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**TITLE: A Systems Approach to Off-grid Hydropower for Community-
led Flood Resilience**

**Spyros Schismenos^{1,5*}, Garry J. Stevens¹, Dimitrios Emmanouloudis^{2,5}, Nichole
Georgeou¹, Surendra Shrestha³ and Nikolaos D. Katopodes^{4,5}**

1: School of Social Sciences
Humanitarian and Development Research Initiative (HADRI)
Western Sydney University
Locked Bag 1797, Penrith, NSW, 2751, Australia
e-mail: {s.schismenos,g.stevens,n.georgeou}@westernsydney.edu.au

2: Department of Forestry and Natural Environment
International Hellenic University
1st km Drama-Mikrochorio, Drama, 66100, Greece
e-mail: demmano@teiemt.gr

3: School of Engineering
Western Sydney University
Locked Bag 1797, Penrith, NSW, 2751, Australia
e-mail: s.shrestha@westernsydney.edu.au

4: Department of Civil and Environmental Engineering
University of Michigan
2350 Hayward St, Ann Arbor, MI 48109, United States
e-mail: ndk@umich.edu

5: UNESCO Chair on Conservation and Ecotourism of Riparian and Deltaic Ecosystems
International Hellenic University
1st km Drama-Mikrochorio, Drama, 66100, Greece

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1. Introduction

Energy availability under both normal and hazard conditions is a key element for sustainable development [1] and resilience against natural disasters [2]. Access to off-grid renewables, such as pico-hydropower, provides multiple benefits particularly to remote communities in low and lower-middle income countries which often lack reliable energy and resources to support hazard planning and response.

Applying a systems approach to these issues could help humanitarian and development practitioners and community stakeholders to co-develop technology-supported projects that address local needs. Systems thinking is a holistic analytic approach that focuses on how different elements within complex systems are interconnected and affect program processes and outcomes [3]. Our study investigates a community systems approach to energy generation and distribution management, and water-based disaster emergencies within a framework of sustainable development. This approach is being applied to localised hydropower and flood warning systems, including a potential hybrid prototype.

2. Background, History, Review-of Literature, or Methodology

The foundation work for this study involved a literature review of best-practice community engagement for disaster risk reduction with a focus on technology-supported solutions. It includes information from community case studies with installed off-grid renewable energy generators and flood warning systems. These highlight the critical role of ‘community-centric’ approaches that seek to reinforce community capabilities and their systems, rather than replacing them [4, 5]. Such approaches are well suited to community-level developments as they canvas a wide range of stakeholder views and address pragmatic issues likely to affect the longer-term viability of developed solutions. Within our current project, this approach supports:

- 1) Engagement with all relevant community stakeholders and a developed understanding of their respective needs
- 2) Identification of priority needs (e.g. in off-grid energy generation and distribution, and localized hazard response)
- 3) Co-development of prototype systems, and
- 4) Solutions regarding long-term support and further development of technology-supported interventions (i.e. how can these be sustained in low-resource environments, with histories of resource inequity and environmental injustice)

3. Results and Findings

Energy availability is a critical factor for sustainable development and hazard response. However, remote communities in low and lower-middle income countries often lack reliable energy sources. This limits their overall capacity. While there are potential solutions, these often need to reconcile diverse needs to form common agreed solutions. Our study employs a systems approach for the development of hydropower generation and flood warning at the local level. These applications can support communities to become more resilient against floods and therefore, more sustainable over time. According to our research design, the approach should emphasize the following:

- Analysis of vulnerability/capability assessments, that confirm energy insufficiency and flood vulnerability in riparian communities
- Community engagement, for the smooth collaboration between different involved stakeholder groups
- Interdisciplinary collaboration for prototype development following systems engineering processes (i.e. SIMILAR process [6]).

4. Discussions and Conclusions

Energy availability is essential for socio-economic sustainability and disaster resilience. Many vulnerable communities need developmental and hazard preparedness support, of the kind afforded by disaster risk reduction and related programming, to ensure safer communities and improved livelihoods. Systems approaches can minimise program failure factors through early hazard detection and smoother process transition in development and implementation phases. Such factors therefore recommend this as a framework for the effective co-development of prototypes. The combination of pico-hydropower and flood warning can serve community needs, but the developed solutions are context specific and require effective community engagement and resource planning to achieve enduring success.

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