Building Effective Community Resilience through Active Participation

Ms. Nathalia Ospina-Uribe, University of Puerto Rico, Mayaguez Campus

Nathalia Ospina Uribe was born in Armenia, Colombia and completed her B.S. degree in Architecture with emphasis in Urban Design from the University of La Gran Colombia (UGC) in (2013). She worked for over three years in the construction industry as a technical and contract architect at companies such as Bureau Veritas and ECOM Trading. She is currently pursuing her M.E. degree in Civil Engineering and Construction Management at the University of Puerto Rico, Mayagüez Campus (UPRM). Ospina Uribe has diverse interests in the research area of Community Resilience; Appropriate Technology, and Climate Change. During her Master's program she become involved in a pilot project to co-develop workshops aimed at strengthening community resilience through the creation of practical solutions for Water, Sanitation and Hygiene challenges in Puerto Rico through opportunities supported by NSF, Oxfam America and the Response Innovation Lab.

Pamela Cristina Silva Díaz

Pamela Cristina Silva Díaz was born in San Juan, Puerto Rico and completed her bachelor's degree in Mechanical Engineering at the Massachusetts Institute of Technology in 2012. She obtained her Master of Science in the same field at the University of Michigan in 2014. After working for over two years in the aerospace industry, she joined Oxfam America as a Technician for Public Health during the Hurricane Maria response and recovery efforts in Puerto Rico. She later joined the Response Innovation Lab and co-developed workshops aimed at strengthening community resilience through the creation of practical solutions for Water, Sanitation and Hygiene challenges.

Dr. Aidsa I. Santiago-Román, University of Puerto Rico, Mayaguez Campus

Dr. Aidsa I. Santiago-Román is a Professor at the Engineering Sciences and Materials (CIIM) Department at the University of Puerto Rico, Mayagüez Campus (UPRM). Dr. Santiago earned a BA and MS in Industrial Engineering from UPRM and Ph.D in Engineering Education from Purdue University. Dr. Santiago has over 20 years of experience in academia and is currently the Department Head of the CIIM Department. She's also the founder and advisor of the first ASEE student chapter in Puerto Rico. Her primary research interests include investigating students' understanding of difficult concepts in engineering sciences, especially for underrepresented populations. She also works in the development and evaluation of various engineering curriculum and courses at UPRM applying the outcome-based educational framework.

Prof. Christopher Papadopoulos, University of Puerto Rico, Mayaguez Campus

Christopher Papadopoulos is Professor in the Department of Engineering Sciences and Materials at the University of Puerto Rico, Mayagüez Campus (UPRM). He earned B.S. degrees in Civil Engineering and Mathematics from Carnegie Mellon University (1993) and a Ph.D. in Theoretical and Applied Mechanics at Cornell University (1999). Prior to UPRM, Papadopoulos served on the faculty in the Department of Civil engineering and Mechanics at the University of Wisconsin, Milwaukee.

Papadopoulos has diverse research and teaching interests in structural mechanics and bioconstruction (with emphasis in bamboo); appropriate technology; engineering ethics; and mechanics education. He has served as PI of several NSF-sponsored research projects and is co-author of Lying by Approximation: The Truth about Finite Element Analysis. He is active in the Mechanics Division.

Engagement in Practice: Building Effective Community Resilience through Active Participation

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1. Introduction

After a "catastrophe" or "disaster" – defined as "a potentially traumatic event that is collectively experienced, has an acute onset, and is time delimited, … attributed to natural, technological, or human causes" [1] – the concept of *Resilience* is useful to understand how communities and societies return "back to normal" or recover to a "new normal". A good working definition of resilience is the capacity acquired to adapt to change [2]. The concept of *Disaster Risk Reduction* (DRR) is closely related to Community Resilience, as it focuses on the capacity of affected communities to overcome a natural disaster with little or no outside assistance [3] Frequently, reducing the scope of the event or in some cases improving their lifestyles [4]. These concepts form the background of our work in various recovery and renormalization efforts in Puerto Rico after Hurricanes Irma and María passed through in September 2017, which grew into a collaboration of Oxfam America, the Response Innovation Lab (RIL), and the University of Puerto Rico, Mayagüez (URPM) to promote community-based "Do-It-Yourself" solutions.

Especially after Hurricane María, many isolated communities were left with no choice other than to respond and adapt relatively independently from government or other aid agencies. The concept of *Community Resilience* is therefore the focus of this study. This concept includes not only temporary measures of 'survival', but also the broader notion of sustainable communities and planning [5]. Our approach to community resilience is participatory, with the understanding that many solutions lie within the innovative capacities of "victims". We draw upon *Creative Capacity Building* (CCB) as an approach to train community members to develop skills to design their own technologies for improving their own livelihoods [5]. "Creative capacity building has a great potential to convert local communities into innovators" [6]. Also, CCB serves as a model of gender inclusion, enabling both men and women to share the same roles [6]. It has been demonstrated that innovations are often most effective when the users also participate in the design [7]. In summary, our mission is to empower and stimulate community members to work together, particularly by leveraging their own genius and wisdom to meet their needs in an effectively. We believe that this work represents the development of what might be called a "participation cluster", a network of people who can share knowledge fluidly with each other as needed, in a manner analogous to how a micro-grid distributes power coherently to its users.

As researchers and educators, we pose five questions: (1) To what extent do members of local communities have well-developed concepts of resilience? (2) What can be learned from the community members' experience, both about their attitudes toward resilience and planning, and the practical means that they developed to address their needs in the wake of catastrophe? (3) What are practical appropriate technologies that can be built and managed within the resources that are typically available in a local community? (4) To what extent will direct participation in designing and building simple technologies lead to their adoption, and ultimately contribute to

community resilience? And (5) How can these efforts be integrated into the curricular and non-curricular activities of engineering students and faculty?

2. Learning from Community Members' Experiences

Best practices in community development require external agents to critically listen to the community [8]. The basic approach that we are developing – the design and delivery of participatory "Do-It-Yourself (DIY)" Solutions Workshops – is informed by a rigorous study conducted by Oxfam America in eight of the most affected communities in Puerto Rico in the months following Hurricanes Irma and María. This study determined that after the immediate threats had passed, people remained without stable water service, and expressed great concerns about hygiene issues and water management for domestic work. Although they were able to access potable water for drinking, they sought methods to improve laundry, hand washing, and household cleaning (particularly in bathrooms). In response, UPRM, Oxfam America, and the Response Innovation Lab developed several "appropriate technologies" – a foot-pump driven sink, a hand-driven laundry apparatus, and homemade cleansers - that can be made with available materials and basic skills. However, rather than simply building and delivering, we adopted a collaborative model of holding DIY Workshops in which interested community members can directly participate in the construction and improvement of the solutions.

We are also using the workshops as an opportunity to continue to learn about the community members' experiences and ideas. In each workshop we ask the participants to complete a written questionnaire and participate in a small group discussion. The approach to this study uses grounded theory as a guiding framework, which is "a design of inquiry from sociology in which the researcher derives a general, abstract theory of a process, action, or interaction grounded in the views of participants" [9]. This process involves using multiple stages of data collection and the refinement and interrelationship of categories of information" [10], [11] to learn about the experiences of the community members with whom we interacted in our workshops. A questionnaire was designed and distributed to inquire about participants' experiences and attitudes pre- and post- catastrophe.

3. Details of DIY Solutions Workshops

A first series of workshops was given in the communities of Comerío, Las Piedras, and Oracovis during the Fall 2018 semester, engaging a total of 32 participants, most of whom were female. These communities were chosen in based on recommendations of Oxfam America. Consent and confidentiality protocols approved by both Oxfam America and the University of Puerto Rico, Mayagüez were used. Each workshop included the following components (see Figure 1):

- Community Resilience Pre- and Post-Survey;
- Training to build "DIY Solutions", including hand-driven plunger-and-bucket washing machines; foot-pump sinks, homemade toilet cleansers;
- Community conversation: Sharing local innovations created in the aftermath of the "natural disaster";
- Feedback form and discussion, including "sticky notes" from participants to identify challenges.

a.  b.  c. 

d.  e. 

Figure 1. Workshop Experiences. (a) Two women using the tools during the manual washing process. (b) The moment of the test and its expression of happiness. (c) Making homemade cleanser. (d) Cutting tubes for the foot-pump sink. (e) Demonstrating the sink.

Feedback gathered after the workshops was used to develop a curriculum, manual, and video tutorials that will allow for future replications of the workshops, currently under development, following a "train-the-trainers" approach adopted from the MIT-D Lab [12]. The curriculum materials demonstrate the technical and material requirements, as well as approaches to promote gender equity and mental health. The role of STEM students becoming "trained trainers" is discussed in Section 5.

4. Community Members' Conceptions of Resilience

The pre-survey that was administered focused on questions regarding how the participants reacted to the hurricanes' effects, both in material terms and their feelings. The analysis of this data is still in progress, but in general, the responses indicated a 'survivalist' posture rather than one of contemplated resilience. However, in the post-survey, it appeared that the participants were able to reframe many of their reactions in terms of resilience.

For example, one common theme expressed by multiple participants was to note that their lives changed, expressing the need to be continually prepared for future changes or disasters. One participant commented: "Everything changed after disaster; this taught us to have another lifestyle. However, it was positive, because we shared more in family and decided to be more prepared to face a possible change". Overall, of the 32 participants, 19 indicated that they are prepared for future events and offered details demonstrating their understanding of techniques and solutions. The remaining 13 also reported being prepared, but without commentary.

A second finding – perhaps a particular instance of the first – was that participants expressed the importance of working in community. On the pre-survey, many participants indicated that they had not known or cared who were the leaders of their communities before the catastrophe, but afterwards they saw the necessity to find solutions in the face of the problems that they were experiencing. One participant commented that "After the catastrophe, the community work was increased"; she and others cited that community members cooperated on tasks such as removing debris from roads, distributing food and water, and sharing transportation. These responses suggest at least a tacit notion of community resilience, and later, several emphasized their new-found realization of the need to work in community as a result of the workshops.

The sense of community transcended immediate reactions, e.g., neighbors helping neighbors to clear rubble, to realizations of the importance of community decision making. One participant from a community which had its own aqueducts system said that the decision to invest in the system decades ago was one of the best decisions that it had made, because it allowed them to function after the disaster, and helped them to understand the importance of continuing to prepare for future changes. This community is now thinking of installing off-grid electricity. Another participant from a community with solar panels at a community center indicated that they had the capacity to power freezers to make ice which could be distributed to neighbors.

Third, reaction to the workshops was generally positive. One participant said, "The workshop helped me to raise awareness of what local materials could I use in case of an eventual change or catastrophe." Thus, the workshops were empowering to teach tools and encourage future innovations in a cooperative learning environment. As further evidence of their positive impact, several participants in all three workshops expressed their desire to teach their neighbors and family members do build the DIY solutions.

5. Integrating DIY Solutions with Engineering Education and Outreach

During the end of the Fall 2017 semester and in the Spring 2018 semester, the authors organized several DIY-style workshops at several community centers and at a vocational school in the region. The UPRM chapter of the Society of Hispanic Professional Engineers (SHPE) and the UPRM University Institute for Community Development (IUDC by its Spanish acronym) were instrumental in organizing and delivering these workshops, which reached a total of approximately 150 participants[1]. These early workshops were focused on the construction of wood-fueled "rocket stoves" from used metal food cans, useful for cooking or boiling water. These early workshops were not yet linked to the hygiene needs recommended by Oxfam America study, but they nevertheless served as a precursor to the current format.

These early experiences, together with the DIY Workshops in Fall 2018 (Section 3), collegial interest, and various other local resilience movements, motivated a decision to create a course that focuses on development and dissemination of practical skills for community resilience. This

[1] One workshop was given as a three-part series to five sections of a science course at the Escuela Superior Vocacional Dr. Pedro Perea Fajardo in Mayagüez, reaching approximately 100 students at the senior level over 15 contact hours. The teacher was able to use the topic to link to some basic scientific principles and the team introduced broader issues about sustainability and technology.

course, entitled “Design and Practice for Community Resilience”, is currently in progress as of the Spring 2019 semester and has 24 enrolled students, 21 of whom are from engineering. The course is divided into several modules, one of which is on DIY Solutions. Other topics include bioconstruction, rain water harvesting, and off-grid electricity, and reflections using ideas from the Philosophy of Technology.

As of the writing of this article, three 3-hour class periods have been devoted toward training the students on the materials and techniques necessary to build the basic DIY solutions and also on how to deliver workshops “train-the-trainers” [12]. This includes training to lead brainstorming activities, conduct mental health exercises, perform surveys, and promote balanced gender roles and language. The students are divided into four groups of six, and each group has the responsibility to identify a community that it interested in the activity and organize a workshop to occur over two half days (it has been discovered that this is favorable to one full day). Funds for materials are provided by Oxfam America and the project Cultivating Responsible Wellbeing in STEM (NSF 1449489).

In addition to the community DIY workshops, the students are engaged in another project to develop capacity at an off-grid restaurant called the Chef’s Garden in the neighboring town of Rincón. The students will build a wood-fired oven using clay/earth/cob as the primary material. But already, the students decided to contribute a model of the foot-pump sink to allow customers to wash their hands. The sink has been well received, and underscores the idea that DIY innovations are not restricted to temporary emergency measures when the “real” services are not available; rather, they can point the way toward becoming the “new” real solutions that are robust and low footprint.

Although the class is in progress and formal assessment has not yet been conducted, students are generally reacting with enthusiasm. They see the practicality and importance of the activities. Figure 2 shows scenes of the class in the DIY training workshops, and Figure 3 shows students working on a project that involves bamboo construction at a local organization called Plenitud Iniciativas Eco-Educativas.

a.  b.  c. 

Figure 2. “Train-the-Trainers”. (a) Making a fragrant toilet cleanser. (b) Testing and signing the foot-pump sink; signing it. (c) Building the hand-driven washing machine.

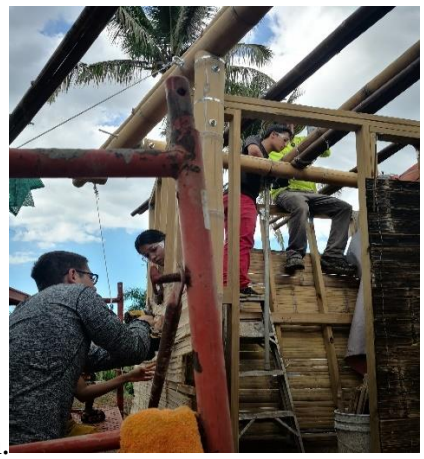
a.  b.  c. 

Figure 3. Bamboo Experience. (a).Working on an outdoor bathroom. (b) Building a lath wall using bamboo "esterilla". (c) Bringing a bucket filled with cement to fill holes in bamboo poles near joints.

Also, in November 2018, we presented concept of the DIY solutions the Forward Research & Innovation Summit, sponsored by the Puerto Rico Science, Technology, and Research Trust. This attracted the interest Ada Monzón, chief meteorologist at Univision Puerto Rico, and President of the Board of Directors at the EcoExploratorio Science Museum of Puerto Rico. She was instrumental in connecting our project with outreach efforts of the EcoExploratorio so that the DIY workshops could be adapted to be delivered in dozens of schools through their science outreach program.

6. Conclusions and Future Work

The experiences so far indicate several positive outcomes. First, it is possible to build useful devices consisting of locally available materials – "appropriate technologies" – that can be used to provide basic needs in the wake of a disaster. Second, the approach to develop these through a participatory learning process is most important, and this is corroborated by positive feedback from participants. Third, participants express positive notions of community resilience, such as the recognition of the need to work with neighbors, and the desire to continue to be prepared, both individually and collectively. Finally, students have also shown enthusiasm to learn about these solutions and propagate them by leading workshops in other communities.

Yet the grand question, "to what extent will direct participation in designing and building simple technologies lead to their adoption, and ultimately contribute to community resilience?", will not be answered through surveys and conversations, but through actual use in real future situations. This could occur in response to major catastrophes as well as more minor service interruptions. We therefore intend to find additional resources that will enable us to document adoption, particularly in light of [6]. We envision maintaining a network of contacts of participants, and through both self-reporting and periodic inquiries, we can learn about the actual usefulness of the solution that we are propagating.

We also hope that the initial solutions that we have developed inspire innovation, both either as improvements or fundamentally new ideas, and developed in partnership with community

members and students. This can take many forms, such as developing cooperative learning projects and design challenges.

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Appendix

Video DIY Solutions: https://cosechacreativa.wetransfer.com/downloads/2f54357e81e48c52c078400f6899269d20190219135559/431e5a174ffcdbed02f270d346d5a80720190219135559/17dd67

Video DIY Solutions: https://cosechacreativa.wetransfer.com/downloads/653fe3b9f7b07173fa49d6351195b6a520190219132248/a3b9efaf66c15aa9a38ec04fa73f5603201902191322248/c96c7f