Science and Technology Group
Annual Report FY2021

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Science and Technology Associate

1 Introduction

In my research, I use economic theory and statistical methods, combined with tools from ecology and biogeography, to analyze social and environmental impacts of natural resource management policies, to formulate optimal strategies to address environmental challenges such as climate change, and to evaluate preferences for ecosystem services. The major contributions of my research have been in advancing fundamental knowledge of: (1) how to do efficient and optimal conservation planning to deal with issues of climate change uncertainty and other economic and environmental uncertainties, and (2) how to quantify and measure the impact of conservation policy such as protected areas.

2 Activities and Findings

1. Managing climate change risk in systematic conservation planning with limited information

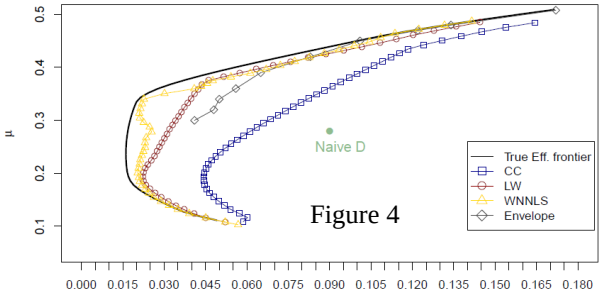

Figure 4

Systematic conservation planning is used for identifying optimal spatial conservation actions and priorities for biodiversity and ecological conservation. Recent advances in systematic conservation planning make use of modern portfolio theory to address the challenges posed by climate change uncertainty. However, these methods are difficult to implement for conservation planning problems at a finer scale when the information on future climate scenarios is limited. We identify three statistical approaches that can overcome the lack of sufficient information and enable the use of modern portfolio theory for fine scale conservation planning (see Figure 4). We illustrate the use of the three methods for identifying efficient portfolio allocation strategies using case studies of wetland conservation planning in North America and coastal conservation planning in Australia. These methods are applicable for a broad range of conservation planning scenarios where the ecological outcome faces climate uncertainty.

2. Robust conservation prioritization under climate change for alpine vegetations in Daisetsuzan National Park using portfolio optimization theory

Daisetsu National Park is an important conservation region in northern Japan. The area is rich in alpine plant species that support biodiversity, provide a range of ecosystem services, and support the tourism industry. These alpine vegetations are expected to be particularly vulnerable to climatic changes. We evaluate the expected changes in four types of alpine vegetation (i.e. snow bed, fellfield, wilderness and shrubs) for three climate scenarios and two GCM models across the approximately 900 sq. km. study site. Our unit of observation is 1 sq. km. by 1 sq. km. grid. We then combine Marxan site prioritization with portfolio optimization to identify which grids are most important for conservation efforts. This is the first study to conduct portfolio optimization at a fine scale and simultaneously combine the Marxan approach to arrive at optimal site selection output.

3 Collaborations

1 .Project: Robust conservation prioritization under climate change for alpine vegetations in Daisetsuzan National Park using portfolio optimization theory

Collaborators: Fumiko Ishihama (Researcher, National Institute for Environmental Studies)
Oguma Hiroyuki (Researcher, National Institute for Environmental Studies)
Amagai Yukihiro (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: 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

5. 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

6. Flexible Conservation Decisions for Climate Adaptation
Collaborators: Jonathan Rhodes (Professor, The University of Queensland)
Paul Armsworth (Professor, University of Tennessee Knoxville)
Brett Bryan (Professor, Deakin University)
Gwenllian Iacona (Assistant Professor, Arizona State University)
Ascelin Gordon (Senior Research Fellow, RMIT University)
Rebecca Runting (Lecturer, The University of Melbourne)
Kerrie Wilson (Professor, Queensland University of Technology)

4 Publications and other output

4.1 Publications

1. Shah, P., Baylis, K., Busch, J. and Engelmann, J., 2021. What determines the effectiveness of national protected area networks? *Environmental Research Letters*.
2. Popov, V., Shah, P., Runting, R. K., and Rhodes, J. R. 2021. Managing risk and uncertainty in systematic conservation planning with insufficient information. *Methods in Ecology and Evolution*.

4.2 Seminar Presentations

1. January 2022: **"**How to design and evaluate conservation policy for a changing world". Invited seminar at Amity University, Rajasthan, India. (via zoom)
2. November 2021: "Application of portfolio theory to conservation planning with climate change uncertainty". Invited seminar at Japan-Tokyo Resource and Environmental Economics (J-TREE) Seminar Series. (via zoom)

4.3 Other activities at OIST

OIST OKEON Steering Committee.
OIST Sustainable Development Goals Working Group.

5 External funding

1. Kakenhi Early Career Scientist I (April 2020 – March 2022)
Project: Multidimensional risk diversification for conserving coastal wetlands under climate change uncertainty; Funding Amount: $22,500

2. Japan International Cooperation Agency (JICA) Grant (April 2022 – March 2026)
Project: Empirical research on the effects of the SHEP approach on small-scale farmers in Ethiopia; Funding Amount: $94,000