Journal of Coastal Research	00	0	000–000	Coconut Creek, Florida	Month 0000

www.JCRonline.org

www.cerf-jcr.org

TECHNICAL COMMUNICATIONS

An Analysis of Federal Expenditures Related to the Coastal Barrier Resources Act (CBRA) of 1982

Andrew S. Coburn[†]* **and John C. Whitehead**[‡]

[†]Program for the Study of Developed Shorelines
Western Carolina University
Cullowhee, NC 28723, U.S.A.

[‡]Department of Economics
Appalachian State University
Boone, NC 28608, U.S.A.

ABSTRACT

Coburn, A.S. and Whitehead, J.C., 0000. An analysis of federal expenditures related to the Coastal Barrier Resources Act (CBRA) of 1982. *Journal of Coastal Research,* 00(0), 000–000. Coconut Creek (Florida), ISSN 0749-0208.

The Coastal Barrier Resources Act (CBRA) of 1982 established the John H. Chafee Coastal Barrier Resources System (CBRS), a congressionally defined set of coastal barrier units located along the Atlantic, Gulf of Mexico, Great Lakes, U.S. Virgin Islands, and Puerto Rico coasts. Coastal areas in the CBRS total approximately 3.5 million acres (14,164 km^2) of islands, beaches, wetlands, and associated aquatic habitat and are delineated on a set of maps enacted into law by Congress and maintained by the Department of the Interior through the U.S. Fish and Wildlife Service (USFWS). Congress enacted the CBRA to minimize the loss of human life and damage to natural resources along the coasts, and to prohibit unwise federal expenditures that encourage and subsidize unwise coastal development. The CBRA approach to conservation does not prevent development and imposes no restrictions on development conducted with nonfederal funds. CBRS units may be developed, but federal taxpayers largely do not underwrite the investments. Although the CBRA has been in existence for over 35 years, the last known federal effort to quantify the benefits of the CBRA was undertaken by the USFWS in 2002, when it estimated that the CBRA would save American taxpayers approximately $1.3 billion by 2010 by restricting federal spending for roads, wastewater systems, potable water supply, and disaster relief. In this study, recent federal agency expenditure and development data were used to enumerate the historical fiscal benefits of the CBRA to U.S. taxpayers, as well as estimate potential future savings. Results indicate that the CBRA has reduced federal coastal disaster expenditures by $9.5 billion (in 2016 dollars) between 1989 and 2013. Future CBRA savings are forecast to range between $11 billion and $108 billion by 2068 (in 2016 dollars).

ADDITIONAL INDEX WORDS: *Disaster, aid, federal, beach, damage, savings, taxpayer*.

INTRODUCTION

Coastal barriers are unique landforms located at the land-water interface that provide protection for diverse coastal and estuarine habitats and serve as the mainland's first line of defense against the impacts of severe coastal storms. Most coastal barriers are made of unconsolidated sediments (sand, gravel, *etc*.), and the dominant physical factors that shape coastal barriers are tidal range, wave energy, and sediment supply (U.S. Fish and Wildlife Service [UFWS], 2018a). Due to their geological composition and exposure to hazardous processes, coastal barriers are risky areas on which to build. Even so, people live on coastal barriers, which are also popular vacation and recreation destinations.

Since 1980, the United States has sustained 219 weather- and climate-related disasters where the overall damage costs reached or exceeded $1 billion (including adjustments based on the consumer price index [CPI]). The cumulative costs for these 219 events exceeded $1.5 trillion, with $850.5 billion (CPI-adjusted) or 55.3% of this amount resulting from tropical cyclone losses. Although tropical cyclones have the highest average event cost ($22.4 billion per event, CPI-adjusted), they represent less than one-fifth (17.4%) of all the billion-dollar events assessed since 1980. According to the National Oceanic and Atmospheric Administration (NOAA), 2017 set a record for natural disaster damages in the United States, with damage estimates totaling over $300 billion (NOAA, 2018).

In response to the events of 2017, Congress passed two supplemental spending bills in September and October 2017 appropriating $34.5 billion in postdisaster funds and forgiving $16 billion of debt for the National Flood Insurance Program (NFIP). Congress approved a 2 year budget in early 2018 that included an additional $90 billion for disaster rebuilding, putting total spending in response to 2017 events at over $130 billion (Wharton, 2018).

Development and redevelopment of coastal barriers is not only costly to the American taxpayers, it also puts people, homes, and infrastructure at risk, interferes with the natural movement of coastal sediment, increases natural erosion processes, and disturbs important habitat for nesting sea turtles, migratory birds, and other fish and wildlife resources.

DOI: 10.2112/JCOASTRES-D-18-00114.1 received 14 August 2018; accepted in revision 25 January 2019; corrected proofs received 26 February 2019; published pre-print online 15 March 2019.
*Corresponding author: acoburn@wcu.edu

In the past, certain actions and programs of the federal government had the effect of encouraging development of fragile, high-risk, and ecologically sensitive coastal barriers. Aware of the risks and values of coastal barriers, Congress adopted the Coastal Barrier Resources Act (CBRA; U.S. Code, 1982), an approach to natural resource conservation that transfers the costs of developing coastal barriers from federal taxpayers to those who voluntarily assume the risks associated with ownership of barrier island property.

Coastal barriers meeting CBRA development criteria are included in the Coastal Barrier Resources System (CBRS), which contains approximately 3.5 million acres (14,164 km^2) of islands, beaches, wetlands, and associated aquatic habitat. The CBRS is divided into two types of units: system units and otherwise protected areas (OPAs). System units contain areas that were relatively undeveloped at the time of their designation within the CBRS, and they are predominantly composed of privately owned areas. Most new federal expenditures and financial assistance, including federal flood insurance, are prohibited within system units. The CBRS currently includes 585 system units encompassing approximately 1.4 million acres (5666 km^2) of land and associated aquatic habitat. OPAs are predominantly composed of conservation and/or recreation areas such as national wildlife refuges, state and national parks, local conservation areas, and private conservation areas. The only federal spending prohibition within OPAs is on federal flood insurance. The CBRS currently includes 277 OPAs encompassing approximately 2.1 million acres (8498 km^2) of land and associated aquatic habitat. System units and OPAs are delineated on a set of maps enacted into law by Congress and maintained by the Department of the Interior through the U.S. Fish and Wildlife Service (USFWS, 2018a).

Although the CBRA has been in existence for over 35 years, little is known about the precise impacts of the law in terms of savings to taxpayers and on development patterns. The last published economic assessment of the program by a federal agency was completed in 2002, when the USFWS estimated that the CBRA would save American taxpayers approximately $1.3 billion (in 1996 dollars) in disaster-related expenses by 2010 (USFWS, 2002). This paper presents an updated assessment of the historical, as well as estimated future, fiscal impacts of the CBRA measured by poststorm-related federal expenditures.

METHODS

This study involved a macroscale economic analysis of the current federal fiscal benefits resulting from implementation of the CBRA, as well as the estimated future federal fiscal benefits resulting from its continued implementation. Disaster expenditures from four federal agencies (Federal Emergency Management Agency [FEMA], Department of Transportation [DOT], Environmental Protection Agency [EPA], and Department of Housing and Urban Development [HUD]) were evaluated. However, only FEMA disaster expenditures were used to calculate current CBRA savings due to the agency's statutory responsibility for coordinating government-wide relief efforts under the Robert T. Stafford Disaster Relief and Emergency Assistance Act (FEMA, 2018a).

FEMA postdisaster disbursement data (excluding federal flood insurance payments) were combined with three future land development and three future damage scenarios to project future federal savings that may be expected in 10, 30, and 50 years due to the CBRA. FEMA data were used to calculate future benefits due to the agency's role in directing, coordinating, managing, and funding response and recovery efforts associated with domestic major disasters and emergencies.

Current CBRA Savings

Federal agency disbursement data in 93 coastal counties, representing 87% of the total acreage of fastland (the portion of a coastal barrier between the mean high tide line on the ocean side and the upper limit of tidal vegetation on the landward side) in CBRS units, and USDA 2012 Natural Resources Inventory (NRI) land development rates were used to calculate annual federal expenditures avoided due to the CBRA (USDA, 2015). The number of newly developed acres in each county in each year was estimated using a methodology similar to that used by the USFWS in 2002:

$$A_{it} = DR_{it} \times CBRA_{it}$$

where, A_{it} is current developed acreage, DR_{it} is the observed development rate (the USFWS assumed a 5% annual rate), and $CBRA_{it}$ is the number of acres in the CBRS for county $i = 1,\ldots,n$ at time $t = 1,\ldots,T$. The cumulative CBRA acreage developed is equal to the sum of current and past development, or $\sum A_{it} = (A_{it} + \sum A_{it-1})$. Annual federal disaster-related costs for each county were calculated as $C_{it} = \sum A_{it} \times c_{it}$, where c_{it} is per-acre cost in year t. The total over the entire time period is then $TC = \sum_{i=1}^{n} \sum_{t=1}^{T} C_{it}$. Due to data limitations, annual federal expenditures avoided due to the CBRA were calculated for the period 1989–2013.

Future Estimated CBRA Savings

While the historical impact of the CBRA is important, a factor of equal or greater importance is the program's ability to reduce damage and associated federal expenditures from future coastal disasters. Based on *ex-post* estimates, forecasts of avoided postdisaster costs for three time windows were developed: 2019–28 (10 year), 2019–48 (30 year), and 2019–68 (50 year). The 10 year window represents the length of time for Congressional Budget Office (CBO) economic growth (gross domestic product [GDP]) forecasts. The 30 year window represents the typical planning horizon for most shoreline stabilization/erosion control structures, while the 50 year window represents the typical planning horizon for U.S. Army Corps of Engineers (USACE) federal shore protection projects.

These forecasts are the product of forecasts of coastal development rates and forecasts of future damage. Each total cost avoided forecast was estimated for each coastal county as:

$$PVTC = \frac{\sum_{i=1}^{n} \sum_{t=1}^{T} C_{it}}{(1+r)^t}$$

where, *PVTC* is the present value of the total cost, and r is the discount rate, which adjusts future values to present values.

To calculate federal costs avoided due to future coastal disasters, three "disaster cost per acre" scenarios were created

Table 1. *Federal expenditures avoided due to CBRA between 1989 and 2013 (in 2016 dollars).*

Agency	Expenditures Avoided
FEMA†	$8,958,923,309
DOT	$469,373,253
EPA	$60,518,267
HUD	$4,416,766
TOTAL	$9,493,231,595

1989–2013 corresponds with 25 years of available disaster relief data. Fastlands in 93 out of 107 CBRS counties are included. NRI development rates ranged between 0.5% and 2% annually.
†*FEMA expenditures exclude NFIP payments.*

(low, medium, and high). A "low" disaster cost estimate is the average of all FEMA disaster expenditures over the 1989 to 2013 time period, or $\bar{c}$ = $7842. The "medium" disaster cost estimate is the "recent" federal disaster cost average of FEMA disaster expenditures over the 2005 to 2013 time period, or $\bar{c}$ = $15,563. The "high" disaster cost estimate was forecast from a linear trend over the 1989 to 2013 time period, or $c_t = \$5265 + \$864t$. For the high disaster cost estimate, the forecast cost begins at $17,201 in 2014 and increases by $864 each year to $63,861 in 2068. All costs were discounted at the 3% rate recommended by the CBO (GPO, 2018).

In addition to three future damage scenarios, three development rate forecasts (low, medium, and high) were calculated for each time window. The "low" growth development rate forecast applied a linear trend to the USDA 2012 NRI county-level land development rates over the full time period of 1989–2013. The resulting equation is: $DR_t = 0.0318 - 0.0011t$. The development rate is higher in the initial periods of the data, so the trend is negative. Cumulative development in this equation is estimated until $DR = 0$, which is predicted to occur in 2016. The "low" growth forecast slightly increases cumulative development until 2016, when it reaches a maximum of 41%.

The "medium" growth development rate forecast used the average development rate from 2008 to 2013, $DR = 0.52\%$. This forecast may still be conservative as these are the lowest growth rates in the 1989 to 2013 data. In the Medium growth scenario, development in CBRA reaches a maximum of 49% of total fastland acreage in 2028, with 59% developed in 2048 and 69% developed in 2068.

The "high" growth development rate forecast used a regression-based approach: $DR_t = 0.0108 + 0.00263 \times GDPGR_t$, where $n = 25$, $R^2 = 0.24$, and $GDPGR$ is the gross domestic product growth rate obtained from the Federal Reserve Economic Database (FRED). The GDP growth rate was used as a determinant of land development rates, and the correlation between the GDP growth rate and forecast future development rates was embedded in the ordinary least squares regression model. Statistically, the correlation (0.49) is the square root of the model R^2 value (0.24). If $GDPGR = 0$, then DR = 1.08%, and if $GDPGR = 1$, then DR = 1.343% ($100 \times [0.0108 + 0.00263]$). The high growth forecast used the actual GDP growth rate from 2014 to 2017, and then CBO forecasts of GDP growth rates from 2019 to 2028 (GPO, 2018). For forecasts beyond 2028, when estimates of the GDP growth rate are not available, linear trends for the development rate from the 10 year (2019–28) forecasts were used. In this scenario, the development rate reached a maximum of 65% of total fastland acreage in 2028, 96% in 2048, and 100% in 2051.

Table 2. *Ten year federal disaster costs avoided: 2019–28 (in billions).*

	Damage Estimate		
Development Rate	Low	Medium	High
Low	$3.78	$7.50	$12.15
Medium	$4.22	$8.37	$13.60
High	$5.28	$10.48	$17.09

Table 3. *Thirty year federal disaster costs avoided: 2019–48 (in billions).*

	Damage Estimate		
Development Rate	Low	Medium	High
Low	$8.69	$17.24	$35.63
Medium	$10.57	$20.97	$44.20
High	$14.71	$29.19	$62.86

RESULTS

Using actual federal postdisaster funding data and NRI county-level land development rates, CBRA reduced federal expenditures associated with damage from coastal storms by $9.49 billion (in 2016 dollars) between 1989 and 2013. FEMA postdisaster expenditures accounted for 94% of all federal expenditures avoided. Table 1 presents a full breakdown by agency.

Future Estimated CBRA Savings

The 10 year present value forecasts of future federal disaster costs avoided for 93 coastal counties from 2019 to 2028 range from $3.78 billion for the low development rate/low damage scenario to $17.09 billion under the high development rate/high damage scenario, as presented in Table 2.

The 30 year present value forecasts of future federal disaster costs avoided for 93 coastal counties from 2019 to 2048 range from $8.69 billion for the low development rate/low damage scenario to $62.86 billion under the high development rate/high damage scenario, as presented in Table 3.

The 50 year present value forecasts of future federal disaster costs avoided for 93 coastal counties from 2019 to 2068 range from $11.4 billion for the low development rate/low damage scenario to $108.59 billion under the high development rate/high damage scenario, as presented in Table 4.

All estimated future federal cost savings attributable to CBRA assume the program continues without substantive change over the next 50 years.

DISCUSSION

Because federal postdisaster disbursement data were only available for 93 of the 107 counties in the CBRS, the results presented in this paper are conservative. In addition, this study examined only a subset of federal expenditures in coastal areas,

Table 4. *Fifty year federal disaster costs avoided: 2019–68 (in billions).*

	Damage Estimate		
Development Rate	Low	Medium	High
Low	$11.40	$22.63	$54.62
Medium	$14.76	$29.30	$73.66
High	$21.25	$42.17	$108.59

which is not reflective of all federal programs providing financial assistance for coastal development, redevelopment, and storm damage mitigation or repair. For example, federal flood insurance claims through the NFIP were not included in this study.

The large disparity between current CBRA savings calculated by this study ($9.49 billion in 2016 dollars) and that estimated by the USFWS in 2002 ($1.9 billion in 2016 dollars) can be attributed to two factors: (1) This study had access to federal postdisaster disbursement and USDA land development rates, and (2) the USFWS study significantly underestimated the extent and degree to which developed U.S. shorelines would be impacted by coastal storms after 2002, as well as the federal costs associated with those impacts.

The 2004 hurricane season, for example, featured four hurricanes that struck Florida, an unprecedented series of events that caused $45 billion in damage (Landsea, 2018). The 2005 hurricane season produced four major landfalling U.S. hurricanes: Dennis, Katrina, Rita, and Wilma—another unprecedented series of events—and set several records, including most tropical storms (28), most hurricanes (15), most category 5 hurricanes (4), most hurricane names to be retired (5), and most damage ever recorded in a hurricane season ($150 billion) (Weather Underground, 2018). In 2012, Superstorm Sandy resulted in more than $70.2 billion in damage, making it the second-costliest storm behind only Hurricane Katrina (FEMA, 2018b).

Future estimated savings from the CBRA include only FEMA postdisaster-related expenditures due to its prominent role as the primary U.S. disaster response agency under the Robert T. Stafford Disaster Relief and Emergency Assistance Act, and the fact that FEMA was responsible for 94% of all poststorm federal expenditures between 1989 and 2013. Although poststorm expenditures by other federal entities such as HUD, DOT, and NFIP were not included in the estimate of future estimated savings due to a lack of available data, their inclusion would result in additional future savings.

Future estimated savings were also predicated on the hypothesis that the CBRA will remain essentially unchanged. While this paper refrains from making predictions regarding future substantive programmatic changes, history suggests that the CBRA is likely to experience reauthorization, CBRS unit boundary adjustments, and the addition and/or removal of individual CBRS units over the next 50 years (USFWS, 2018b). Although these modifications are expected to have a negligible impact on calculated future estimated savings, expansion of the CBRA to include currently developed barriers has the potential to significantly increase future CBRA savings. Conversely, a reduction in CBRA scope and/or extent can substantially reduce future benefits.

Barring any substantive programmatic changes to the CBRA over the next 50 years, future estimated savings are ultimately dependent on the quantity, intensity, duration, and location of coastal storms, as illustrated in this paper.

It should be noted that neither the current nor the future estimated savings resulting from CBRA include benefits afforded by the protection and preservation of natural estuarine and coastal ecosystems such as salt marshes, mangroves, and coral reefs. Although the fiscal/monetary benefits provided by healthy coastal ecosystems are often difficult to quantify, studies completed under the auspices of the United Nations Millennium Ecosystem Assessment show that they can be significant, and future CBRA assessments should attempt to quantify them (Brown, 2006).

CONCLUSIONS

Congress enacted the CBRA to minimize the loss of human life and damage to natural resources along the coasts and serve as a market-based approach to reducing imprudent federal expenditures that encourage and subsidize unwise coastal development. This economic analysis demonstrates that the CBRA has provided a substantial fiscal benefit to federal taxpayers by reducing federal expenditures associated with damage from coastal storms. Looking forward, the estimated federal fiscal benefits of the CBRA over the next 50 years are forecast to be more than ten times greater than historical benefits, depending on land development patterns/rates and storm impacts. Although the CBRA does not prevent development and imposes no restrictions on development conducted with nonfederal funds, it has clearly achieved its goal of reducing federal expenditures associated with hazardous coastal development.

ACKNOWLEDGMENTS

This study was supported by the National Audubon Society.

LITERATURE CITED

Brown, C., 2006. *Marine and Coastal Ecosystems and Human Well-Being: Synthesis*. Nairobi, Kenya: United Nations Environment Programme (UNEP) World Conservation Monitoring Centre, 80p.

FEMA (Federal Emergency Management Agency), 2018a. *About the Agency*. https://www.fema.gov/about-agency

FEMA, 2018b. *FEMA Fact Sheet: Mitigation Assessment Team Results—Hurricane Sandy*. https://www.fema.gov/mat-results-hurricane-sandy.

GPO (Government Publications Office), 2018. *Budget and Economic Outlook 2018 to 2028*.Washington, D.C.: U.S. Government Printing Office, 168p.

Landsea, C.W., 2018. *Hurricanes and Global Warming*. Washington, D.C.: National Oceanic and Atmospheric Administration Hurricane Research Division. http://www.aoml.noaa.gov/hrd/Landsea/gw_hurricanes/#FN1

NOAA (National Oceanic and Atmospheric Administration), 2018. *2017 U.S. Billion-Dollar Weather and Climate Disasters: A Historic Year in Context*. NOAA Climate.gov. https://www.climate.gov/news-features/blogs/beyond-data/2017-us-billion-dollar-weather-and-climate-disasters-historic-year

U.S. Code, 1982. Title 16, section 3501, *Coastal Barrier Resources*.

USDA (U.S. Department of Agriculture), 2015. *Summary Report: 2012 National Resources Inventory*. Washington, D.C.: Natural Resources Conservation Service, and Ames, Iowa: Center for Survey Statistics and Methodology, Iowa State University, 210p.

USFWS (U.S. Fish and Wildlife Service), 2002. *The Coastal Barrier Resources Act: Harnessing the Power of Market Forces to Conserve America's Coasts and Save Taxpayers' Money*. Arlington, Virginia: USFWS.

USFWS, 2018a. *Coastal Barrier Resources System*. https://www.fws.gov/cbra/Coastal-Barriers.html

USFWS, 2018b. *Summary of Changes to the Coastal Barrier Resources System*. https://www.fws.gov/cbra/Historical-Changes-to-CBRA.html

Weather Underground, 2018. *Hurricane and Tropical Cyclones*. https://www.wunderground.com/hurricane/record2005.asp

Wharton Risk Management and Decision Processes Center, 2018. *Federal Disaster Rebuilding Spending: A Look at the Numbers*. https://riskcenter.wharton.upenn.edu/disaster-aid/federal-disaster-rebuilding-spending-look-numbers/