

**PROGRESS REPORT ON NATIONAL RESEARCH INITIATIVES
TO REDUCE IMPACTS OF WIND HAZARDS - PART 2.
COMPARISON AND SYNTHESIS OF RECOMMENDATIONS
FOR NATIONAL PROGRAM**

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PROGRESS REPORT ON NATIONAL RESEARCH INITIATIVES TO REDUCE IMPACTS OF WIND HAZARDS – PART 2. COMPARISON AND SYNTHESIS OF RECOMMENDATIONS FOR NATIONAL PROGRAM

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1. Introduction

On June 24, 2008 the U.S. House of Representatives Committee on Science and Technology's Subcommittee on Energy and Environment and the Subcommittee on Research and Science Education held a joint hearing to examine the status of hurricane research and ways in which current research efforts could be improved. The Subcommittees also received testimony on the House resolution H.R. 2407, the National Hurricane Research Initiative Act of 2007 (Act). Various issues related to this Act and other topics of relevance to the nation's effort to reduce losses due to hurricanes and other types of strong winds were discussed during this hearing. In addition to H.R. 2407, reference was also made to the National Windstorm Impact Reduction Program (NWIRP), whose current authorization will expire soon and Congressional efforts are underway towards re-authorization of this program.

In context of the above developments it seemed to the author that a brief overview/comparison of the above Congressional initiatives might be of interest to the members of American Association for Wind Engineering (AAWE) and to broader audience involved in research, practice, education, outreach and other aspects related to reduction of destructive impacts of hurricanes and other strong wind phenomena. As a background to the comparison of NWIRP and NHRI, two reports – a report developed by AAWE in collaboration with ASCE (denoted hereafter as the AAWE/ASCE Report) and a report developed by a Task Force of the National Science Board (denoted hereafter as the NSB Report) – are briefly summarized and compared. Next, a discussion and synthesis of the NWIRP and the NHRI concept postulated in the Act are presented.

A detailed overview of the NHRI Act was reported by the author in the July 2007 issue of The Wind Engineer (the AAWE Newsletter, available at www.aawe.org), entitled "Progress Report on National Research Initiatives to Reduce Impacts of Wind Hazards – Part 1. NHRI Act of 2007. In this context it seemed appropriate to label the present contribution as Part 2 of the two-part write-up devoted to national initiatives to reduce impacts of wind hazards.

2. Comparison and Synthesis of Recommendations of AAWE/ASCE and NSB Reports

In late 2003 and early 2004, AAWE in collaboration with the American Society of Civil Engineers (ASCE) developed a comprehensive report entitled "Wind Engineering

Research and Outreach Plan to Reduce Wind Losses due to Wind Hazards”. This report was submitted to the U.S. House of Representatives Committee on Science and Technology in February 2004, during one of the Congressional hearings held in conjunction with Congressional activities leading to establishment of the National Windstorm Impact Reduction Program (NWIRP), signed into law in November 2004. A copy of the report can be accessed at www.aawe.org and www.windhazards.org/pdf/Wind_Eng_Report_Feb04.pdf.

Building on over 20-year experience (and lessons learned) from the National Earthquake Hazards Reduction Program (NEHRP), the report outlined a proposal for a comparable program focused on research, implementation, education and outreach activities geared towards reduction of hazards due to strong winds. The proposed program was denoted in the report as the National Wind Hazards Reduction Program (NWHRP). Recommendations and refinements proposed for NEHRP, presented in a report issued in 2003 by the Earthquake Engineering Research Institute, were adapted for wind hazards and incorporated in this proposal. The structure and scope of activities of NWHRP were delineated and a detailed budget estimate was developed for specific tasks and sub-tasks of the program. The principal components and sub-components of NWHRP are schematically presented in Table 1. Areas of activities within each component/sub-component are labeled in parentheses, for further referencing.

Table 1. Schematic representation of the NWHRP proposed in AAWE/ASCE Report (2004)

Component A Understanding of Wind Hazards	Component B Assessment of Impact of Wind Hazards	Component C Reduction of Impact of Wind Hazards		Component D Enhancement of Community Resilience, Education, & Outreach
		Sub-Component Ca	Sub-Component Cb	
(Aa) Enhanced Knowledge and Data on Severe Winds	(Ba) Performance of Buildings, Structures and Critical Infrastructure Using Data Collection, Experimentation & Synthesis	(Caa) Retrofit Measures for Existing Buildings, Structures & Infrastructure	(Cba) Cost Effectiveness of Loss Mitigation	(Da) Community Resilience to Wind Hazards
(Ab) Improved Understanding & Quantification of Wind Loading on Buildings and Structures	(Bb) Tools for Component and Structure-Level Simulation & Computational Modeling	(Cab) Innovative Technologies for New Buildings, Structures & Infrastructure	(Cbb) Financial Instruments for Risk Transfer	(Db) Cross-Area Outreach & Education
(Ac) Mapping of Wind Hazards	(Bc) Tools for System-Level/Loss Assessment	(Cac) Land Use & Cost Effective Construction	(Cbc) Emergency Response & Recovery	(Dc) Education & Public Outreach

In January 2007, the National Science Board released a report entitled “Hurricane Warning: The Critical Need for National Hurricane Research Initiative”. This publication is available at www.nsf.gov. The Report presented an agenda for nation-wide action -- a National Hurricane Research Initiative (NHRI) – that would provide hurricane science and engineering research and education involving a broad range of entities and stakeholders in the United States.

The NHRI structure and the scope of activities proposed in the NSB Report are schematically presented in Table 2. Specific areas of activities within each category are labeled in parentheses. In addition, priority levels assigned in the NSB Report to each area (H = high, M = medium) are indicated. Italic font is used to distinguish activities of medium priority. The NHRI areas overlapping with the areas proposed for NWHRP in Table 1 are shown shaded in Table 2.

Table 2. Schematic representation of the NHRI proposed in NSB Report (2007)

Category 1 Understanding & Prediction	Category 2 Impacts	Category 3 Preparedness & Response Measures	Category 4 Crosscutting Activities
(1a) Predicting Hurricane (H)	(2a) Interaction of Hurricanes with Engineered Structures (H)	(3a) Assessing & Improving Resilience of Built Environment (H)	<i>(4a) Computational Capability (M)</i>
(1b) Understanding Air-sea Interactions (H)	(2b) Economic & Social Impacts & Mitigation Measures (H)	(3b) Disaster Response & Recovery (H)	<i>(4b) Training & Education Programs Related to Hurricane Impacts (M)</i>
(1c) Predicting Storm Surge, Rainfall, Urban Flooding (H)	(2c) Interaction of Hurricanes with Natural Ecosystems (H)	(3c) Human Behavior & Risk Planning (H)	
(1d) Improved Observations (H)		(3d) Evacuation Planning (H)	
<i>(1e) Hurricanes vs Climate (M)</i>			
<i>(1f) Hurricane Predictability (M)</i>			
<i>(1g) Hurricane Modification (M)</i>			

Table 3 shows a synthesis of the activities of the national programs proposed in the AAWE/ASCE Report (NWHRP) and in the NSB Report (NHRI). The presented structure represents one of possible integrations of the two programs. It is based on the activities breakdown (into components) originally proposed for NWHRP, as shown in Table 1. It takes into account the overlap of the activities of the NWHRP and NHRI, indicated as shaded blocks (see also Table 2) and it incorporates non-overlapping areas of NWHRP. The non-overlapping areas of NHRI, activities labeled (1e) through (1g) in Table 2 - all of medium priority level assigned in the NSB Report - have been either

incorporated in other hurricane-related areas (in Table 3) or eliminated. To clarify the synthesis of the two programs, the labeling of the areas of activities of NWHRP (in Table 1) and NHRI (in Table 2) is retained in Table 3. It should be pointed out that the synthesized program in Table 3 includes the National Infrastructure Database and Research Model – a national initiative (in support of the NHRI) recommended in the NSB Report.

Table 3. Synthesis of National Programs Proposed in AAWE/ASCE and NSB Reports

Understanding & Prediction	Assessment of Impact	Reduction of Impact		Enhancement of Community Resilience, Education, & Outreach
		Engineering & Construction	Economic & Social	
(1a) Predicting Hurricanes (H) & (1b) Understanding Air-sea Interactions (H)	(Ba) Performance of Buildings, Structures and Critical Infrastructure Using Data Collection, Experimentation & Synthesis (2a,H)	(Caa) Retrofit Measures for Existing Buildings, Structures & Infrastructure (3a,H)	(Cba) Cost Effectiveness of Loss Mitigation	(Da) Community Resilience to Wind Hazards
(1d) Improved Observations (for Hurricanes (H)	(Bb) Tools for Component and Structure-Level Simulation & Computational Modeling	(Cab) Innovative Technologies for New Buildings, Structures & Infrastructure (3a,H)	(Cbb) Financial Instruments for Risk Transfer	(Db) Cross-Area Outreach & Education (4b,M)
(Aa) Enhanced Knowledge and Data on Severe Winds for Eng. Analysis	(Bc) Tools for System-Level/Loss Assessment	(Cac) Land Use & Cost Effective Construction (3a,H)	(Cbc) Emergency Response & Recovery (3b,H)	(Dc) Education & Public Outreach (4b,M)
(Ab) Improved Understanding & Quantification of Wind Loading on Buildings and Structures	(4a) Computational Capability for Hurricane Modeling (M)		(3c) Human Behavior & Risk Planning (H)	
(1c) Predicting Storm Surge, Rainfall, Urban Flooding (H)	(2b) Economic & Social Impacts & Mitigation Measures (H)		(3d) Evacuation Planning (H)	
(Ac) Mapping of Wind Hazards	(2c) Interaction of Hurricanes with Natural Ecosystems (H)			
National Infrastructure Database and Research Model				

3. Comparison and Synthesis of NWIRP (2004) and NHRI Concept (Act of 2007)

Public discourse and legislative activities of 2004 resulted in Congressional approval and Presidential signature into law of Act of 2004, calling for establishment of the National Windstorm Impact Reduction Program (NWIRP). The main components and scope of activities of this program are schematically presented in Table 4. Although the NWIRP was authorized by Congress and signed into law by President (in 2004), no funding has been appropriated yet (by Congress) for this program.

As discussed earlier, following the release of the NSB Report several legislative initiatives responding to recommendations formulated in this report have been undertaken in Congress. The most recent has been the National Hurricane Research Initiative Act of 2007 (H.R. 2407) introduced in U.S. House of Representatives in May 2007. The content of this bill was discussed in detail in Part I. A schematic representation of the main NHRI components and scope of activities (specified by this Act) are presented in Table 5.

Table 4. Components and Congressionally mandated scope of activities of NWIRP (2004)

COMPONENT I. IMPROVED UNDERSTANDING OF WINDSTORMS	COMPONENT II. WINDSTORM IMPACT ASSESSMENT	COMPONENT III. WINDSTORM IMPACT REDUCTION
A. Research to improve knowledge of and data collection on the impact of severe wind on buildings, structures, and infrastructure.	A. Development of mechanisms for collecting and inventorying information on the performance of buildings, structures, and infrastructure in windstorms and improved collection of pertinent information from sources, including the design and construction industry, insurance companies, and building officials.	A. Development of improved outreach and implementation mechanisms to translate existing information and research findings into cost effective and affordable practices for design and construction professionals, and State and local officials;
	B. Research, development, and technology transfer to improve loss estimation and risk assessment systems;	B. Development of cost-effective and affordable windstorm-resistant systems, structures, and materials for use in new construction and retrofit of existing construction.
	C. Research, development, and technology transfer to improve simulation and computational modeling of windstorm impacts.	C. Outreach and information dissemination related to cost-effective and affordable construction techniques, loss estimation and risk assessment methodologies, and other pertinent information regarding windstorm phenomena to Federal, State, and local officials, the construction industry, and the general public.

Table 5. Components and scope of activities specified in NHRI Act of 2007 (H.R. 2407)

	PROGRAM I. NATIONAL HURRICANE RESEARCH INITIATIVE (NHRI)	PROGRAM II. NATIONAL INFRASTRUCTURE DATABASE (NID)	PROGRAM III. NATIONAL HURRICANE RESEARCH MODEL (NHRM)
1	PREDICTING HURRICANE INTENSITY CHANGE	Cataloging and characterizing the physical, social, and natural infrastructure in order to provide a baseline for developing standards, measuring modification, and determining loss	Facilities and cyber infrastructure
	UNDERSTANDING OCEAN-ATMOSPHERE INTERACTIONS	Providing information to Federal, State, and local government officials to improve information public policy related to hurricanes and tropical storms	Software integration
	PREDICTING STORM SURGE, RAINFALL, INLAND FLOODING, AND STRONG WINDS PRODUCED BY HURRICANES AND TROPICAL STORMS DURING AND AFTER LANDFALL	Providing data to researchers to improve their ability to measure hurricane impacts, separate such impacts from other effects, both natural and anthropogenic, make effective recommendations for improved building codes and urban planning practices, and develop effective procedures for responding to infrastructure disruption	Data collection platforms and data provisioning systems
	IMPROVED OBSERVATIONS OF HURRICANES AND TROPICAL STORMS		
2	ASSESSING VULNERABLE INFRASTRUCTURE		
	INTERACTION OF HURRICANES WITH ENGINEERED STRUCTURES		
3	RELATIONSHIP BETWEEN HURRICANES, CLIMATE, AND NATURAL ECOSYSTEMS		
4	TECHNOLOGIES FOR DISASTER RESPONSE AND RECOVERY		
5	EVACUATION PLANNING		
6	COMPUTATIONAL CAPABILITY		

A comparison of Tables 4 and 5 shows a significant overlap of a number of the activities of NWIRP and those proposed in the NHRI Act. Based on this observation, a synthesis of the two programs is proposed in Table 6.

The format of the synthesis in Table 6 is similar to that employed in a comparison of the programs proposed by the AAWE/ASCE Report and the NSB Report, see Table 3. The NWIRP's component structure is retained and the NHRI areas of activities (in bold capitol italic font) are added in appropriate columns. The National Infrastructure Database (NID) and the National Hurricane Hazards Research Model (NHRM), referred

to in the NHRI Act, are incorporated in the synthesized program. The NHRM is expanded beyond hurricanes and it includes hazards due to other types of strong winds. Accordingly, it is labeled as the National Wind Hazards Research Model (NWHRM).

Table 6. Synthesis of NWIRP and national program proposed in NHRI Act of 2007

NWIRP COMPONENTS		
I. IMPROVED UNDERSTANDING OF WINDSTORMS	II. WINDSTORM IMPACT ASSESSMENT	III. WINDSTORM IMPACT REDUCTION
A. Research to improve knowledge of and data collection on the impact of severe wind on buildings, structures, and infrastructure.	A. Development of mechanisms for collecting and inventorying information on the performance of buildings, structures, and infrastructure in windstorms and improved collection of pertinent information from sources, including the design and construction industry, insurance companies, and building officials.	A. Development of improved outreach and implementation mechanisms to translate existing information and research findings into cost effective and affordable practices for design and construction professionals, and State and local officials;
<i>NHRI-1. PREDICTIONS, UNDERSTANDING & OBSERVATIONS OF HURRICANES & TROPICAL CYCLONES</i>	B. Research, development, and technology transfer to improve loss estimation and risk assessment systems;	B. Development of cost-effective and affordable windstorm-resistant systems, structures, and materials for use in new construction and retrofit of existing construction.
<i>NHRI-3. RELATIONSHIP BETWEEN HURRICANES, CLIMATE, AND NATURAL ECOSYSTEMS</i>	C. Research, development, and technology transfer to improve simulation and computational modeling of windstorm impacts.	C. Outreach and information dissemination related to cost-effective and affordable construction techniques, loss estimation and risk assessment methodologies, and other pertinent information regarding windstorm phenomena to Federal, State, and local officials, the construction industry, and the general public.
	<i>NHRI-2. ASSESSING VULNERABLE INFRASTRUCTURE & ENGINEERING STRUCTURES</i>	<i>NHRI-4. TECHNOLOGIES FOR DISASTER RESPONSE AND RECOVERY</i>
	<i>NHRI-6. COMPUTATIONAL CAPABILITY</i>	<i>NHRI-5. EVACUATION PLANNING</i>
<i>NATIONAL INFRASTRUCTURE DATABASE (NID)</i>		
<i>NATIONAL WIND HAZARDS RESEARCH MODEL (NWHRM)</i>		

4. Comparison of Proposed Budgets

The budget for NWHRP proposed in the AAWE/ASCE Report is summarized in Table 7. A detailed budget breakdown is included in the report. As can be seen, the average annual budget proposed for the program is \$61.8M.

Table 7. Budget for NWHRP proposed in AAWE/ASCE Report (in \$M)

PROGRAM COMPONENT		YR 1	YR 2	YR 3
A	UNDERSTANDING OF WIND HAZARDS	7.5	15.0	22.5
B	ASSESSMENT OF IMPACT OF WIND HAZARDS	8.5	16.9	25.4
C	REDUCTION OF IMPACT OF WIND HAZARDS	9.4	17.8	26.1
D	ENHANCE COMMUNITY RESILIENCE, EDUC. & PUB. OUTR.			
	COMMUNITY RESILIENCE TO WIND HAZARDS	1.5	3.0	4.5
	EDUCATION AND PUBLIC OUTREACH	4.6	9.1	13.7
	TOTAL	31.4	61.8	92.1

Table 8 shows the budget authorized by Congress in 2004 to support activities of the NWIRP. As mentioned earlier, no funds have been appropriated yet for this program. The average annual authorized budget is \$23.3M.

Table 8. Budget authorized (in 2004) for NWIRP (in \$M)

	Y1	Y2	Y3	Total
FEMA	8.7	9.4	9.4	27.5
NSF	8.7	9.4	9.4	27.5
NIST	3.0	4.0	4.0	11.0
NOAA	2.1	2.2	2.2	6.5
Total	22.5	25.0	25.0	72.5

Finally, the annual budget specified in the NHRI Act of 2007 is presented in Table 9. It should be pointed out that the Act called for 10-year program duration.

Table 9. Annual and overall budget proposed in Act of 2007 for NHRI (in \$M)

National Hurricane Research Initiative (NHRI)	285
National Infrastructure Database (NID)	20
National Hurricane Research Model (NHRM)	130
TOTAL (per annum)	318
[TOTAL (for 10 years)]	[\$3.18B]

5. Remarks

Recent Congressional and other national initiatives geared towards better understanding of hurricanes and other wind hazards, their impacts and mitigation of undesired impacts of strong winds, are encouraging. Members of wind engineering community are urged to get involved in related discussions and other actions aiding this process. It is hoped that these developments will lead to conditions conducive to timely appropriation of research funds for national wind hazards reduction program needed to reduce property and human losses, within a reasonable time framework.