

**University of Waterloo**

**FACULTY OF ENVIRONMENT**

**Global Governance Program**

**NOTICE OF PH.D. THESIS ORAL EXAMINATION**

Of the Doctoral Thesis Entitled:

**Supporting uncertain policy decisions for global catastrophic risks**

by Ph.D. Candidate: **Scott Janzwood**

Advisor: Dr. Thomas Homer-Dixon (ENV)

Thesis Committee: Dr. Jason Thistlethwaite (SEED)  
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Dr. Vanessa Schweizer (KI)  
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The External Examiner is: Dr. James Wilsdon  
Information School  
Digital Science Professor of Research Policy  
University of Sheffield

This Committee has been appointed and approved by the Graduate Studies Committee of the Faculty.

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Date

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Associate Dean, Graduate Studies

The Examination is set for:

**Thursday, May 6, 2021**  
**12:00 p.m (EDT) 5:00 p.m. (GMT)**  
**Remotely**

ABSTRACT IS ATTACHED.

A copy of the thesis is on display in EV1 335.

## Abstract

The three articles in this dissertation explore the contested, multi-dimensional concept of uncertainty and how experts and decision makers collectively grapple with it at governance organizations tasked with addressing global catastrophic risks (GCRs). This project examines the foundational concept of uncertainty and then explores “decision support” dynamics at the National Aeronautics and Space Administration (NASA) and the Intergovernmental Panel on Climate Change (IPCC) – the primary knowledge brokers in the governance regimes addressing planetary defense and climate change respectively.

Article #1 begins by examining the contested, multidimensional concept of uncertainty itself. The paper presents a critical analysis of the conceptual literature on uncertainty that has become increasingly standardized behind the tripartite distinction between uncertainty location, uncertainty level, and the nature of uncertainty. I argue that the epistemological foundation on which this framework is built is both vague and inconsistent. Perhaps most surprising is its exclusion of the term “confidence” – which has become the dominant perspective for characterizing and communicating uncertainty in many disciplines and policy contexts today. This article reinterprets the tripartite framework from a Bayesian epistemological perspective, which views uncertainty as a mental phenomenon arising from “confidence deficits” as opposed to the ill-defined notion of “knowledge deficits” that dominates the literature. I propose a more consistent set of rules for determining when uncertainty may or may not be quantified, a clarification of the terms “ignorance” and “recognized ignorance,” and an expansion of the “level” dimension to include levels of uncertainty reducibility. Lastly, I challenge the usefulness of the conventional distinction made between aleatory and epistemic uncertainty and propose a more useful distinction based on developments in the field of complexity science that highlights the unique properties of complex reflexive (i.e. human) systems.

Article #2 explores the decision support process of uncertainty reduction. “Mission-oriented” public research organizations like NASA invest in R&D to improve decision-making around complex policy problems, thus producing “public value.” However, the estimation of benefits produced by such R&D projects is notoriously difficult to predict and measure – a challenge that is magnified for GCRs. This article explores how public research organizations systematically reduce key uncertainties associated with GCRs. Building off of recent literature highlighting the organizational and political factors that influence R&D priority-setting at public research organizations, this article develops an analytical framework for explaining R&D priority-setting outcomes that integrates the key stages of decision analysis with organizational and political dynamics identified in the literature. This framework is then illustrated with a case study of the NASA planetary defense mission, which addresses the GCR of near- Earth object (asteroid and comet) impacts. The case study reveals how organizational and political factors interact with every stage in the R&D priority-setting process – from initial problem definition to project selection. Lastly, the article discusses the extent to which the case study can inform R&D priority-setting at other mission-oriented organizations, particularly those addressing GCRs.

Article #3 investigates the decision support process of uncertainty communication. The uncertainty language framework used by the IPCC is designed to encourage the consistent characterization and communication of uncertainty between chapters, working groups, and reports. However, the framework has not been updated since 2010, despite criticism that it was applied inconsistently in the Fifth Assessment Report (AR5) and that the distinctions between the framework’s three language scales remain unclear. This article presents a mixed methods

analysis of the application – and underlying interpretation – of the uncertainty language framework by IPCC authors in the three special reports published since AR5. First, I present an analysis of uncertainty language term usage in three recent special reports: Global Warming of 1.5°C (SR15), Climate Change and Land (SRCCL), and The Ocean and Cryosphere in a Changing Climate (SROCC). The language usage analysis highlights how many of the trends identified in previous reports – like the significant increase in the use of confidence terms – have carried forward into recent assessments. These observed trends, along with ongoing debates in the literature on how to interpret the framework’s three language scales inform an analysis of IPCC author experiences interpreting and implementing the framework. This discussion is informed by interviews with lead authors from the SRCCL and SROCC. Lastly, I propose several recommendations for clarifying the IPCC uncertainty language framework to address persistent sources of confusion highlighted by the authors.