Pre-Proposal Application USGS
TWRI USGS Graduate Student Research Program 2018- 2019

1. Title.

Evaluating the impact of the Katy Prairie and adding HCAD Plan 5 Reservoir on Flooding of Addicks and Barker Reservoirs in Houston, Texas.

2. Project Type. Research

3. Focus Categories. Floods (FL), Management and Planning (M&P), Hydrology (HYDROL)

4. Research Category. Climate and Hydrologic Processes

5. Keywords. Urban Flooding, Flood Management, Katy Prairie, Stormwater Management

6. Start Date. 3/1/2018

7. End Date. 2/28/2019

8. Principle Investigators. **Ferne Maulsby** *Graduate Student*, Rice University, Civil and Environmental Engineering Department, Environmental Engineering, ferne.maulsby@rice.edu, 713-348-3798.

Dr. Philip Bedient. Herman Brown Professor of Engineering, Civil and Environmental Engineering, Rice University, bedient@rice.edu. 713-348-4953.

9. Congressional District. 2nd District

10. Abstract.

In recent decades, rapid urbanization and the increased frequency of extreme rainfall events along the Texas Coast have challenged the integrity and storage capacity of the Addicks and Barker reservoirs in Houston, Texas. In August 2017, unprecedented volumes of rainfall due to Hurricane Harvey caused water levels in the two reservoirs to surpass their design capacity and inundate thousands of homes within the reservoir boundaries. This hazardous and costly flood event has emphasized the need to improve ageing flood infrastructure for the regions near the Addicks and Barker reservoirs in order to protect residents in Houston.

This study aims to quantify the effect of Harris County's Plan 5, a proposal for an additional reservoir upstream of Addicks and Barker reservoirs, compared to the natural depression storage of the Katy Prairie, on the overland flows into Addicks and Barker reservoirs. A suite of Radar Rainfall and Lidar datasets serve as inputs for hydrologic models and GIS mapping applications. These models determine the floodplains within Addicks and Barker reservoirs for the outlined flood mitigation structures. Results of this study will inform policy makers of the impacts of the Katy Prairie and the Plan 5 reservoir on flood prevention in nearby communities.

11. Budget Breakdown.

Cost Category	Federal	Non-Federal	Total
1. Salaries and Wages - Principal Investigator(s) - Graduate Student(s) - Undergraduate Student(s) - Others Total Salaries and Wages	$2,166.00	$4,472.00	$6,638.00
2. Fringe Benefits - Principal Investigator(s) - Graduate Student(s) - Undergraduate Student(s) - Others Total Fringe Benefits	$0	$1,163.00	$1,163.00
3. Tuition - Graduate Student(s) - Undergraduate Student(s) Total Tuition	$834.00	$0	$834.00
4. Supplies	$1,000.00	$3,000.00	$4,000.00
5. Equipment			
6. Services or Consultants			
7. Travel	$1,000.00	$1,365.00	$2,365.00
8. Other direct costs			
9. Total direct costs			
10a. Indirect costs on federal share	XXXXXXX XXXXXXX	$0	$0
10b. Indirect costs on non-federal share	XXXXXXX XXXXXXX	$0	$0
11. Total estimated costs	$5,000	$10,000	$15,000
Total Costs at Campus of the University on which the Institute or Center is located.	$0	$0	$0
Total Costs at other University Campus Name of University: Rice University	$5,000	$10,000	$15,000

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12. Budget Justification.

Salaries and Wages for PIs. Provide personnel, title/position, estimated hours and the rate of compensation proposed for each individual.
Professor Phil Bedient will contribute effort equal to 0.25% of academic year time salary
Salaries and Wages for Graduate Students. Provide personnel, title/position, estimated hours and the rate of compensation proposed for each individual. (Other forms of compensation paid as or in lieu of wages to students performing necessary work are allowable provided that the other payments are reasonable compensation for the work performed and are conditioned explicitly upon the performance of necessary work. Also, note that tuition has its own category below and that health insurance, if provided, is to be included under fringe benefits.)
Ferne Maulsby (PI) will work 135 hours on the grant at $16/hour
Salaries and Wages for Undergraduate Students. Provide personnel, title/position, estimated hours and the rate of compensation proposed for each individual. (Other forms of compensation paid as or in lieu of wages to students performing necessary work are allowable provided that the other payments are reasonable compensation for the work performed and are conditioned explicitly upon the performance of necessary work. Also, note that tuition has its own category below and that health insurance, if provided, is to be included under fringe benefits.)
Salaries and Wages for Others. Provide personnel, title/position, estimated hours and the rate of compensation proposed for each individual.
Fringe Benefits for PIs. Provide the overall fringe benefit rate applicable to each category of employee proposed in the project. . Note: include health insurance here, if applicable.
The fringe benefit rate for Professor Phil Bedient is 26% of academic year time faculty fringe benefits.
Fringe Benefits for Graduate Students. Provide the overall fringe benefit rate applicable to each category of employee proposed in the project. Note: include health insurance here, if applicable.
Fringe Benefits for Undergraduate Students. Provide the overall fringe benefit rate applicable to each category of employee proposed in the project. Note: include health insurance here, if applicable
Fringe Benefits for Others. Provide the overall fringe benefit rate applicable to each category of employee proposed in the project. . Note: include health insurance here, if applicable.
Tuition for Graduate Students.
$834 Tuition Remission at a rate of 38.5%.
Tuition for Undergraduate Students
Supplies. Indicate separately the amounts proposed for office, laboratory, computing, and field supplies. Provide a breakdown of the supplies in each category.
$1000 will be spent to purchase high resolution radar rainfall data from Vieux and Associates
Equipment. Identify non-expendable personal property having a useful life of more than one (1) year and an acquisition cost of more than $5,000 per unit. If fabrication of equipment is proposed, list parts and materials required for each, and show costs separately from the other items. A detailed breakdown is required.
Services or Consultants. Identify the specific tasks for which these services, consultants, or subcontracts would be used. Provide a detailed breakdown of the services or consultants to include personnel, time, salary, supplies, travel, etc.
Travel. Provide purpose and estimated costs for all travel. A breakdown should be provided to include location, number of personnel, number of days, per diem rate, lodging rate, mileage and mileage rate, airfare (whatever is applicable).
$1,000 will be spent to present the results of the study at the 2018 AGU Conference.
Other Direct Costs. Itemize costs not included elsewhere, including publication costs. Costs for services and consultants should be included and justified under "Services or Consultants (above). Please provide a breakdown for costs listed under this category.
Indirect Costs. Provide negotiated indirect ("Facilities and Administration") cost rate.
F&A rate at the approved rate of 56.5%.

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13. Title.

Evaluating the impact of the Katy Prairie and adding HCAD Plan 5 Reservoir on Flooding of Addicks and Barker Reservoirs in Houston, Texas.

14. Statement of regional water problem.

Houston has been struggling with floods since its founding by the Allen brothers in 1836 (Harris County Flood Control District, 2017). More recently, Greater Houston ranked among the highest in the nation in terms of cost of damages due to repeatedly flooded properties (National Wildlife Federation, 1998). Houston's flood susceptibility is due to the combination of three main contributing factors: a flat landscape, outdated infrastructure, and increased urban development.

Houston has jumped from an estimated 1.6 million to 2.3 million residents from the year 1990 to 2016 (Texas State Library and Archives, 2013; Harris County Flood Control District, 2017). This increase in population coupled with relatively low land prices has caused a trend of urban sprawl. In Addicks reservoir, development has even encroached to locations lower than the 100-year rainfall design capacity. Urban sprawl has significantly increased percentage of land covered by impermeable surfaces, added channels, and decreased the percentage of land covered by vegetation in Houston and as a result has increased peak flow and flooding (Khan , 2005; Suriya & Mudgal, 2011). Parts of Houston remain undeveloped; however, recent trends of increasing population are projected to continue into the future and therefore the need to develop more area for housing will continue.

A city of big skies and no hills or mountains to be seen, Houston is renowned for its flat landscape. The change in elevation is an average of about one foot vertically for every 1 mile horizontally (Zhu, Quiring, Guneralp, & Peacock, 2015). Communities rely on being able to drain water from their properties and streets into the city's bayous. The slope decreases the flowrate of water in Houston's waterways, allowing for more water to collect and overtop their banks. Flooding in neighborhoods occurs from both the overtopping of bayous and water that backs up into the streets when waterways are full.

The unchanging flat landscape and increase of urban sprawl into the future will continue to intensify flooding issues if Houston does not radically adjust their existing infrastructure.

15. Statement of expected results and benefits:

The results of this study will provide information regarding the changing flood risk to neighborhoods in and near Addicks and Barker Reservoirs associated with Plan 5 Reservoir or changes to the Katy Prairie. Specifically, the quantitative results of this study will be the elevations of water in the Addicks and Barker Reservoirs and will provide a better understanding of the direct areas that will be inundated under each of the proposed conditions. Previous studies on the Plan 5 implementation have only assessed the effects of up to 100-year rainfall events (Johnson, Odom, & Vick, 2015). Alternatively, this study will provide the measured elevations for 500-year rainfall events and recent historical rainfall events larger than the 100-year rainfall event in the Houston area. This extended analysis is important given the devastation caused by Hurricane Harvey in neighborhoods adjacent to the reservoirs. The results of this study will determine the effectiveness of these flood protection measures for the communities in and near Addicks and Barker reservoirs and may merit their implementation.

16. Nature, scope and objectives of the research, including timeline of activities:

This study employs natural and structural rainfall detention techniques for the contributing watersheds and quantifies water elevations for Addicks and Barker reservoirs to assess the impact of detention techniques on flood risk for homes in and near the Addicks and Barker Reservoirs in West Houston, Texas.

This scope of this study centers on Addicks and Barker Reservoirs and their contributing watersheds. The Addicks and Barker reservoirs get their runoff principally from the local overland runoff. However, there is a significant amount of water that overflows from Cypress Creek watershed into streams within the Addicks and Barker watersheds for 10-year and greater rainfall events. Ultimately, this additional water from Cypress Creek must be stored within the reservoirs and acts as an additional strain on their capacities. The protected lands of Katy Prairie are mostly located within the Cypress Creek watershed with small parts extending into Addicks and Barker watersheds. The Addicks and Barker reservoirs are affected by the runoff from these three watersheds and were originally designed for the 100-year rainfall event with little to no development present. Parts of the contributing watersheds have been urbanized, but there are still some areas which remain undeveloped.

Because the 100-year rainfall event has become an inadequate standard to for design, employing additional flood mitigation strategies are necessary to alleviate the volume of water entering Addicks and Barker reservoirs. This case study assesses flood mitigation strategies needed for Addicks and Barker Reservoirs, and has important implications for the future expansion of Houston.

Timeline:

March- June 2018: Validation of M3 Models and Creation of additional Models in HEC-HMS
June-August 2018: Runs for design Rainfall and Historic rainfalls in HEC-HMS
August-October 2018: Determine Floodplain in Addicks and Barker reservoirs for each Scenario
October 2018- January 2019: Analyzing Results and Report writing

17. Methods, procedures and facilities:

This study is broken into two major parts: hydrologic modeling of contributing watersheds and floodplain mapping and analysis inside of the Addicks and Barker reservoirs.

Hydrologic Analysis Methodology: The hydrologic modeling is analyzed for tributaries in Cypress Creek, Addicks and Barker watersheds using HEC-HMS modeling system. HEC-HMS is a physically based lumped parameter model which is often implemented for delineating floodplains (Hydrologic Engineering Center, 2016). Harris County Flood Control District Model & Map Management (M3 Models) has developed HEC-HMS models for the watersheds in Harris County which will be used in this study. The M3 models will be validated to ensure models reflect current conditions by comparing the flows produced by the models to USGS Streamflow data collected from gages for historic rainfall events.

Once the M3 models are validated, models including the Plan 5 reservoir, additional prairie restoration area, and replacement of existing prairies with urban infrastructure will be created. Each model will run 100-year (1%) and 500-year (0.2%) design storms and April 2016 (Tax Day Flood) and August 2017 (Hurricane Harvey) historic rainfall events. The output for these models will determine the volume of water entering Addicks and Barker reservoirs.

Reservoir Floodplain Mapping and Analysis: The storage volume to elevation relationship used for this study will be acquired from the United States Army Corps of Engineers (USACE) Galveston District Water Control Manual for Addicks and Barker Reservoirs. The volume of inflow into Addicks and Barker Reservoirs over time will determine the elevation in the reservoirs for each of the scenarios. ArcGIS Spatial Analyst extension is a tool for combining different geographical layers for analysis (Childs, 2004). ArcGIS will be used to create elevation contours from 2008 high resolution Lidar data acquired from Houston-Galveston Area Council (H-GAC). The floodplain elevation contours will be overlaid onto the neighborhoods existing in Addicks and Barker reservoirs to access the level of damage for each scenario.

18. Related research.

Harvey Related Research: In the wake of such a catastrophic storm as Hurricane Harvey, there has been many papers published about the record rainfall and its effects on the city. In a 2017 study by Oldenborgh, the rainfall from Harvey was evaluated for likelihood of increasing rainfall intensities due to global warming (van Oldenborgh, et al., 2017). Other studies regarding Hurricane Harvey have analyzed the physical and social causes of Houston's flood prone infrastructure. A 2017 article by Aldrich highlights the physical and social causes for the flooding during Harvey (Alderich, 2018). While there have been many studies regarding the causes of Hurricane Harvey and social and economic impacts of the storm, there is not much literature quantifying the flooding due to Harvey's rainfall using hydrologic models. This study aims to use lumped parameter hydrologic models and hydraulic models to evaluate the effectiveness of possible flood mitigation techniques in the Addicks and Barker reservoirs.

Hydrologic and Hydraulic Modeling and Flood Plain Analysis: Many projects have successfully used similar methodologies to model the flows from a storm using HEC-HMS, GIS and radar rainfall. A study in 2005 by Knebl uses HEC-HMS calibrated to the stream gages in the San Antonio River Basin to obtain regional flood modeling (Knebl, Yang, Hutchison, & Maidment, 2005). HEC-HMS is used broadly to predict inflows from rainfall data in studies such as studies conducted by Anderson et al. (2002) and Pistocchi et al. (2002). Other studies have analyzed the usefulness of coupling GIS and HEC-HMS models (Olivera, 2001). Many studies have successfully modeled the floodplain using similar models and validation techniques; however, the specific Addicks and Barker watersheds have had few studies to evaluate their floodplains. A report prepared for the Harris County Flood Control District in 2015 contained similar hydrologic and hydraulic analysis, but only evaluates the reservoirs and flood mitigation for up to 100-year flooding events (Johnson, Odom, & Vick, 2015) which excludes large storms like Harvey, larger than 500-year storm. Instead, this study aims to quantify the floodplains for larger flood events in and near the Addicks and Barker reservoirs with flood mitigation and compare results with current conditions.

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References

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Anderson, M., Chen, Z., Kavvas, M., & Feldman, A. (2002). Coupling HEC-HMS with Atmospheric Models for Prediction of Watershed Runoff. *Journal of Hydrologic Engineering* , 312-318.

Childs, C. (2004, July-September). Interpolating Surfaces in Arc GIS Spatial Analyst. *ArcUser*, pp. 32-35.

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Johnson, B. L., Odom, T. F., & Vick, J. A. (2015). *Final Study Report: Cypress Creek Overflow Management Plan.* Contract Report, Texas Water Development Board.

Khan , S. D. (2005, May). Urban development and flooding in Houston Texas, inferences from remote sensing data using neutral network technique. *Environmental Geology, 47*(8), 1120-1127.

Knebl, M., Yang, Z., Hutchison, K., & Maidment, D. (2005, June). Regional scale flood modeling using NEXRAD rainfall, GIS, and HEC-HMS/RAS: a case study for the San Antonio River Basin Summer 2002 storm event. *Journal of Environmental Management, 75*(4), 325-336.

National Wildlife Federation. (1998). *Higher Ground: A Report on Voluntary Property Buyouts in the Nation's Floodplains, A Common Ground Solution Serving People at Risk, Taxpayers and the Environment.* Washingtion, D.C.: National Wildlife Federation.

Olivera, F. (2001). Extracting Hydrologic Information from Spatial Data for HMS Modeling. *Journal of Hydrologic Engineering* , 524-530.

Pistocchi, A., & Mazzoli, P. (2002). Use of HEC-RAS and HEC-HMS models with ArcView for hydrologic risk management. *9th International Congress on Environmental Modelling and Software*, 304-310.

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U.S. Census Bureau. (2017, May). *Annual Estimates of the Resident Population for Incorporated Places of 50,000 or More, Ranked by July 1, 2016 Population: April 1, 2010 to July 1, 2016.* Retrieved from U.S. Census Bureau 2016: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

US Army Corps of Engineers Galveston District. (2009). *Addicks and Barker Reservoirs Master Plan.* Retrieved from http://www.swg.usace.army.mil/Portals/26/docs/2009%20Addicks%20and%20Barker%20MP.pdf

van Oldenborgh, G., van der Wiel, K., Sebastian , A., Singh, R., Arrighi, J., Otto, F., . . . Cullen, H. (2017). Attribution of extreme rainfall from Hurricane Harvey, August 2017. *Environmental Research Letters*, 1-11.

Zhu, L., Quiring, S., Guneralp, I., & Peacock, W. (2015). Variations in tropical cyclone-related discharge in four watersheds near Houston, Texas. *Elsevier, 7*, 1-10.

19. Training potential. This project will allow training for Hydrologic and Hydraulic modeling, HEC-RAS and HEC-HMS, and GIS modeling for both the Primary Investigator (Ferne Maulsby) and an undergraduate.

20. Student's qualifications. See attached resumes for PI's.

Ferne E. Maulsby

Education

Rice University, Houston, TX **August 2017 - Present**

- **M.S. Civil and Environmental Engineering**
- Focus in Hydrology and Hydraulic Engineering

Texas A&M University, College Station, TX **August 2013 -August 2017**

- **Major:** Biological and Agricultural Engineering Major
- Focus in Natural Resource Engineering
- Overall GPR 3.0, Major GPR 3.1

Katholieke Universiteit Leuven, Leuven**,** Belgium – TAMU Study Abroad Program **Summer 2016**

- Studied Hydrology and waste management
- Applied knowledge learned in class to water and waste treatment and hydrologically significant sites

Experience

Texas Commission on Environmental Quality-Houston Region, Houston, TX **May 2017- August 2017**

- *Mickey Leland Environmental Internship Program* – Responsible for assisting the environmental investigators with reports, filing and when onsite for investigations.

TAMU Transportation Services, College Station, TX **April 2016- May 2017**

- *Student Dispatcher* –Responsible for directing and answering questions for drivers, managing time sensitive issues under pressure, performing routine clerical and administrative functions.

TAMU Transportation Services, College Station, TX **October 2014- May 2017**

- *Student Aggie Spirit Bus Driver*- Driving students around campus on commercial bus and answering passenger questions. Current Texas Class B Commercial driver's license.

Hugh Lindsay, Attorney at Law -- College Station, TX **July 2014- July 2015**

- *Office Assistant / Filer*- filing closed cases and organizing files and boxes

Volunteering and Organizations

ASABE Member, Texas A&M University, College Station **January 2015- August 2017**

Big Event, Texas A&M University, College Station, TX **April 2016, March 2015, 2014**

- *Volunteer* – Helping people around College Station for a day by preforming miscellaneous house work and various other small projects

BCP Veterinary Pharmacy – Houston, TX **August 2013**

- *Pharmacist Assistant*- Filing invoices, Assisting in experiments, Labeling medications for shipment

Awards

Texas Fundamentals of Engineering Exam- (passed on first attempt) **February 2017**

Dwight Look College of Engineering Study Abroad Scholarship **May 2016**

BAEN Study Abroad Scholarship **April 2016**

Skills

Computer Skills

- Proficient in Microsoft Word, Excel, Power Point, SolidWorks, AutoCAD, and
- Introductory Experience with ArcGIS, HEC-HMS, HEC-RAS, Python, and MATLAB

Interpersonal Skills

- Adaptable, Friendly, Open-Minded, Creative, Responsible, Hardworking, Teachable, Willingness to Accept New Challenges, Willingness to Travel

Philip B. Bedient
Brief Resume

PROFESSIONAL ADDRESS:

Herman Brown Professor of Engineering
Professor of Civil and Environmental Engineering
Rice University
6100 Main St./MS - 317
Houston, Texas 77005
(713) 348-4953 or 348-4951
email – bedient@rice.edu

1. PROFESSIONAL PREPARATION:

B.S. Physics, University of Florida, Gainesville, Florida, 1969
M.S. Environmental Engineering, University of Florida, 1972
Ph.D. Environmental Engineering Sciences, University of Florida, 1975

2. APPOINTMENTS:

Herman Brown Professor of Engineering - Civil and Environmental Engineering - Rice University - July 2001 to present.
Professor - Environmental Engineering - Rice University - 1986 to 2001.
Professor and Chair - Department of Environmental Science and Engineering, Rice University, Houston, Texas, 1992 - 1999.
Asst & Associate Professor - Environmental Engineering – 1975 - 1986.

3. PUBLICATIONS (selected from over 120 journal articles):

Torres, Jacob M., Benjamin Bass, Nicholas Irza, Zheng Fang, Jennifer Proft, Clint Dawson, Morteza Kiani, and Philip Bedient. "Characterizing the hydraulic interactions of hurricane storm surge and rainfall–runoff for the Houston–Galveston region." Coastal Engineering 106 (2015): 7-19.

Christian, J., Fang, Z., Torres, J., Deitz, R., Bedient, P. (2014). "Modeling the Hydraulic Effectiveness of a Proposed Storm Surge Barrier System for the HSC during Hurricane Events." ASCE Natural Hazards Review, http://dx.doi.org/10.1061/(ASCE).

Fang, N., Dolan G., Sebastian, A., & Bedient, P.B. (2014). Case Study of Flood Mitigation and Hazard Management at the Texas Medical Center in the Wake of Tropical Storm Allison in 2001. ASCENatural Hazards Review, 15(3). doi: 10.1061/(ASCE)NH.1527-6996.0000139.

Sebastian, A., Bedient, P., Proft, J., Dietrich, J., Dawson, C., (2013) "Characterizing hurricane storm surge behavior in Galveston Bay using the SWAN+ADCIRC Model" Coastal Engineering. http://dx.doi.org/10.1016/j.coastaleng.2014.03.0020378-3839

Christian, J., A. Teague, L. Duenas-Osario, Z. Fang, and P. Bedient, (2012). "Uncertainty in Floodplain Delineation: Expression of Flood Hazard and Risk in a Gulf Coastal Watershed." Journal of Hydrological Processes, doi:10.1002/hyp.9360

Five Other Publications:

Bedient, P. B. and W. C. Huber, 2012, "Hydrology and Floodplain Analysis", 5th Ed. Prentice-Hall Publishing Co., Upper Saddle River, NJ, February, 2012, 800 page textbook.

Brody, S.D., Blessing, R., Sebastian, A., Bedient, P., (2013) "Delineating the Reality of Flood Risk and Loss in Southeast, Texas" Natural Hazards Review, May 2013, Journal of Hydrologic Engineering, ASCE.

Bedient, P. B., 2012 "Lessons learned from Hurricane Ike" Ed. Philip Bedient. College Station, TX: Texas A&M University Press, College Station, TX: 2012, 194 Pages.

Ray, T., Stepinski, E., Sebastian, A., Bedient, P.B. (2011)"Dynamic Modeling of Storm Surge and Inland Flooding in Texas Coastal Floodplain" ", Journal of Hydrologic Engineering, ASCE, Vol. 137, No.10, October 2011, ISSN 0733-9429/2011/10-1103-1110

Doubleday, G., Sebastian, A., Luttenschlager, T., and Bedient, P. (2013). Modeling Hydrologic Benefits of Low Impact Development: A Distributed Hydrologic Model of The Woodlands, Texas, Journal of AWRA.

4. RESEARCH and AWARDS:

Dr. Philip B. Bedient is also Herman Brown Professor of Engineering in the Dept. of Civil and Environmental Engineering at Rice University. He teaches and performs research in surface and ground water hydrology, disaster management, and flood prediction systems. He served as Chair of Environmental Engineering from 1992 to 1999. He has directed 60 research projects over the past 36 years, has written over 180 articles in journals and conference proceedings. He is lead author on a text on "Hydrology and Floodplain Analysis" (Prentice Hall, 5th ed., 2012) used in over 75 universities across the U.S. Dr. Bedient received the Herman Brown endowed Chair of Engineering in 2002 at Rice University. He was elected to Fellow ASCE in 2006 and received the C.V. Theis Award from the American Institute of Hydrology in 2007. He earlier received the Shell Distinguished Chair in Environmental Science (1988 to 1993). Dr. Bedient has over 39 years of experience working on flood and flood prediction problems in the U.S. He routinely runs computer models such as HEC-HMS, HEC-RAS, SWMM, and VFLO for advanced hydrologic analysis. He developed one of the first radar based rainfall flood alert systems (FAS-3) in the U.S. for the Texas Medical Center.

He is the director of the Severe Storm Prediction Center (SSPEED) at Rice University (since 2007) consisting of a team of seven universities and 15 investigators from Gulf coast universities dedicated to improving storm prediction, education, and evacuation from disaster. The Center has been funded at over $7.0 million for the past 5 years from various sources including the Houston Endowment. A book has been developed and published by TAMU press titled "Lessons from Hurricane Ike" published in June 2012. The SSPEED Center has taken a regional approach to developing mitigation strategies and has identified various zones of interest in the Houston-Galveston region: the Houston Ship Channel, West Bayshore, Galveston Island and the Lone Star National Coastal Recreation Area (LSNCRA). The new approach is called H-GAPS.

COLLABORATORS:

Dr. Sam Brody-TAMU College Station
Dr. Clint Dawson-University of Texas Austin
Dr. Hanadi Rifai -University of Houston
Dr. John Pardue – Louisiana State Univ
Dr. Jamie Padgett – Rice University
Dr. Nick Fang – Univ of Texas Arlington

Ph.D. DISSERTATIONS (past 10 yr)

Jason Christian 2012
Ria Safiolea 2006
Natalie Capiro 2006
Nick Fang 2008
Aarin Teague 2011

CURRENT Ph.D.

Andrew Juan 2015
Antonia Sebastian 2016
Jacob Torres 2015
Benjamin Bass 2016