

#### VANDERBILT UNIVERSITY

# I. INTRODUCTION AND MOTIVATION

- The decision to migrate is complex and is influenced by economic, social, and environmental factors across scales.
- Agent-based models (ABM) can be useful to study the ways environmental stress interacts with livelihood and migration.
- Pattern-oriented modeling is an approach for evaluating ABM's by assessing a model's ability to reproduce multiple observed patterns.
- Here we use a pattern-oriented approach with an original ABM to compare different decision-making methods of environmental migration based on behavioral psychology.



Figure 1: Class diagram of ABM of environmental migration. The decision method can take multiple forms including Theory of Planned Behavior (TPB), Protection Motivation Theory (PMT), utility maximization, and a mobility potential method. The migration decision is made at the household level.

# Pattern-oriented modeling to test frameworks of environmental migration decisions in Bangladesh

Kelsea Best<sup>1</sup>, Jonathan Gilligan<sup>1</sup>

<sup>1</sup>Department of Earth & Environmental Science, Vanderbilt University, Nashville, TN

k	0	

### **III. PATTERN-ORIENTED APPROACH**

Pattern 1: As the proportion of a community impacted by environmental shock increases, rates of migration initially decrease but then increase above a threshold of approximately 20%. Pattern 2: Households that are directly impacted by environmental shock are less likely to migrate.

Previous work found that an economic model sporadically reproduced patterns (Fig 2), motivating more complex decision methods.



Figure 2: Calibration of migration utility and migration threshold (cost) both in Bangladeshi taka. Points are parameter combinations tested, and colors represent predicted success of reproducing Pattern 1 (a), Pattern 2 (b), and both patterns simultaneously, where red is higher success and blue is lower success.

# **IV. ADDITIONAL DECISION-MAKING METHODS**

#### **Theory of Planned Behavior**

A behavioral intention (I) is determined based on a combination of behavioral attitudes (BA), perceived behavioral control (PBC), and social norms (SN) where (Eqn. 1) I = PBC x SN x BA

### **Protection Motivation Theory**

A threat appraisal (TA) is first taken, which combines perceived severity (S) and perceived vulnerability (V) and

TA = S \* V

If TA exceeds a threshold, then a coping appraisal (CA) is assessed, which combines response efficacy (RE), self-efficacy (SE), and cost efficacy (CE) where CA = w1 \* RE + w2 \* E + w3 \* CE with w1 + w2 + w3 = 1

### **Mobility Potential**

Each household has a unique threshold of environmental stress before migrating based on mobility potential (MP), which includes place-attachment and rootedness, and adaptive capacity (AC), which includes land, wealth, and social capital.

(Eqn. 2) (Eqn. 3)

Figure 3: Initial TPB results household average migrations at varying scales of community impact (from 0 to 1). Rates of migration do not increase with community impact factor.

Figure PMT decision-making results of average household migrations scales varying community impact (from 0 to Rates 1). migration of with community increase impact factor but do not initially decrease.

## **VI. DISCUSSION AND NEXT STEPS**

- migration decision.
- a livelihood strategy without environmental threat.
- incorporate economic opportunity or networks.
- More calibration of all theories is needed.
- Next, a hybrid decision-making method will be developed.

# ACKNOWLEDGEMENTS

Special thanks to Ao "Leo" Qu, Dr. Bishawjit Mallick, and Dr. David Furbish. This work was supported by the National Science Foundation Coupled Human-Natural Systems Grant No. 1716909







Model results vary based on the behavioral theory used in the

• TPB explicitly incorporates social norms and is highly flexible. • PMT considers risk tolerance but does not consider migration as

• Mobility Potential incorporates place attachment but does not