

# The Economic Effects of Hurricane-Induced Deforestation on the Timber Industry of the Southeastern United States

## Research Question

How resilient is the timber industry of the southeastern U.S. to future changes in hurricane activity caused by climate change?

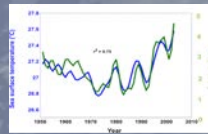
## Background

Of all the natural phenomena that affect our planet, hurricanes are among the most spectacular, walking a fine line between destructive and beautiful. From Australia to Bangladesh to the Gulf of Mexico, hurricanes form in the tropical regions around the world. In the Atlantic basin, hurricane season occurs from June to October, sharply peaking from late August through September. Most tropical storms do not grow to become full-fledged hurricanes. However, every several years a monster category 4 or 5 hurricane forms in the Atlantic basin and strikes the southeastern United States, causing devastating effects. An often-overlooked ramification of hurricanes, timber damage caused by a large hurricane can reach the billions. Given an IPCC A1B climate change scenario, cyclonic deforestation may increase significantly by 2100, causing individual land owners to potentially lose millions in damaged timber. The image below (left) shows a hurricane-damaged forest, while the map below (right) shows the path of Atlantic basin hurricanes, which usually form off the coast of Africa and move west towards the Gulf of Mexico.

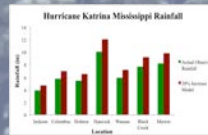


## The Effects of Climate Change on Hurricane Activity

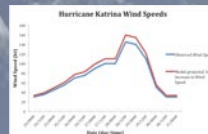
Observed records of Atlantic hurricane activity (Emanuel, 2007) show a strong correlation between local Atlantic SSTs and the Power Dissipation Index. PDI is an aggregate measure of Atlantic hurricane activity, combining frequency, intensity, and duration of hurricanes in a single index. Both Atlantic SSTs and PDI appear to be very well correlated, which you can see in the top figure (Emanuel, 2007). Large increases in Atlantic SSTs projected for the late 21st century by an IPCC A1B scenario would imply very substantial increases in hurricane intensity, roughly a 300% increase in the PDI by 2100 (Emanuel, 2007).



Knutson (2008) predicts that by 2100, climate change will cause hurricanes to have average rainfall rates 20% higher than present-day hurricanes. The middle figure shows how a 20% increase in rainfall rates would affect rainfall amounts in select locations in Mississippi during Hurricane Katrina.



Knutson (2008) also predicts that by 2100, average hurricane wind speeds will increase by up to 10%. The bottom figure shows how the model-projected 10% increase in wind speeds would affect Hurricane Katrina winds. As you can see, Hurricane Katrina would have been much more intense with the model-projected increased wind speeds and rainfall.



## Thesis Statement

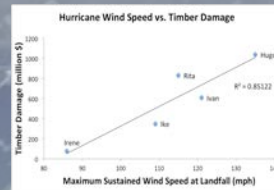
Average timber damaged caused by a category 4 or 5 hurricane could increase by \$200 million by 2100 under an IPCC A1B scenario. While the timber industry as a whole may be resilient to such significant increases in cyclonic deforestation, individual landowners without insurance may be at serious risk.

## Cyclonic Deforestation in the Southeastern U.S.

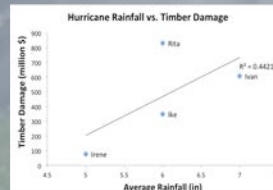
Natural disturbances such as hurricanes strongly affect forest composition, structure and dynamics. When hurricanes make landfall in forested areas, they can damage hundreds of thousands of acres of timberland, causing hundreds of millions of dollars in timber damage. If this damaged timber is not salvaged and/or is not fully insured, the timber industry of the southeastern United States can lose millions of dollars in lost timber. When Hurricane Katrina struck the Gulf coast in August 2005, it swept through Louisiana, Mississippi and Alabama, causing a total timber damage of \$5 billion (Oswalt et al. 2008). The table below shows the timber damage caused by six Atlantic basin hurricanes that struck the southeastern United States from 1989-2011. In total, these six hurricanes caused approximately \$7.7 billion in timber damage.

Hurricane and Year	Hugo (1989)	Ivan (2004)	Katrina (2005)	Rita (2005)	Ike (2008)	Irene (2011)
Max Sustained Wind Speed (at landfall)	135 mph	121 mph	127 mph	115 mph	109 mph	86 mph
Landfall Location	South Carolina	Alabama	West Mississippi	East Texas	East Texas	North Carolina
Value of Damaged Timber (million)	\$1,040	\$610	\$5,000	\$833	\$351	\$80

The figure below shows maximum sustained wind speed at landfall vs. timber damage for 5 Atlantic basin hurricanes. I excluded Hurricane Katrina because Katrina caused an unusually high amount of timber damage that is not typical of an average category 4 or 5 hurricane. As the figure below shows, timber damage is well correlated with wind speed. Thus, if climate change causes hurricane wind speeds to increase, it is likely that timber damage will increase as well.



The figure below shows average rainfall (within 200 miles of the storm's center) vs. timber damage for 4 Atlantic basin hurricanes. I excluded Hurricane Hugo because rainfall during Hugo was unevenly distributed and it was difficult to gauge average rainfall. Timber damage is not as well correlated with rainfall as it is with wind speed, but it does appear that timber damage increases as rainfall increases. Thus, if climate change causes hurricane rainfall amounts to increase, it is likely that timber damage will increase as well.

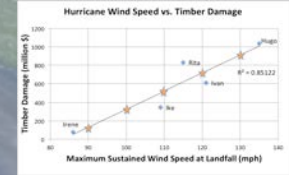


## Methodology

I used several different methodologies for this project. First, I analyzed data from the National Hurricane Center, Alabama Forestry Commission, Texas Forest Service, and similar sources to analyze the amount of timber damage caused by past hurricanes. I then analyzed models and projections from Emanuel (2007), Vecchi et al. (2008) and Knutson (2008) to determine how an IPCC A1B climate change scenario may alter hurricane activity by 2100. I then took these model-projected increases in hurricane wind speeds and rainfall rates and applied them to cyclonic deforestation. I plotted timber damage vs. wind speed and rainfall rates to get an average timber damage given a specific wind speed or rainfall rate. I then explored how these model-projected increases could increase average timber damage caused by a category 4 or 5 hurricane. Finally, I analyzed which elements of the timber industry make it more or less resilient to this increased hurricane intensity, and from that made more generalizable laws about what makes any industry more or less resilient to future climate change.

## Future Cyclonic Deforestation

The figure to the right shows that timber damage increases by about \$200 million for every 10 mph increase in maximum sustained wind speed at landfall. Knutson (2008) projects that given an IPCC A1B scenario, maximum sustained wind speeds could increase by as much as 10% by 2100. An increase this large would surpass 10 mph for a category 4 or 5 hurricane. Thus, average timber damage caused by a category 4 or 5 hurricane could increase by \$200 million by 2100.



This figure does not take into account rainfall because rainfall is not as well correlated with average timber damage as wind speed is. However, the model-projected 20% increase in rainfall rates by 2100 (Knutson, 2008) will likely increase average timber damage per category 4 or 5 hurricane. Thus, average timber damage caused by a category 4 or 5 hurricane could increase by even more than \$200 million by 2100 if rainfall is increased as well.

## Forms of Resiliency

There are four main elements that increase the resiliency of the timber industry to future changes in hurricane activity: salvage logging, government assistance, casualty loss deductions, and insurance. Together, these four elements help to make the timber industry more resilient against future increases in cyclonic deforestation.

**Salvage Logging:** Downed and damaged trees following a hurricane soon die and eventually rot and decay. However, if the damaged timber is salvaged soon enough, some of the value of the damaged timber can be saved. However, salvage logging following a hurricane usually floods the timber market, driving timber prices way down.

**Government Assistance:** The emergency disaster relief-funding package signed in October 2004 includes \$25 million for assistance to family forest owners in the southeastern United States (Long et al. 2012).

**Timber Casualty Loss Deductions:** When a timber stand is storm-damaged, landowners may be able to recover the loss as a casualty loss on their federal income tax return as outlined in the Internal Revenue Code.

**Insurance:** Most timber owned by large timber companies is fully or nearly fully insured against hurricane damage. However, most of the timberland in the southeastern U.S. is privately owned by individual land owners. Many of these smaller plots of timber may not be insured against hurricane damage and may be at serious risk if cyclonic deforestation increases due to climate change.

## Conclusions and Solutions

While the timber industry of the southeastern U.S. as a whole may be resilient to significant increases in cyclonic deforestation over the next century, individual landowners without insurance may be at serious risk. Some losses can be recovered through government assistance and casualty loss deductions, and some damaged timber can be salvaged. However, not all damaged timber can be salvaged or be claimed as a casualty loss deduction. Thus, insuring timber is the best way for private landowners to protect their timber against increasing cyclonic deforestation. As climate change continues to impact the world in the future, insurance will be the best way for any industry to protect itself.

## Key Sources

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