Hurricane Katrina: Preliminary Estimates of Commercial and Public Sector Damages

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Abstract: Hurricane Katrina's impact on the economy and infrastructure of Louisiana, Mississippi and Alabama represents an immediate concern to commercial enterprises, area residents, and policymakers at all levels. Understanding the severity of the damages and the magnitude of the recovery efforts are important for both private and public decision makers deploying resources in the affected area. This paper provides initial estimates of damages in a number of infrastructure categories and residential and commercial structures, content and equipment. The estimation is based upon earlier analysis (Burton and Hicks, 2003) which provided an economic model of damages based upon the upper Mississippi floods of 1993. Specifically we estimate that Hurricane Katrina has generated commercial structure damages of $21 Billion, commercial equipment damages of $36 Billion, residential structure and content damages of almost $75 Billion, electric utility damages of $231 Million, highway damages of $3 Billion, sewer system damages of $1.2 Billion and commercial revenue losses of $4.6 Billion. We are unable to estimate water system, and some key infrastructure damages at this point, and have not included the economic consequences of the loss of life or damage to the regions environmental amenities.

INTRODUCTION AND MOTIVATION

Hurricane Katrina's impact on the economy and infrastructure of Louisiana, Mississippi and Alabama represents an immediate concern to commercial enterprises, area residents, and policymakers at all levels within the affected region. Policymakers are working to deploy appropriate resources to mitigate damages, alleviate suffering and reconstruct the affected area. Area firms are attempting to assess the degree to which commerce might be interrupted and how their individual industries (from finance and tourism to energy and transportation) will fare in the wake of this tremendous natural disaster. Residents are concerned about several factors, not least of which is the loss of personal belongings located within homes which may have been destroyed by flood, wind or rain associated with Katrina.

It is within this context that this paper seeks to estimate a portion of the public and private damages associated with Hurricane Katrina. Before describing the methods and data employed to estimate these damages, we must first make clear what we do not measure in this paper. We limit our economic estimates to private and public infrastructure damage (homes, businesses and associated public infrastructure) and a few other damage categories. We make no long-term predictions regarding recovery. We do not estimate the costs associated with providing immediate assistance to displaced residents. We do not estimate the cost of repairing or replacing large infrastructures with unique characteristics such as large bridges or sports venues. We do not estimate the cost in human life. Finally, we do not estimate environmental damage associated with this storm. We do not undertake these estimates because they are unimportant but simply because it is too early to make useful evaluations of these impacts.

BACKGROUND AND LITERATURE REVIEW

Estimates of economic damages associated with natural disasters are derived from a number of sources. The most commonly reported of these reflect concerns of individual sectors of the economy. Thus, the insurance industry will report insured losses to private activity, the energy sector reports lost revenues and the cost of repair to infrastructure, while the Federal government will report costs associated with the rescue and levee reconstruction effort.

Economic studies of natural disasters have used data from past events to model impacts of damages. However, existing economic literature provides only limited basis for empirical models of flood damages useful to this analysis. The most applicable literature relied on economic, demographic and flood characteristics as basis for empirical modeling of damages. As part of this effort to construct damage simulation models the study team modified existing efforts to estimate damages to match data availability and regional variation.

Agarwal and Roy [1991] provide a model of damage assessments for south Asian flooding using duration of flood in days, number of people affected by flood, per capita income, household types and other data. Krzystofowicz and Davis [1983] employ a similar model with expected number of floods per year, decision (forecast) time, average actual lead time, actual flood crest, probability of the actual crest, maximum possible damage for the reach category (economic variables) among others. These results employed data similar to that of Whipple [1969], in one of the earliest studies. Wind, Nierop, de Blois, and de Kok [1999] provide evidence from the Meuse River that experience with floods mitigates damages in later events. This led the study team to include the number of flood events in its model, a strategy that was empirically rejected in these data.

Other issues such as data availability with respect to actual site damages were reviewed in Adams [1993] for flood damages in Africa. This experience was similar to the region analyzed here. Aleseyed, Rephann, and Isserman [1998] evaluated the presence of water development projects on regional income and growth. Ramirez [1988] and other studies evaluated the benefits of mitigation on flood damages. Other research evaluated agricultural damages using river flow and regional crop yields (see Morris and Hess, 1988). Weiner [1996] provides a strong argument for studies of this type.

Burrus, Dumas, Farrell and Hall [2002] estimated the impact of low-intensity hurricanes as ‘business interruption’ of regional economies in North Carolina. Burton and Hicks [2003] estimated the transportation sector impacts of flood damages on data from the 1993 upper Mississippi flood. In this model the authors estimated three ranges of damage categories, which estimate a variety of flood associated damages. A second extension of this model (Burton and Hicks, 2003a) simulated damages on unprotected regions of the upper Mississippi using a similar modeling approach which accounted for both agricultural and commercial damages.

THE MODEL AND DATA

Building on earlier research (Burton and Hicks, 2003, 2003a) we estimate flood damages along the upper Mississippi and Missouri river basins. The premise that underlies this analysis is that flood damages within specific categories is functionally related to the economic and demographic conditions that were evident prior to the flood, as well as the hydrological and hydraulic characteristics of the event itself. As with the earlier work this construct can be represented functionally as:

$$M_i = f(\mathbf{D}, \mathbf{E}, \mathbf{F})$$

Where:

M_i = The monetary value of flood damages within the i^{th} damage category.

D = A vector of demographic variables including but not limited to total population, age distribution, geographic dispersion.

E = A vector of economic variables, including but not limited to per capita personal income, number of commercial establishments, industrial mix, extent and value of public infrastructures.

F = A vector of variables describing the flood event(s), including but not limited to the maximum stage above flood, the duration of the flood event(s), and the maximum flows associated with the flood event, the length of any period of warning, and prior flood histories.

All data are defined on a county specific basis, so that the value of the damages within each category is the total dollar value for the county in question during 1993. Importantly, by correcting for floodplain data this value represents the floodplain damages (located within a single county boundary). In some cases, specific variables are relevant to only a few damage categories. For example the miles of rail line within a county is a good predictor or rail infrastructure damages, but it is of little value in predicting other damages. Likewise, the annual value of agricultural production is useful in estimating agricultural damages, but may not be particularly valuable in estimating other damages. Alternatively, there are more general variables such as population and the number of business establishments that were useful predictors of damages in nearly every damage category. A full description of the model employed in this estimate is contained in Burton and Hicks, 2003.

Hurricane Katrina offered several additional modeling challenges. First, we have no estimates of wind damage, so we must base our estimates on damages associated with flooding. Second, the duration of flooding, and the climactic conditions suggest the potential for much heavier structural damage than those associated with earlier floods of the Mississippi and its tributaries. This is especially true in New Orleans. Thus, a direct estimate of residential and commercial damage derived from Census Data and the reported extent of the flooding are used.[1]

It is helpful to review the data employed in this estimate. These data are summarized in Table 1. Demographic and economic data were gathered from a variety of sources. Census data were based on 2000 values. Economic and Demographic data are summarized in Table 2

Table 1, Economic and Demographic Characteristics of Hurricane Katrina Affected Counties (2000 Census)

	Alabama	**Louisiana**	**Mississippi**
Business Establishments	13,529	76,741	14,241
Annual Payroll ($000s)	5,428,384	35,626,104	5,277,647
Per Capita Income	23,422	23,940	20,738
Population	575,133	3,251,575	707,506
Land - Square Miles	3,910	18,957	8,605
Highway Lane Miles	15,947	60,727	28,889
Housing Units	247,509	1,313,663	286,337
Median value	88,667	83,397	68,393
Counties Affected (8/29 disaster declaration)	3	31	15

[1] For New Orleans, we assumed 80% flood damages of residential structures, with values estimated from 2000 Census. The commercial structure values were estimated at 2.5% of annual revenues.

ESTIMATION RESULTS

We report aggregate impacts in the affected counties in Alabama, Louisiana and Mississippi in eight damage categories. We were unable to estimate impacts on rail structures and disaggregate revenue impacts. Also, given the unprecedented contamination that is reported, decontamination of water services may be far costlier than our model suggests, so it is not included in this analsis. Results appear in Table 2.

Table 2, Aggregate Damage Estimates in Affected Counties

Damage Category	Current Dollars (1,000's)
Commercial Structure Damages	$21,109,006
Commercial Equipment Damages	36,401,310
Residential Structure Damages	49,724,451
Residential Contents Damages	24,437,028
Commercial Revenues Damages	4,634,533
Electric Utility Damages	231,371
Highway Damages[2]	3,049,758
Sewer System Damages	1,262,512
Total Damages	**$156,650,004**

Some interpretation and comparison of these data are warranted. First, these are preliminary estimates, which do not include several important categories as noted in the introduction. Second, the model estimates are based on flood damages to the upper Mississippi, and provide less precise impacts of the duration of flooding on residential and commercial structures. However, we believe it likely that losses in these categories are likely close to the maximum of the existing value of structures and contents. In past

[2] Readers are reminded that this figure excludes the value of bridge repair / replacement for major structures.

models we have been able to prepare estimates of rail and water system damages. However, we do not believe the data support extrapolating these methods to Hurricane Katrina and so do not report them.

The magnitude of these impacts, while quite large are not inconsistent with other reports we have seen reported in the media.[3] Also, while these estimates are almost double the impact of the next most costly Hurricane, increased population density in parts of the affected area and increases in the values of homes, contents, commercial economic activity and public infrastructure suggest that the damage estimates provided in this model are reasonable. For a comparison see Table 3.

Table 3, Previous Hurricane Impacts

Rank	Hurricane	Year	Category	U.S. Damage (current 1'000's)
1	Florida/Alabama	1926	4	96,758,700
2	Andrew (FL/LA)	1992	4	44,289,000
3	Texas (Galveston)	1900	4	35,619,900
4	Texas (Galveston)	1915	4	30,180,900
5	Florida	1944	3	22,566,300
6	New England	1938	3	22,255,500
7	Florida/Lake Okeechobee	1928	4	18,459,300
8	Betsy (FL/LA)	1965	3	16,638,900
9	Donna (Florida/Eastern U.S.)	1960	4	16,128,300
10	Camille (MS/LA/VA)	1969	5	14,674,200

Source: Pielke and Landsea (1998) with authors adjustments to reflect current dollars.

SUMMARY AND CONCLUSION

This analysis provides estimated damages associated with flood damages caused by Hurricane Katrina in 49 counties in southern Alabama, Louisiana and Mississippi in August, 2005. To estimate these damages we employed a model used for the upper

[3] Risk Management Solutions reports commercial losses could exceed $100 billion, while the Insurance Information Institute estimates insured losses at roughly $35 Billion.

Mississippi (Hicks and Burton, 2003, 2003a). The TVA is currently employing these methods and models for policy analysis and simulations.

The estimates of total damages included above are roughly $156 Billion. This makes Hurricane Katrina roughly half again as costly as the most expensive hurricane in US history. Again, this study does not include predictions regarding recovery, estimates of the costs associated with providing immediate assistance in providing basic needs to displaced residents (also known as mission costs). We do not estimate the cost in human life, nor do we estimate environmental damage associated with this storm. That is not because these impacts are unimportant (or indeed greater than those provided above), but simply because as of this writing there is insufficient data for us to provide and informed estimate.

Estimation of these damages is of immediate importance because policy decisions regarding mitigation and recovery of the effects of Hurricane Katrina are in the early stages. Policymakers at all levels may use these results to better inform decisions on aid and extent of effort. As with all modeling efforts, this estimate can be improved. More precise estimates of the known damages can be used to adjust these estimates. Also, there are several important, but unknown impacts that we believe warrant immediate evaluation.

Estimation on the impact of delayed port operations in the affected regions and especially long-term shift of trade patterns to current ports is necessary. A better understanding of the response of trade flows to long supply interruptions is required. Further, the role of permanent out-migration as a result of the disaster, especially to urban centers is of immediate concern. Understanding this dimension, especially the role of family size, education and income distribution on post flood migration is needed to inform post flood policies ranging from land use patterns to infrastructure recovery. We do not know the cost of repairing and refitting the levee system, nor do we understand how supply constraint in construction could interact to change costs to consumers, businesses and local, state and Federal government as they rebuild. We do not know how the industrial mix of the affected region will shift and whether cities, particularly New

Orleans, will be able to support similar population levels and income and education attainment mixes. Also, those items we mention earlier which are not part of our analysis are critical factors in determining appropriate deployment of resources.

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