Other natural disasters can be seen to have adverse effects on insurance markets (Viscusi and Born, 2006) and infrastructure quality (Escaleras and Register, 2016).

Hallegatte and Dumas (2009) study the "productivity effect" that can arise due to the accelerated replacement of capital after a natural disaster. Their analysis finds that depending on the reconstruction quality post disaster, technical change can either increase or decrease disaster costs, but technical change cannot turn a disaster into a positive event. They also find that a slower reconstruction amplifies the short-term consequences of disasters, but does not benefit the countries in the long term.

Loayza et al. (2009) and Fomby et al. (2011) look at the relationship between economic growth and natural disasters. Loayza et al. (2009) find that disasters do not always effect economic growth negatively, and that moderate disasters can have positive effects of growth in some sectors of the economy. The findings from Fomby et al. (2011) reflect this as well – they find that some natural disasters have positive effects on economic growth, and that the effects of natural disasters are stronger for developing countries compared to advanced countries.

Other economists (Cuaresma, et al., 2008) research the correlation between natural disasters and long run economic growth by looking at the opportunities to update capital stock and adopt new technologies post disaster. Their findings show that only countries with relatively high levels of development can benefit from trade and by upgrading capital after a natural disaster.

Additionally, natural disasters can also lead to increased tourism post disaster; and can help generate income for the country and assist in the rebuilding of broken communities and infrastructure. This can be seen through disaster tourism (Tucker et al., 2016), dark tourism, and blue tourism (Lin et al., 2018). Disaster tourism can also be linked to disaster recovery (Tucker et al., 2016). By examining the tourism industry in Christchurch, New Zealand, following the major earthquakes of September 2010 and February 2011, Tucker et al. highlight how post-

earthquake tourism narratives can transition from a narrative of destruction and loss to one of hope and renewal.

Another explanation for an increase in tourism post disaster can be discussed using the concept of "Dark Tourism" (Dark tourism, explained: Why visitors flock to sites of tragedy). Dark tourism refers to the act of tourists around the world visiting some of the unhappiest places on Earth. This includes sites of accidents, natural disasters, or death. Some well-known destinations of dark tourism are the 9/11 memorial in New York, Auschwitz, and Chernobyl. By visiting areas in which dark events of human history have taken place, such as genocide, assassination, and disaster; tourists are able to experience emotions and empathize with the community impacted by such disasters.

The subset of dark tourism relevant to this study is disaster tourism. Disaster tourism is "the act of visiting locations that have been subjected to man-made or natural environmental disasters" (Disaster tourism explained: What, why and where). Disaster tourism is popular as people are interested in learning more about the world, as well as learning about communities that have lived through traumatic experiences. Two places that faced increases in tourism post-disaster are Kathmandu after the 2015 earthquake, and New Orleans after the 2005 hurricane.

Though post-disaster tourism is usually associated with dark tourism and death, in Japan the concept of Blue Tourism has also been coined (Lin et al., 2018) in the coastal area of Minamisanriku as a community-led approach to post-disaster tourism development. Blue Tourism includes non-dark tourist activities that concentrate on the beauty of nature, environmental sustainability, and the development of tourist experiences. Their paper argues that Blue Tourism is not a subset of Dark Tourism, but is instead a form of resilience that builds around local practices and traditional community knowledge. Therefore, Blue Tourism is also capable of achieving sustainable disaster recovery and tourist satisfaction simultaneously.

Negative effects of natural disasters can also be seen through Viscusi and Born's (2006) research on insurance markets and Escaleras and Charles' (2016) analysis on the quality of a country's infrastructure. Viscusi and Born look at homeowners' insurance by state, firm, and year from 1984 to 2004 to understand the effects of natural disasters on insurance companies, and find that disasters have adverse effects on both insurance companies as well as those insured. Escaleras and Charles' research also shows a negative impact of natural disasters, as they find that there is a negative and strong relationship between a country's infrastructure quality and the

deaths due to disasters. This shows us how investments in high-quality infrastructure would result in positive returns when disasters strike.

b. Studies measuring economic resilience

Economic resilience is used to assess the speed and ability of an economic system to recover from a disaster shock (Cheng and Zhang, 2020). Regions with stronger economic power tend to experience less economic loss and require less time to recover from disaster shock than regions with weaker economic conditions (Cheng and Zhang, 2020).

In measuring a country's economic resilience, important factors to analyze include foreign capital inflows (Uminski and Borowicz, 2021), GDP growth (Jose and Maza, 2020), tourism (Cheng and Zhang, 2020), and employment levels (Ringwood et al., 2019). Uminski and Borowicz perform a comparative analysis of foreign inflows versus foreign direct investment in the Polish economy to understand whether Poland benefits from their proximity to large investors in neighboring countries. The results of their analysis show that an increase in foreign capital has a positive effect on the post-pandemic recovery of Poland. The level of resilience in an economy may depend negatively on the construction and manufacturing sectors from the country's GDP and have a positive impact from the service sector of GDP (Jose and Maza, 2020). Through their research, human capital is also shown to be an important variable in order to minimize the negative effect of a crisis on an economy.

Cheng and Zhang investigate if tourism stimulates economic recovery after the Wenchuan earthquake shock in order to measure economic resilience. They do so by creating an index system of economic resilience, and through their analysis conclude that countries with tourism-based economic models have a lower resilience index but higher average growth rate than those without. This means that tourism development stimulates economic activity, and indicates that tourism development may promote economic growth and resilience. Other economists (Ringwood et al., 2019) analyze the effects of employment levels on economic resilience by developing a two-dimensional quantitative measure of resilience using observed differences between actual and expected employment in a region following a shock. Their results demonstrate how different regions of the United States responded to the shock of the Great Recession in terms of resilience, with county local recessions lasting longer than the national recession (Ringwood et al., 2019).

c. Studies on the economic resilience to natural disasters

Academic literature on the economic resilience of a country after a natural disaster finds that the measurement of resilience is important as it allows economists to evaluate strategies in order to reduce economic losses from disasters (Rose, 2004). By introducing a computable general equilibrium model, Rose evaluates how his framework is essential to analyzing the behavior of markets, businesses, and individuals. A CGE model works by combing economic theory with real economic data in order to computationally derive the impacts of policies or shocks in the economy. This study also emphasizes the importance of measuring resilience by concluding that failing to incorporate resilience in economic loss estimation will result in escalated estimations of losses in disasters, and a failure to incorporate resilience in policy making would result in bypassing opportunities that could further reduce losses. Other economists study the resilience of an economy by looking at the effects of terrorist attacks and natural disasters on business interruption and property damage. They argue that one of the most prominent indicators of resilience is the ability for a business to reschedule to recapture lost production after a disaster (Park et al., 2010). Their results indicate that resilience to a disaster is dependent on three factors - the length of business interruption, the state of the damage, and the location. A longer length of business interruption and larger state of damage would lead to a lower recovery rate of production.

Stefania and Lazzeretti (2018) analyze the major earthquakes in Japan in order to measure the economic resilience to natural disasters. By adding to the existing literature and discussion about regional economic resilience, they are able to construct indices of resistance and recovery for Japanese prefectures that were affected by major earthquakes, and able to draw connections between the measure of economic resilience to changes in employment due to the event of a natural shock or disaster.

One study performed by Xie et al. (2018) analyzes the role of dynamic economic resilience to the economy's recovery from the Wenchuan earthquake of 2008. This study develops a computable general equilibrium model and finds that the incorporation of resilience strategies during economic recovery could have significantly reduced GDP losses from the Wenchuan earthquake by 47.4% between 2008 and 2011. This could have been done by accelerating the pace of recovery post disaster by one year, and therefore reducing a large percentage of losses.

This study also further adds to the emphasis on the importance of measuring economic resilience after a disaster takes place.

### d. Studies analyzing the effects on GDP Growth and Tourism Post-Disaster

Growth theory predicts that an impact of a natural disaster should lower GDP per capita (Gabriel and Gröschl, 2014). In their paper, Gabriel and Gröschl build a database of natural disasters and their intensities in order to test the growth effects of natural disasters. Their findings reveal a substantial negative and robust average impact effect of natural disasters on a country's growth. Their results indicate strong negative growth effects of natural disasters on GDP, and they conclude their paper by saying that poorer countries are affected more strongly by geophysical disasters compared to rich countries.

Other studies also analyze the impact on GDP after a natural disaster (Guglielmo and Mocetti, 2014; Hochrainer, 2009). Guglielmo and Mocetti examine the effect on GDP per capita after two large earthquakes in Italy. Their results indicated negligible effects on GDP in the short run for both earthquakes, but they find that in the long run there was a positive impact on GDP per capita for one earthquake, and a negative impact for the other earthquake. Their results also find that by observing GDP in the absence of financial aid received, there is a negative impact on GDP for the country. This shows us that financial aid plays an essential role in post disaster recovery, and is an important variable to include in our study. Hochrainer also assesses the macroeconomic impact of natural disasters, and reaches the conclusion that there is a negative effect of large natural disasters on GDP. This paper also tests the impact of international aid inflows, and is able to show that a greater inflow of aid reduces the adverse macroeconomic consequences of natural disasters.

Other economists have studied the effects following a natural disaster through the lens of the tourism industry (Rosselló et al., 2020; Barbhuiya et al., 2020; Tsai et al., 2011). Rosselló et al. perform a global evaluation of the impact of natural disasters on international tourism flows. Their results find evidence of different natural disasters affecting the tourism industry differently—volcanic eruptions had the greatest negative impact on international tourism flows, while droughts did not show a significantly negative relationship between the disaster cost and tourism. Their analysis on earthquakes and tsunamis showed that all the significant parameters studied were negative, indicating that these disasters act as negative motivators to potential

visitors. Therefore, the findings of this study presented evidence of natural disasters in a country negatively affecting international tourism arrivals.

Another study analyzing the effects of natural disasters on the tourism sector in India (Barbhuiya et al., 2020) finds that natural disasters have a negative effect on foreign tourists, and analyzes tourism resilience post natural disaster by identifying breaks in tourist arrivals and studying corresponding recovery times. This study examines the effects of natural disasters on domestic and foreign tourism in 22 Indian states, and concludes that more states suffered from breaks in foreign compared to domestic tourist arrivals after a natural disaster, and the time to recover was greater in foreign tourist arrivals than domestic tourism trends. Tsai et al. (2011) also look at the tourism industry after a natural disaster, and study the effects of natural hazards on Taiwan's tourism industry after the 2009 typhoon damaged the Alishan National Forest Area in Taiwan. This study shows that Alishan's tourism industry suffered losses worth NT$1 billion, and their analysis goes on to provide policy-making suggestions for future sustainable development in that area.

Bauman et al. (2019) develop a measure to assess tourist's empathy towards natural disasters, as a way to explain increases in tourism post disaster. Their study explores the relationship between the California wildfires and the wine tourists at California wineries. One of the major outcomes of the paper shows how empathy influences tourists' intent to revisit a destination impacted by a natural disaster, and the importance of allocating more resources to attract tourists to destinations where they are willing to support the regions that are affected.

This paper contributes to the body of existing literature by comparing countries affected by the 2004 Indonesian tsunami to those that were not affected. By comparing the rates of resilience and growth of the countries affected by the earthquake to those that were not affected, and looking at how long it took countries to return to their levels of growth, this paper aims to answer the question of how the natural disaster left the countries impacted. Previous literature has found that different natural disasters have left countries better off, worse off, or at the same growth level as before being struck by a natural disaster. In this paper, I look at the GDP growth rates and amount of international tourism to determine countries' resilience to the 2004 Indonesian tsunami. Through the course of the paper I hope to analyze whether this natural disaster left

countries better or worse off in terms of economic growth and tourism, and my analysis will allow me to look at how long the impacts persisted.

# III. Data and Results

## a. Qualitative Description of Data

The panel data set used in this paper was compiled from data by The World Bank. The World Bank works closely with international statistical agencies such as the United Nations (UN), the Organization for Economic Co-Operation and Development (OECD), and the International Monetary Fund (IMF) to collect the data provided. The data collected in this study ranges from 10 years before the earthquake to 14 years after the earthquake (1994-2018). The 21 different variables studied include the GDP per capita and unemployment rates, found to be important in Xiao and Feser's (2013) paper about the unemployment impact of the 1993 US Midwest flood.

Other variables used in this study include the foreign direct investment, the net official development and aid assistance received (these variables were used by Hochrainer (2009) and Guglielmo and Mocetti (2014)), and international tourism rates (Rosselló et al., 2020) for the 5 countries affected by the earthquake and the 15 countries that act as the control group. The 15 countries acting as the control group in this study are characterized as countries that followed similar growth trajectories to the countries affected by the earthquake prior to the disaster. Other interesting variables looked at while researching this study are the school enrollment rates (Rush, 2018) and the poverty headcount ratio (Warr et al., 2019). Three variables that were removed from this study were data on social insurance programs, research and development expenditure, and the population living in slums in these countries. These three variables had to be dropped as there were many gaps in the data available, which led to the number of observations in the regression to decrease and the countries with missing data could not be considered in the regression analysis.

Two indicator variables were created from the dataset. The first variable distinguished between countries that were affected by the earthquake with those that were unaffected. Countries affected by the earthquake are called the "Treatment" group, and were given a value of 1, and those in the "Control" group were given the value of 0. The second indicator variable compared the time period being studied, with years after the earthquake being coined "Post" and being given a value of 1, and years before the earthquake being given a value of 0.

The two outcome variables used in this study are the GDP Growth rate as an annual percent change and international tourism as the receipts in current US dollars gained by the country due to tourism.

The research discussed in the literature review shows us the importance of using GDP growth rates and tourism as variables to analyze the economic impacts following a natural disaster. In this paper, I start by looking at the GDP growth rate as an outcome variable, and then analyze international tourism as an outcome variable as well. International tourism in this paper is defined as the receipts in current US dollars gained by the country due to tourism. The variable international tourism has been scaled to the unit millions of US dollars in order to report significance of results.

b. Quantitative Description of Data

In this study, I first look at the GDP growth rate as an annual percentage in order to analyze the economic resilience of the countries affected by the 2004 Indonesian Tsunami. Based on economic literature discussed earlier in this paper, my hypothesis is that the earthquake would cause a reduction in the economic growth of the countries, and we would therefore be able to see a declining growth rate for GDP.

Table 1 presents the average GDP growth, unemployment rate, amount of aid received, and international tourism receipts over the time period of this study. This table shows us the amount by which each listed country grew depending on the variable between the years 1994 and 2018. For example, Bangladesh's GDP grew by 5.7%, and the country's unemployment rate grew by 3.9% over that time period.

**Table 1: Table of Average Means (1994-2018)**

| Country | Mean GDP Growth (Annual %) | Mean Total Unemployment (% of Total Labor Force) | Mean Aid Received (Millions of Current US$) | Mean International Tourism (Receipts (Millions of Current US$)) |
|---|---|---|---|---|
| Bangladesh | 5.713 | 3.947 | 1600.000 | 143.757 |
| China | 9.320 | 3.746 | 1060.000 | 18173.630 |
| Hong Kong SAR, China | 3.477 | 4.258 | 9.149 | 23642.190 |

| | | | | |
|---|---|---|---|---|
| India | 6.651 | 2.960 | 2030.000 | 13819.940 |
| Indonesia | 4.646 | 5.668 | 932.000 | 8865.647 |
| Japan | 0.959 | 4.070 | | 15097.920 |
| Kenya | 4.241 | 8.080 | 1370.000 | 1238.333 |
| Malaysia | 5.281 | 3.241 | 40.500 | 13695.420 |
| Maldives | 5.972 | 4.886 | 39.100 | 2548.375 |
| Mauritius | 4.276 | 7.758 | 61.500 | 1308.083 |
| Myanmar | 9.287 | 1.067 | 604.000 | 574.208 |
| Nepal | 4.534 | 4.428 | 627.000 | 338.833 |
| Pakistan | 4.191 | 4.117 | 1810.000 | 788.625 |
| Peru | 4.931 | 4.881 | 377.000 | 2188.542 |
| Philippines | 5.039 | 5.238 | 500.000 | 3884.333 |
| Seychelles | 3.364 | 5.440 | 19.300 | 344.000 |
| Singapore | 5.587 | 4.197 | 7.005 | 10927.250 |
| South Africa | 2.750 | 26.908 | 804.000 | 7379.667 |
| Sri Lanka | 5.223 | 7.034 | 427.000 | 1569.292 |
| Thailand | 3.732 | 1.305 | 155.000 | 23840.880 |

Figures 1-4 show the data represented in Table 1 graphically. Through this, we are able to identify outliers in the data. China is one example of an outlier while looking at GDP growth rates, having a much larger mean GDP growth rate over the time period (9.32%) compared to the rest of the countries. We are also able to identify South Africa as an outlier in the unemployment data set, with a mean unemployment rate of 26.91%.

**Figure 1: Mean GDP Growth by Country**

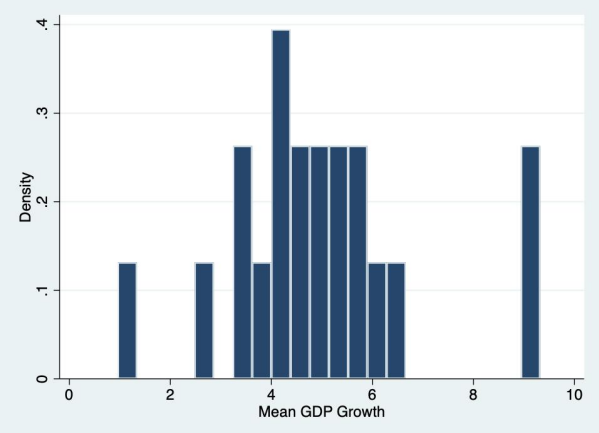



**Figure 2: Mean International Tourism (receipts (current US$)) by Country**

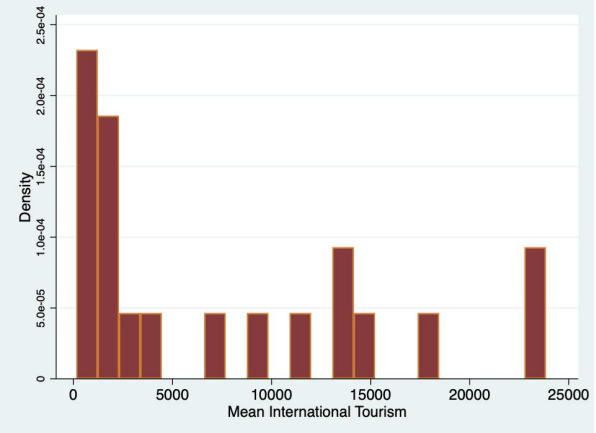


**Figure 3: Mean International Aid Received by Country**

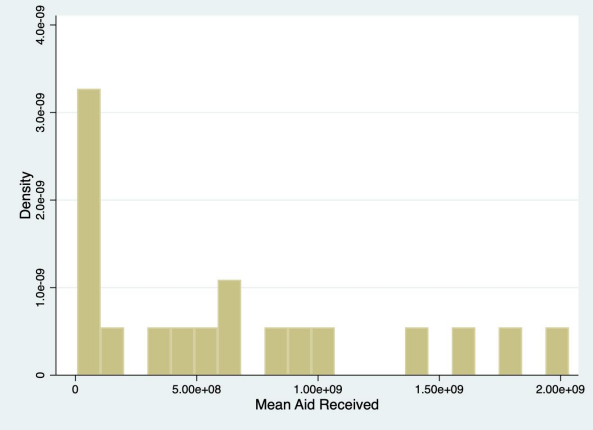
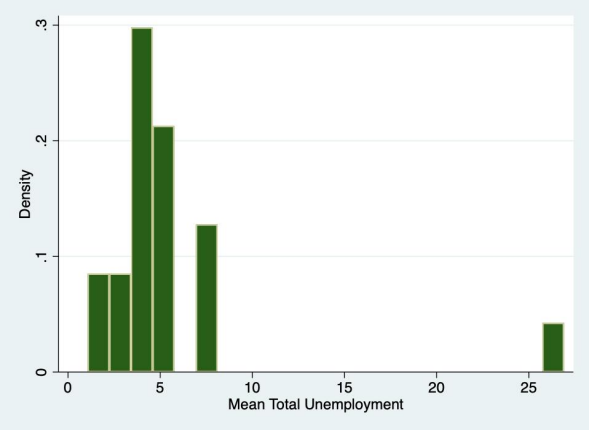



**Figure 4: Mean Total Unemployment by Country**




Note: Figures 1-4 were generated using the "histogram" command on Stata and edited using the graph editor tool.

Pre-regression analysis of the summary statistics indicates that there is no significant relationship between the GDP Growth rate before and after the earthquake for the countries affected by the tsunami. By comparing the countries affected by the earthquake to those that were not affected, we can see that the trends in GDP growth followed a similar trajectory both before and after the earthquake. The trend of GDP growth over time can also be seen in Figure 5, where countries affected by the earthquake are compared to those that were not affected. This graph shows us that the countries affected by the earthquake followed a similar trend to those that were not affected both before and after the natural disaster.

**Figure 5: GDP Growth Pre and Post Disaster**

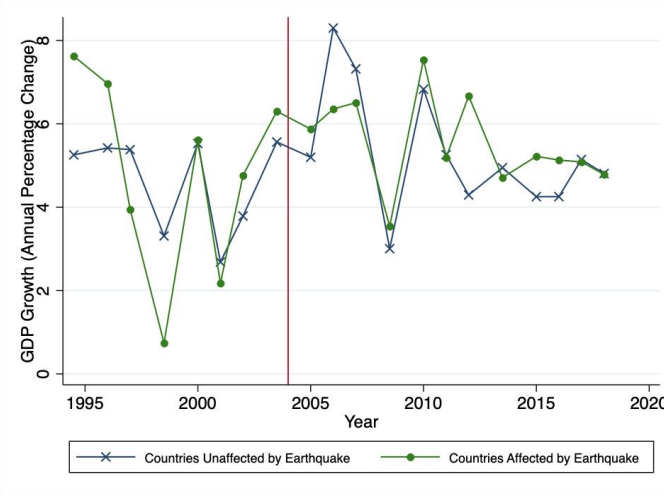
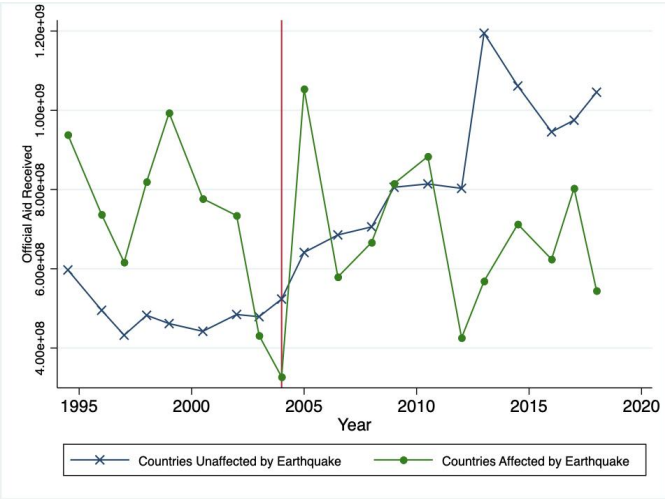



**Figure 6: Increase in Aid Post Disaster**




Note: Figures 5 and 6 were generated using the "binscatter" command on Stata and edited using the graph editor tool

Figure 6 graphically represents the differences in international aid received by countries that were affected by the earthquake and those that were not. The spike in aid in 2005 for countries affected by the disaster show us the effect of the earthquake, and also show us that aid received is an important variable to control for during this analysis. Another reason to control for aid received post disaster can be seen in Kligerman et al.'s (2015) paper about international aid and natural disasters. They study the 2010 Haiti earthquake, and find that the time period after the earthquake had an increase in total number of healthcare and surgical facilities. They also find that the driving force behind the recovery in healthcare in Haiti was due to an increase international aid.

c. Empirical Analysis

The method used in this study is a difference-in-differences analysis. A difference-in-differences (DiD) technique uses data from treatment and control groups in order to estimate the effect of a specific event by comparing the changes in outcomes over time between a population that is affected by the event (the treatment group) and a population that is not (the control group). A DiD model assumes that the treatment and control groups have a similar trend before the event

and removes biases in post-event period comparisons between the treatment and control group that could be the result of permanent differences between those groups, as well as biases from comparisons over time in the treatment group that could be the result of trends due to other causes of the outcome (Difference-in-difference estimation).

In this study, the countries in the treatment group are Indonesia, India, Thailand, Sri Lanka, and Malaysia. The countries in the control group are the Philippines, South Africa, Pakistan, China, Hong Kong, Singapore, Peru, Bangladesh, the Maldives, Mauritius, Kenya, Japan, Seychelles, Myanmar, and Nepal. The countries in the control group were chosen due to their similarities in economic growth prior to the earthquake compared to the countries that were affected by the tsunami (the treatment group). The similarities in trajectories of GDP growth between the countries affected versus those unaffected prior to the earthquake can be seen in Figure 5. The Stata command of "diff" used in this study accounts for the fixed effects in order to keep the country and year constant. A fixed effects effect regression is an estimation technique used while analyzing panel data that allows us to control for time-invariant characteristics that could be correlated to the independent variables. By employing this technique, we are able to remove omitted variable bias by measuring changes in groups across time. A country fixed effect is used in a similar manner in order to create a country specific intercept in the regression model that does not vary over time.

Economists have used the DiD approach to look at the effects of natural disasters on economies and communities. Ayumu (2015) studies the impacts of the Great Hanshin-Awaji earthquake on plant growth in Kobe using the DiD approach. By distinguishing between the affected and non-affected plants in the region, the author is able to conduct a DiD analysis based on the hypothesis that natural disasters enhance the growth of plants in affected areas. Similarly, Mottaleb et al. (2013) studies the volatility in rice income caused by crop failures as a result of natural disasters, and applies the DiD estimation method in a natural experimental setting. Economists also use DiD strategies within a regression framework in order to look at the variation on the incidence of natural disasters across municipalities in Mexico (Rodriquez-Oreggia et al., 2013). By creating pre- and post-disaster welfare outcomes and covariates, and controlling for different sets of pre-shock variables, their DiD analysis shows a significant and adverse effect of natural disasters on poverty and human development.

Barth et al. (2021) study the application of difference-in-differences strategies in finance by looking at banks raising deposit rates to encourage deposits and meet the demands for loans as a result of rebuilding that takes place in light of natural disasters. This study tests three variations of the DiD model, starting with comparing branches of banks in countries experiencing natural disasters to adjacent countries not experiencing disasters. The next DiD model estimates different sets of matching variables for bank branches in two types of countries, and the last DiD model compares branches in which the pre-disaster common trend was satisfied versus where it was not satisfied. The DiD approach can also be used to look at the effects of natural disasters on housing prices (Kiel and Matheson, 2018). The model in this paper analyses whether house buyers in areas of different risk levels prior to the fire adjust their expectations differently after a fire. Their findings reveal that buyers in the highest risk area are most likely to change their perceptions in response to a fire.

Though there are various methods and models that can be used to measure the economic impacts of natural disasters, in this paper I focus on a difference-in-differences approach.

d. Regression Equation

I estimate the impact of the 2004 earthquake on GDP growth and international tourism using the following regression model:

$$\mathbf{Y_{it} = \beta 0 + \beta 1*[Treatment_i] + \beta 2*[Post_t] + \beta 3*[Treatment*Post] + \beta 4*[X_{it}] + \beta 5*[Country\ Fixed\ Effects_i] + \varepsilon_{it}}$$

Where *i* and *t* represent the country and year, respectively. In this study, two specifications are considered, with the dependent variable $Y_{it}$ coming in two flavors, $Y_{it1}$ and $Y_{it2}$. $Y_{it1}$ is GDP Growth as an annual percentage and $Y_{it2}$ is international tourism as the number of receipts in US dollars. The year *t* represents the period from 1994 to 2018. The independent variables in this study are the treatment group, which varies by country, whether the time period is post-disaster, and the interaction term between the treatment and post variables. The independent variables in this study, represented by $X_{it}$, are the amount of aid received by the

country, net foreign direct investment, and the number of tourist arrivals to the country. The number of tourist arrivals to the country (an independent variable) is different from $Y_{it2}$ (a dependent variable) as the tourist arrivals accounts for the number of people who enter the country, compared to $Y_{it2}$ (international tourism) which refers to the receipts in current US dollars gained by the country due to tourism. In this study, the number of tourist arrivals to the country is only used as a control in the model using $Y_{it1}$ (GDP growth as the outcome variable), and not in the model using $Y_{it2}$ (international tourism as an outcome variable).

e. Results and Discussion

Table 2 displays the results of the regressions of the Difference-in-Differences model using GDP growth as an outcome variable. Column I presents a regression not controlling for any covariates. This is done through the Stata command "diff GDPGrowth, t(Treatment) p(Post)". The "diff" command on Stata is used for all the DiD regressions in this paper. From this, we are able to see that the difference in GDP growth between the countries in the treated and control group due to the earthquake is 7.1%. This value is not significant as the p-values for the coefficient estimates are greater than 0.1. The $R^2$ for this regression is only 0.01, telling us that only 1% of the observed variation can be explained by this model. As we include controls, we can see the value of $R^2$ increase.

Column II in the table compares the GDP growth rate for the treatment and control group before and after the earthquake while controlling only for the foreign aid received. Figure 6 shows us an increase in foreign aid received by the treatment group post disaster, and therefore controlling for it would allow us to create a more accurate model. The results from column II also do not show statistical significance, as the p-values for the coefficient estimates are greater than 0.1.

Column III of the table controls for all the covariates used in this study. The results show that there was a 35.5% change in GDP growth between the treatment and control group before the earthquake, and a difference of 61.8% after the earthquake. This gives us a difference of 26.3% in GDP growth rate before and after the earthquake took place, but this value is still not significant based on the p-values of the coefficient estimates.

Column IV controls for all variables in the study, except international tourism. This again yields no statistical significance. The value of $R^2$ can be seen to increase to 0.08, showing us that 8% of variation in the observations can now be explained using this model.

**Table 2: Regression Results using GDP Growth as the Outcome Variable**

| | I | II | III | IV |
|---|---|---|---|---|
| Difference in Treated and Control | 0.165 | -0.164 | 0.355 | -0.336 |
| Before the Disaster | (0.560) | (0.558) | (0.572) | (0.582) |
| Difference in Treated and Control | 0.236 | -0.192 | 0.618 | -0.100 |
| After the Disaster | (0.495) | (0.505) | (0.572) | (0.501) |
| Diff-in-Diff | 0.071 | -0.028 | 0.263 | 0.236 |
| | (0.747) | (0.754) | (0.776) | (0.768) |
| No Controls | X | | | |
| Controls: | | | | |
| Aid Received | | X | X | X |
| Net Foreign Direct Investment | | | X | X |
| Number of Tourist Arrivals | | | X | X |
| International Tourism (Receipts) | | | X | |
| $R^2$ | 0.01 | 0.02 | 0.07 | 0.08 |
| Observations | 498 | 444 | 352 | 408 |

Note: Inference: *** p<0.01; ** p<0.05; * p<0.1

All regressions include Country Fixed Effects. Standard Errors reported in parentheses.

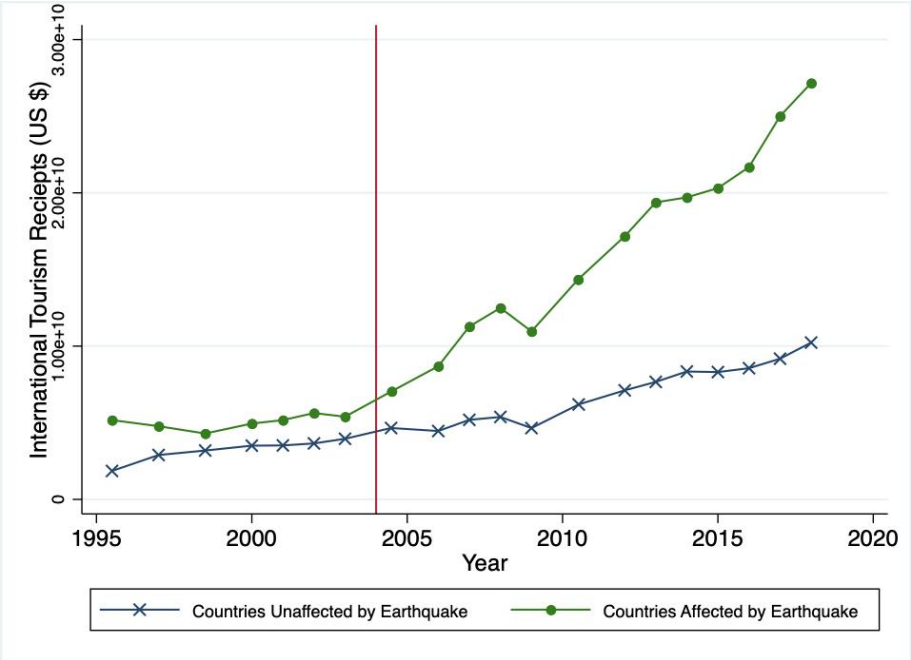
One explanation for no apparent impact on GDP growth can be explained by the article "How Natural Disasters Affect U.S. GDP" (Sweet, 2017). In this article, Sweet studies the economic impacts of Hurricane Harvey and argues that economic costs would not be accurately measured in national or regional statistics. He also looks at the effect of GDP growth after Hurricane Katrina, and shows how though the cost of the disaster was 0.86% of US GDP, there was no discernible impact on GDP growth. This is because of what GDP measures. Though GDP measures the country's current production of goods and services, it is not directly affected by the loss of property, vehicles, and capital that was produced before.

Another reason that can be used to explain the lack of impact on GDP growth after the 2004 disaster can be the increase in tourism receipts per US dollar. Figure 7 shows us the

increase in international tourism measured in receipts per US dollar after the natural disaster in the treatment group. This is especially interesting as previous literature (Rosselló et al., 2020) predicts a decrease in tourism post disaster.

In Figure 7, we can also see that both the control and treatment group followed a similar trend in international tourism receipts before the earthquake. However, after the disaster, the trajectory of international tourism in the countries affected increased by a greater amount than in those not affected. This means that after the 2004 disaster there was an increase in the real amount spent per tourist in the countries affected by the disaster.

**Figure 7: International Tourism Pre and Post Disaster**




Note: Figure 7 was generated using the "binscatter" command on Stata and edited using the graph editor tool

Table 3 shows us the regression results using international tourism as the outcome variable in this study. Column I does not control for any covariates. This regression shows a statistical significance after the disaster, as well as in the difference-in-differences model. The results show us that before the earthquake the difference in international tourism receipts between the control and treatment group was $1.93 billion, and after the earthquake it was $9.64 billion. This gives us a difference of $7.71 billion, which is significant at the 99% level.

As there was an increase in foreign aid received in the affected countries post disaster, which can be seen in Figure 6, a more accurate model would control for the variable of aid received. This can be seen in column II of Table 3. Even after controlling for aid received, we can see a statistical significance before, after, and in the difference between the time periods for international tourism. To further this analysis, we can also remove India from the group of treated countries, as the impact of the tsunami was mainly on the southern and western regions of the country, and had a low impact in north India where tourism is also highly prevalent. The results of this regression can be seen in column III of Table 3, and can be interpreted to be significant after the earthquake, as well as in the difference between the time periods. After the earthquake, the difference in international tourism receipts between the countries affected (excluding India) and unaffected by the earthquake is $9.3 billion. The difference between the international tourist receipts before and after the earthquake is $7.2 billion. Both of these values are significant at the 99% level, showing a positive impact of the natural disaster on the level of international tourism in affected countries.

**Table 3: Regression Results using International Tourism as the Outcome Variable**

| | **I** | **II** | **III** |
|---|---|---|---|
| Difference in Treated and Control Before the Disaster | 1938.274<br>(1689.630) | 2262.132*<br>(1255.108) | 2101.635<br>(1805.663) |
| Difference in Treated and Control After the Disaster | 9644.514***<br>(1302.246) | 1.4e+04***<br>(1006.799) | 9324.160***<br>(1408.880) |
| Diff-in-Diff | 7706.240***<br>(2133.235) | 1.2e+04***<br>(1609.011) | 7222.525***<br>(2290.276) |
| No Controls | X | | X |
| Control for Aid Received | | X | |
| Countries | All | All | All Except India |
| $R^2$ | 0.18 | 0.38 | 0.16 |
| Observations | 420 | 367 | 404 |

Note: Inference: *** p<0.01; ** p<0.05; * p<0.1

Standard Errors reported in parentheses.

As mentioned in the literature review, tourism can increase following a natural disaster. Some reasons for this include increases disaster tourism (Tucker et al., 2016), dark tourism, blue tourism (Lin et al., 2018), and poverty tourism.

Another reason that could explain the high levels of tourism after the 2004 tsunami could be the use of tourism development as a disaster relief effort. A study by Liu-Lastres et al. (2020) looks at the case study of Aceh, Indonesia after being struck by a natural disaster and developing tsunami tourism as a strategy to recover. Their findings reveal how tourism can contribute to different community assets and create a resilient destination in the aftermath of a crisis. This study also shows us how in recent years a growing number of destinations have incorporated tourism development as a post disaster strategy, and as a result have enhanced community livelihood and built resilience.

# IV. Conclusion

## a. Summary and Discussion

In this paper, 24 years of data were analyzed in order to determine the relationship between the GDP growth rates and international tourism receipts between the countries affected by the 2004 tsunami and those that were not affected. This study aims to determine the resilience of the countries affected by looking at when GDP growth rates and international tourism returned to the same rate as pre disaster. The analysis found that the GDP growth rates for countries affected by the disaster followed the same trend as the countries acting as the control group post disaster. This, along with insignificant statistics in our regression analysis, shows us the little impact that the disaster had on GDP growth rates post disaster. A similar analysis was performed by looking at unemployment rates of the countries affected versus not affected by the earthquake, and the results show us how countries affected by the disaster followed the same trend as the countries that were acting as the control group post disaster. These findings show the lack of impact this natural disaster had on unemployment rates in the countries affected by the tsunami, and is the reason why unemployment rates were not used as an outcome variable in this study.

International tourism, however, can be seen to increase for the countries affected post disaster. This result is interesting as the countries affected by the earthquake had a much larger growth in international tourism after the earthquake than the countries that were unaffected by the earthquake. These results were backed up by the regression analysis performed for international tourism, which showed significance at the 99% level for the difference in international tourism in the group of countries affected by the earthquake before and after the earthquake.

My initial hypothesis was to look at the 2004 tsunami and assess whether it caused an economic boon or downfall for the countries affected. Through my analysis, I was able to find that this disaster did not affect GDP growth rates but had a significant and positive impact on international tourism. This is not enough information to determine whether the disaster had a positive or negative impact on the countries' affected economies. In order to expand this study, increasing the number of outcome variables to include measures of human development such as healthcare provisions and literacy rates would allow for a more holistic analysis on country's resilience to natural disasters.

b. Policy Implications

It is also important to look at how these results can affect government policies in the future. The analysis in this paper shows us that while the number of tourists arriving to the countries affected by the disaster was not statistically significant, the amount of real US dollars the tourists spent in the countries had a positive and significant impact post disaster. Therefore, it could be useful for governments and policy makers in these countries to know that a natural disaster in the future could lead to a greater amount spent by tourists in that country, and help mitigate the losses in GDP.

One policy that can be implemented by governments in the future is the use of tourism to rebuild the economy post disaster. Along with seeking foreign aid, governments could invest in tourism to generate revenue as well as rebuild their community. This can be seen through the implementation of measures that promote disaster tourism (Liu-Lastres et al. 2020) and how the use of tourism development can be seen as a disaster relief effort.

Disaster tourism can have both positive and negative impacts on the local community. Those who are suffering from loss after a disaster might not appreciate the influx of tourists witnessing their pain, and might view disaster tourism as a means of objectifying their suffering. However, disaster tourism can also be looked at through the lens of rebuilding the economy and encourage tourists to volunteer in the community as a rescue or aid mission.

Pottoroff and Neal (2010) also discuss how mitigative efforts and planning can help the tourism industry boost the economy post disaster. Their research shows how post disaster behavior can be influenced by factors such as altruism and mass convergence, and can positively affect the tourism industry. Similarly, Wright and Sharpley (2016) study the aftereffects of an earthquake on the Italian city L'Aquila, and find that an increase in dark (and disaster) tourism in the city has supported the disaster recovery process. This also shows us how resilience can be created as a result of efforts to increase tourism post disaster, as tourism can contribute to building community as well as generating revenue in the aftermath of a crisis.

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