# Science and Technology Group
# Annual Report FY2019

Payal Shah
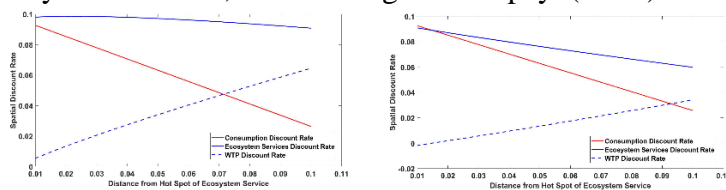Science and Technology Associate

## 1 Introduction

My research focuses on issues of environmental conservation and sustainability of natural resources. I use economic theory and statistical methods, combined with tools from ecology and biogeography, to evaluate the impact of conservation policies and to develop optimal strategies for conservation efforts in the face of environmental and economic uncertainties. I also use contingent valuation methods to quantify the willingness of people to support and fund conservation efforts. In collaboration with other PIs and researchers at OIST, I am working with the OKEON (Okinawa Environmental Observatory Network) group on using a watershed model and historical land use change data to identify terrestrial "hot spots" that are adversely impacting coral reefs in Okinawa.

## 2 Activities and Findings

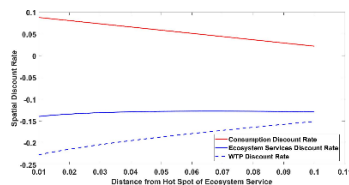**1. Spatial Discounting of Ecosystem Services**

The impact of conservation efforts targeted at preserving ecosystem services will largely depend on the welfare implications associated with spatial variations in the provision of ecosystem services. We establish a theory of spatial discounting that closely follows the concept of time discounting pertaining to climate change, and show spatial discount rates in the consumption, ecosystem service, and willingness to pay (WTP) numeraires. We consider the role of key parameters such as pure rate of spatial preference, consumption change, ecosystem services change, population density, and elasticity of marginal utility. We use numerical simulations (see figure 1) to illustrate how the three different spatial discount rates vary with the spatial distance from the source of ecosystem services and with consumption patterns, implying many more possible spatial variation of WTP.



Panel a: $\theta(c) = \sqrt{c}$

Panel b: $\theta(c) = 1/\sqrt{c}$

**Figure 1**

Panel c: $\theta(c) = c(1 - \frac{c}{k})$

**2. Determinants and Implications of Global Protected Area Effectiveness**

Establishing protected areas is a cornerstone of global conservation policy targeted at preservation of species and ecosystems and mitigating the impacts of climate change. We use a high resolution global data of forest cover loss from 2000 to 2012 to evaluate the effectiveness of global protected area network.

In figure 2, we illustrate the protected area impact on reducing forest cover loss by region and income group.
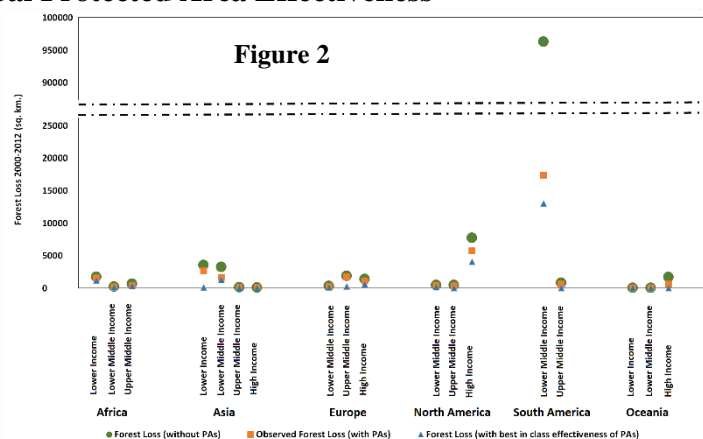


Figure 2

We then use machine learning methods to evaluate the key determinants of protected area effectiveness. In figure 3, we show the results for based on regression tree and bagging tree methods. We find that higher agricultural pressures, lower economic growth rates and better governance are associated with greater PA effectiveness.
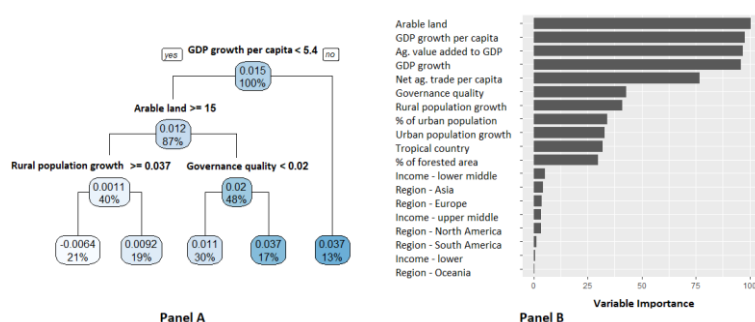


**Figure 3**

# 3 Collaborations

1. Project: Spatial Discounting of Ecosystem Services
   Collaborator: Rintaro Yamaguchi, Researcher, National Institute for Environmental Studies
2. Project: Okinawa watershed modeling to identify terrestrial "hot spots" that impact coral reefs
   Collaborators:  Evan Economo, Assistant Professor, OIS Graduate University
   Satoshi Mitarai, Associate Professor, OIST Graduate University
   Kenneth Dudley, Technician, OIST Graduate University
3. Project: Optimal conservation planning and climate change uncertainty
   Collaborators: Amy Ando, Professor, University of Illinois at Urbana-Champaign
   Glenn Guntenspergen, Research Ecologist, United States Geological Survey
4. Project: Determinants and implications of global protected area effectiveness
   Collaborators: Kathy Baylis, Associate Professor, University of Illinois at Urbana-Champaign
   Jonah Busch, Chief Economist, Earth Innovation Institute
   Jens Engelmann, Ph.D. Candidate, University of Wisconsin
5. Project: Multidimensional risk diversification for invasive species management: A quasi-dynamic portfolio theory approach
   Collaborators: Charles Sims, Associate Professor, University of Tennessee
   Amy Ando, Professor, University of Illinois at Urbana-Champaign
6. Project: Fine scale conservation planning with limited climate change information
   Collaborators: Valentin Popov, Lecturer, University of St. Andrews
   Jonathan Rhodes, Professor, The University of Queensland
   Rebecca Runting, Lecturer, University of Melbourne

# 4 Publications and other output

### 4.1 Conference Presentation

May 2019: Determinants and Implications of Global Protected Area Effectiveness, AERE Summer Conference, Lake Tahoe, USA.

# 5 External funding

1. Kakenhi Early Career Scientists 1, April 2018 - March 2020