Research Proposal Template

A. PROJECT TITLE

Decision making under uncertainty – a review of new tools and approaches for assessing risk in complex environmental problems

B. PROJECT TEAM

Project Leader:	**Investigators:**
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C. ABSTRACT

This project will develop an easily accessible summary of recent research and tools to support risk assessment and decision making under uncertainty. Many of these new developments have occurred in the fields of engineering safety, climate science and decision analytics. We will evaluate their potential application to complex resource management decisions in marine environments. Emphasis will be placed on methods to assess cumulative effects from multiple stressors, 'tipping points' and 'surprises', and to facilitate participation from stakeholders and Māori in the evaluation and management of risk. Opportunities to apply one or more of the tools will be identified with the Challenge partners and a small, informative case study will be implemented to evaluate the tool's utility.

D. RELEVANCE TO CHALLENGE OBJECTIVE

- Ecosystem based management depends upon the effective application of science and mātauranga Māori to reduce uncertainty in policy decisions about environmental risks
- Decisions about the use of natural resources must, nevertheless, be made when knowledge about an activity or its potential effects on the environment is incomplete and when existing scientific data and mātauranga Māori are insufficient to characterise the risk
- This project will review and evaluate methods to support decision making under conditions of significant uncertainty about risk.

E. INTRODUCTION

Decisions about the utilisation of natural resources entail making predictions about how ecosystems will respond to prospective changes in use. Any predictions about complex systems are necessarily uncertain and contentious. Risk analysis is used widely as a tool to support decision-making in this context because it provides a systematic approach to estimate the likelihood of uncertain, undesirable impacts from activities or events[1,2]. There are many different approaches to risk

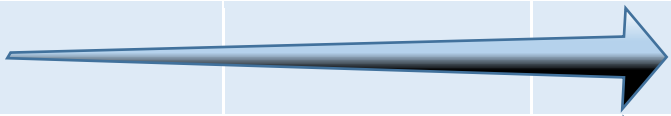
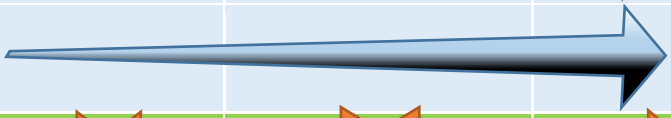
analysis, each tailored to the nature of the problem under consideration and the kinds of data and knowledge that can be applied to it[3]. These range from simple, subjective classifications of risk using matrices with predetermined sets of likelihood and consequence categories[4], to probabilistic assessments that use existing data to parameterise an analytical model that describes relationships between the activity and the probability of undesirable outcomes[5]. Truly probabilistic risk analyses, where the frequency of an event can be estimated from long-run data, are the exception rather than the norm in natural resource decisions[3,6]. In most circumstances, estimates of the likelihood of a future outcome rely upon the use of Bayesian probabilities or subjective 'expert' judgements, which are conditioned on existing knowledge and are open to challenge[3,7,8]. Significant uncertainty occurs in risk analyses when there is limited existing knowledge about an activity or its intended operating environment, when the range of potential consequences is unknown or in dispute, and when existing data are insufficient to estimate future consequences (Table 1). These circumstances - characterized as 'deep uncertainty'[6] – are common in natural resource decisions[9]. Scientists, stakeholders and decision-makers can have very different views of the nature of the problem, the environmental values to be protected, and the legitimacy of outputs from risk analyses. Māori, in particular, believe that mātauranga Māori, which incorporates knowledge, culture, values and beliefs[10], is not adequately incorporated or weighted alongside scientific knowledge in decisions about environmental risk[11].

Recent reviews of risk analysis under deep uncertainty have pointed to the need for more deliberative processes that include stakeholders and decision-makers in constructing and reviewing the analyses[2,3,12] and for more seamless integration with adaptive management and monitoring[3,13]. New methods developed within the engineering, decision analytic and computing sciences to support decision-making under deep uncertainty hold promise for natural resource management, but have not yet had wide application[14-16]. This project will review and summarize some of these tools and evaluate their potential application to three research priorities for ecosystem based management (EBM) that are core elements of the Sustainable Seas Science Challenge:

- Assessment of cumulative and indirect effects on marine ecosystems from multiple stressors,
- Evaluating the likelihood of highly uncertain transitions among ecosystem states ('tipping points') and
- Mitigating against unforeseen events ('surprises').

Table 1. Spectrum of risk management under uncertainty.†

Risks associated with activities that have a track record of assessment, monitoring and management (A) are usually well described and can be managed by established practice. 'Deep uncertainty' arises when the activity has few precedents, occurs in a novel setting and / or there are limited data and knowledge of potential mechanisms of effect (C). These circumstances are also associated with a high level of interest by potentially affected stakeholders.

	Factor	A	B	C
Decision context	Type of activity	Nothing new or unusual Well understood Good practice well-defined	New to the geographic area Infrequent or non-standard Good practice not well defined or more than one option available	New development or activity Novel or understudied setting Multiple, interacting activities No established good practice
	Risks	Well understood	Can be assessed using established data and methods	Few relevant data Assessment methods unproven Lack of consensus among subject matter experts
	Uncertainty			
	Stakeholder interest			
Assessment method	Best practice			
	Risk assessment			
	Precaution / adaptive management			
	Deliberative Decision Making			

†Adapted from: Oil & Gas UK (2014) *Guidance on risk-related decision making*. Oil & Gas UK. London. 25 p.

F. AIMS

- Compile an easily accessible review of novel methods for risk analysis and decision making under uncertainty
- Identify potential applications of the methods to research and management problems within the Sustainable Seas challenge
- Implement a small case study trial of one or more tools
- Develop a detailed research plan for use of the tools in the case study area during Phase 2 of the Sustainable Seas Challenge.

G. PROPOSED RESEARCH

This project (to June 2019) will review risk analysis tools that have been developed in other disciplines for dealing with uncertainty in complex decision problems. Many of these approaches were developed for, or have been applied to, problems related to climate change[17-19] or engineering safety[5,20]. Our aim is to build upon some of the best practice guidance that has been developed in these disciplines and translate it into a format that is easily accessible to marine resource managers, scientists, stakeholders and Māori[21,22]. A proposed structure for the review and the topics to be covered within it are described in the following sections. The review will provide an overview of each method, including the kinds of analysis problems they may be applied to, their utility and any difficulties in application.

A key consideration will be how mātauranga Māori is considered alongside scientific knowledge to frame risks and evaluate their significance. To ensure the review covers this effectively, we will hold an initial advisory group workshop to identify what existing frameworks of applied mātauranga Māori are used to evaluate risk. The workshop is intended to be transdisciplinary, where kaupapa Māori researchers (aligned with the Challenge), Māori regulatory policy advisors (e.g., Kaupapa Kura Taiao, Environmental Protection Authority), and quantitative and qualitative risk assessment experts will co-develop the direction of the desk top review. Where appropriate, the proposed structure of the review may be revised to explicitly determine how to evaluate cumulative risk within a mātauranga Māori based framework that incorporates values measured against criteria that recognise or provide for mātauranga Māori.

Proposed structure of the review

1. Key concepts and definitions

The review will begin with a general overview of some key concepts and definitions used in risk analysis, including a taxonomy of the types of uncertainty that can arise in complex management problems (e.g., Figure 1)[23]. This provides the basis for more detailed evaluation, in later sections, of tools that can be applied to address specific sources of uncertainty. It will include discussion of:

- The role of risk analysis in decision-making
- Differences between ‘frequentist’ and ‘subjective’ probabilities and their use
- Aleatory uncertainty (variability),
- Epistemic uncertainty (inadequate knowledge) about
    - specific values or quantities to be modelled or estimated (parameter uncertainty)
    - functional relationships between potential risk factors and response variables (model uncertainty)
    - the range of potential stressors and assessment endpoints (i.e., consequences) that should be included in the analysis (completeness)[22,24,25], and
- Decision uncertainty.

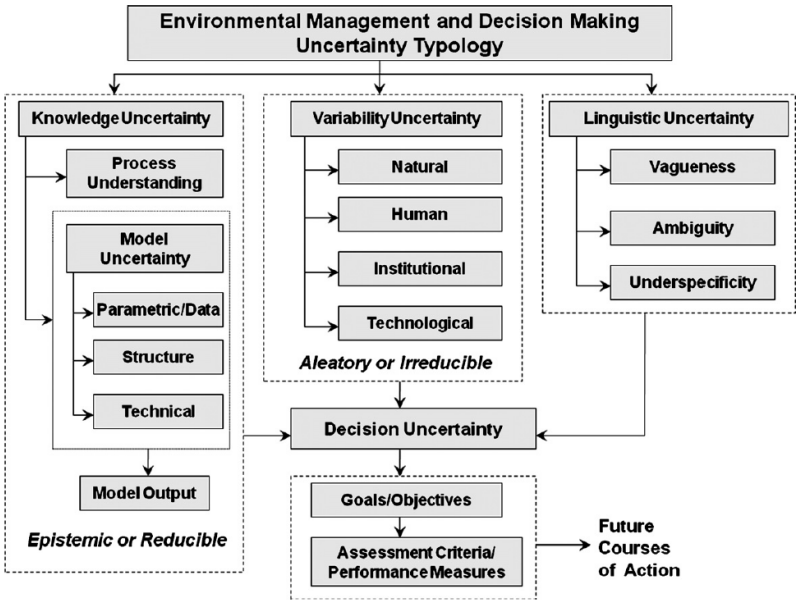


Figure 1. A typology of uncertainty in risk analysis and decision making[26].

2. Deliberative approaches to decisions about risk

To provide context for the description and evaluation of methods for decision-making under uncertainty, we will briefly review evolving best practice for participatory decisions about risk. *Risk-Informed Decision Making* (RIDM) describes the interaction of stakeholders, risk analysts, subject matter experts, and decision-makers throughout the decision process to ensure that a range of objectives, values, knowledge and alternative strategies are considered in the design and scrutiny of the technical risk analysis[27]. Complex decisions often involve competing objectives, beliefs and technical judgements. The collective knowledge provided by a range of affected parties is necessary to ensure that they integrate the technical analysis with other values (e.g., social and political)[2]. Although the types of technical analyses that inform the risk decision can vary widely, RIDM describes a stepped process for traversing the decision when there are high consequences and deep uncertainty. Best practice models for RIDM have been developed by NASA, the US Nuclear Regulatory Commission and others[12,22,28,29] and will be used as a basis for evaluating the utility of different technical methods.

RIDM requires the inclusion of all parties at an early stage to frame the decision problem and contribute to collective decisions about the analysis. This requires technical methods that are:

- able to be understood (at least in general terms) by non-specialists,
- amenable to participatory conceptualization, parameterization and evaluation,
- scientifically robust when applied to complex problems where there are knowledge gaps,
- able to incorporate different types of qualitative and quantitative information, and
- are relatively accessible.

In a New Zealand context, RIDM must also be able to incorporate different cultural perceptions of decision consequences that are difficult to quantify. Our method for evaluating how mātauranga Māori is considered alongside scientific knowledge to frame risks and evaluate their significance in the context of RIDM will be guided by an initial workshop with subject matter experts.

3. Methods for representing and propagating uncertain quantities

Risk analysis makes extensive use of knowledge-based probabilities to reflect beliefs about the likelihood of an event[1]. In this section, we will describe best practice guidance on:

- protocols for eliciting subjective probabilities from experts to reduce known sources of bias[30,31]
- reconciling qualitative descriptors of uncertainty as quantitative subjective probabilities[21,32] and
- methods for eliciting and propagating highly uncertain probabilities in risk analysis.

The last of these components includes specific treatment of *probability bounds analysis* (PBA)[*33*] and elicitation and use of *imprecise probabilities* (IP)[14,19]. PBA is used to separate and represent uncertainty associated with natural variability and incomplete knowledge of a parameter simultaneously. IP theory[14] provides an approach for capturing ambiguous beliefs when knowledge is poor. In climate change research, IPs have been used to elicit the bounds of expert beliefs (and uncertainty) about the prospect of tipping points between highly uncertain system states[19].

4. Methods for assessing cumulative and indirect effects of multiple stressors

We will review approaches that have been used or proposed to analyse cumulative risks to natural ecosystems. These include a range of planning tools, network and biological models and geospatial analyses[34]. Our review will have a specific focus on methods used to:

- aggregate exposure, vulnerability or impacts across time, space and multiple stressors, and
- represent and evaluate indirect, and synergistic effects from multiple or repeated stressors.

We will summarise and compare metrics[35], statistical[36,37] and geospatial[38] methods that have been used to aggregate and describe risk.

We will also examine the utility of *Qualitative Network Models* (QNM[39]) for representing cumulative risk. QNMs provide a simple visual means of depicting and exploring relationships between different components of complex systems and the pathways through which perturbations may propagate. They are flexible and can incorporate feedback loops and quantitative risk analysis within better-known sub-components[40]. Methods have also been developed for comparing multiple QNMs to examine uncertainty in model structure[41] and to incorporate imprecise probability distributions to examine threshold effects[19].

Recent applications of QNMs to EBM have included frameworks for evaluating:

- cumulative effects of range shifts by marine species in response to climate change[42]
- the effects of multiple perturbations on exploited fisheries[43,44]
- cumulative effects on marine biodiversity and their management [45,46]
- indicators for monitoring ecosystem states[47] and
- cumulative risks from coal-seam gas development (S. Barry, CSIRO, pers. Comm.).

5. Scenario analysis

Approaches have also been developed to support decision making under uncertainty that involve generation and evaluation of multiple plausible future scenarios[48]. These include optimization methods for choosing among a set of alternative strategies[49], methods for evaluating combinations of stressors most likely to disrupt management objectives[20], and methods for determining strategies

that are 'robust' to threats[15]. This section of the report will review several of these approaches. Illustrative examples are provided below.

a. Mean-variance analysis

Mean-variance analysis is often applied to portfolio selection problems in risky settings to understand variability in decision-makers' tolerance of risk. In this approach, if activities have the same returns (or variances) but one activity has lower variances (or higher expected return) then it is preferred by decision-makers[50]. Historical observations, surveys of experts or simulation methods such as Monte Carlo simulation and Latin Hypercube are often used to incorporate variability into these approaches, generating different distributions for varying parameters. Mean-variance analysis than selects the single and optimal activity considering the expected mean and variance of outcomes.

The mean-variance approach can be extended into a dynamic programming (DP) model[51] to model changes in attitudes to risk over time. In DP it is assumed that the decision-maker adjusts his/her activities to achieve the optimal outcome over the entire period of analysis[52]. Other approaches frequently used to model the response of risk-averse decision-makers to risky situations include the safety-first, value at risk, minimization of total absolute deviations, stochastic programming and other models[50,52].

b. Markov Decision Processes (MDPs)

MDPs are also optimization procedures that are used to model decisions under uncertainty[49]. They are useful for sequential decisions that involve trade-offs between strategies[16], for deciding on optimal actions that can be applied to different parts of a system that may be in different states[53], and for adaptive management problems where there is the opportunity to learn from iterative decisions[54].

MDPs define (1) a set of possible states for the system, (2) a set of decision actions that could be implemented, (3) a transition function that represents the probability of the system moving from one state to another given a decision action and (4) a reward or 'utility' function that provides the basis for evaluating the benefits of any decision for the system. In this context, finding the best decisions under uncertainty is an optimisation problem in which the sum of future expected utility is maximised over time[16].

Stochastic Dynamic Programming (SDP) is typically used as the method to find optimal solutions under uncertainty to solve Markov decision problem[16]. In SDP distributions for the stochastic elements are generated using simulation procedures such Monte Carlo or Latin Hypercube. The simulations utilise decision trees with probabilities that the branching process is induced by gradual stages[55]. The stochastic programming considers that (1) the decision variables are carried on for the decision node from one stage to the next stage, (2) an ancestor matrix reflects the order of the nodes in the decision tree and (3) the probabilities for each nodes are assigned[56].

Advances in computing power have increased the functionality and accessibility of these methods. Extensions have included characterising spatially heterogeneous resources as a network (Graph-Based Markov Decision Process), where each spatial domain is represented as a node within a network and dependencies between the domains are denoted as edges between them[6,53]. Methods have also been developed to model hierarchical decisions with different time horizons[57,58]. MDPs have had some application in biosecurity[57,58] and conservation science[16,54,59], but new software tools will likely increase their availability to other researchers[16,60].

c. Robust Decision Making (RDM)

RDM is a computer-assisted decision-support tool that compares the 'robustness' of multiple plausible decision scenarios. It incorporates quantitative analysis and qualitative deliberation and review of risk. Its basic tenet is that, under deep uncertainty, multiple, contrasting views of the future provide a better representation of available knowledge than any single model. Unlike optimization methods, RDM characterizes vulnerabilities in alternative strategies and evaluates the best ways of hedging against them. It seeks to identify strategies that perform reasonably well, compared to alternatives, across a wide range of plausible futures, expectations and values[15]. RDM has been applied to problems that involve uncertain threshold responses (i.e., tipping points)[61], adaptive management scenarios[62], and to hedge against unforeseen outcomes (i.e., surprises)[63].

RDM is designed to be participatory. It uses a computer-assisted process to generate many plausible future scenarios, each of which represents one potential state of the system and one choice among many alternative management strategies. This process – 'scenario discovery' - provides a basis for analysts, decision makers and stakeholders to posit and review differences in their expectations for the future system state[15]. It begins with one or more models of a system that relate the management action(s) to outcomes and a set of many plausible probability distributions over the uncertain parameters in the model(s)[17]. It can incorporate a variety of qualitative and quantitative information, uncertain structural relations within the data and even uncertainties about social values[63].

An algorithm is used to sample the specified model(s) experimentally across the range of uncertain inputs for each specified management action. This creates a library of many plausible states in response to each management option. Statistical and data mining search methods and visualization techniques are then used to extract from this library information about vulnerabilities that is useful in distinguishing among decision choices[63]. By summarizing a large range of plausible future states, the strengths and weaknesses of each candidate strategy may be more apparent[64]. Interactive graphics allow users to discover the failure modes of strategies and find those that perform well under stress. Several software tools are now available to assist scenario discovery and RDM[65].

d. Resilience Analytics

Resilience Analytics (RA) is a form of scenario analysis that seeks to identify the stressors that most disrupt the priority of risk management actions[20]. Scenarios are framed as instantaneous compilations of management actions, objectives, stakeholder preferences, and uncertainties. It uses a range of metrics to compare the resilience of the scenarios to perturbation. Unlike RDM (below), the scenarios are defined *a priori*. Although developed initially to evaluate the resilience of energy infrastructure to threats, RA has had some application in climate change and natural resource management[48,66].

Case study analysis

Following completion of the review, we will convene a second workshop with select Project Leaders, stakeholders and Māori involved in the Sustainable Seas Challenge to report on the outcomes and identify potential case studies within the Challenge community that would benefit from application of the tools. A simple case study, using one or more methods described in the review will be developed and implemented in Year 2 of the project to demonstrate its application and utility. The Cross Programme Project CP2.1 provides a pathway for trialling such tools with stakeholders and Māori involved in co-governance within the challenge Tasman Bay - Golden Bay case study area. In scoping and developing the case study, we will work closely with the Project team for CP2.1 to identify useful tools and opportunities for their application. Outcomes from the workshop and case

study will also be used to scope a proposal for a larger application in Phase 2 of the Challenge (post June 2019).

H. RESEARCH ROLES

Researcher	Organisation	Contribution
Graeme Inglis	*NIWA*	Dr Inglis will provide strategic oversight and management of the project. He has experience in applying a variety of quantitative and qualitative methods to risk assessment for marine resource management (particularly in biosecurity applications) and in stakeholder engagement.
Kelly May	*NIWA*	Kelly May will lead the Kaupapa Māori perspective to the research and its outcomes. A core part of this will be ensuring that the work is well aligned with any risk assessment initiatives being undertaken by regulatory agencies and other parties who are beginning to develop cultural tools for assessment of risks to Māori interests. As a member of the Environmental Protection Authority's Ngā Kaihautū Tikanga Taiao advisory board, Kelly brings experience with EPA decision-making processes and their ability to consider Māori issues and perspectives.
Tarek Soliman	*Landcare Research*	Dr Soliman brings expertise in the application of quantitative risk assessment and economic modelling to policy analysis. He has developed risk models for applications in biosecurity, health sciences, climate change mitigation, and water quality management. Dr Soliman will lead the review of methods for scenario-based policy assessment.
Utkur Djanibekov	*Landcare Research*	Dr Djanibekov is an early-career researcher with a background in risk management and economics. He has expertise in the development of dynamic programming models to evaluate resource management policy scenarios, with previous applications to land use policy in agricultural and forestry systems.

The Project Leader (Dr Inglis) will convene an initial meeting of the principal investigators in early February 2018 to finalise the project plan, scope and style of the project outputs. Dr Inglis will coordinate the overall review and, with support from a research assistant, will lead development of content on 'concepts and definitions', 'RIDM', 'methods for representing and propagating uncertain quantities' and 'methods for assessing cumulative and indirect effects'. Ms May will lead the Kaupapa Māori component, including coordinating advice and input on proposed methods from other subject matter experts. Dr Soliman will lead review of the scenario-based methods with assistance from Dr Djanibekov. The three section leads will participate in each of the four planned workshops with Kaupapa Maori experts, challenge researchers and policy stakeholders to communicate the results of the review and participate in selection of a case study application.

I. LINKAGES AND DEPENDENCIES

This project complements research being undertaken in the following funded projects within the Challenge:

- 1.1.1 Testing EBM -supportive participatory processes for application in multi-use marine environments
- 1.2.2 Navigating marine social-ecological systems
- 4.2.1 Tipping points in ecosystem structure, function and services
- 5.1.4 Interactive tools for enabling participation and knowledge exchange
- CP2.1 Trialling EBM

Project 1.1.1 is undertaking a review of processes and frameworks that can be used to facilitate broader participation in marine resource planning and management. We anticipate that findings from Project 1.1.1 will feed into the evaluation of processes that can potentially be used for deliberation and evaluation of risk. However, this project (5.1.3) will look explicitly at best-practice that has been developed to achieve greater participation in decisions about risk.

Project 1.2.2 is investigating how cumulative effects assessment can be better integrated into existing statutory and policy frameworks for decision making. Its focus is understanding the barriers, boundaries, and possible pathways towards the establishment of adaptive governance frameworks to support EBM. Other themes in 1.2.2 are tasked with understanding how Māori and other stakeholders perceive risk and uncertainty in the context of marine resource use and building trust in marine governance.

Project 3.1.2, *He Pou Tokomanawa* will investigate frameworks through which mātauranga Māori can be used to inform kaitiakitanga more broadly in the context of EBM. This project (5.1.3) will contribute to that objective, by exploring culturally appropriate approaches for framing risk and evaluating potential impacts to Māori interests.

We anticipate that data and metrics generated in Project 4.2.1 may be integrated with some of the tools identified in this project. Gaps in data or parameters that cannot be estimated from empirical studies may be elicited or modelled with some of the tools we will review.

The risk and uncertainty project will also contribute to the development of interactive tools for participatory decision making (Project 5.1.4). Project 5.1.4 is already trialling one form of interactive scenario analysis - Bayesian network models. Several of the scenario analysis tools we will review are designed to be computer-assisted and are supported by software designed to generate scenarios and visualizations for interaction with stakeholders[64].

J. RISK AND MITIGATION

The main risk to delivery is in defining and implementing the case study within the available time-frame and resources. Choice of an appropriate case study within the Sustainable Seas Challenge Community will be informed by the Science Leadership team following evaluation of the first stage document review. We anticipate that the case study will be developed jointly with a small group of stakeholders and Māori to frame the risk setting and parameterize the model. Success will depend upon the willingness of these groups to participate in and contribute to the study. To mitigate this risk, we are exploring the possibility of integrating a case study trial of one or more of the interactive tools for scenario analysis with the Cross Programme Project -C.P.2.1 Trialling EBM – which will also begin in the 2017-18 financial year. We have budgeted for three workshops with prospective case-study participants to: (1) present the outcomes of the review and canvass potential applications of the methods, (2) frame and parameterise the case study, and (3) test the case study results.

K. ALIGNED FUNDING AND CO-FUNDING

This project aligns with work being undertaken in MBIE Targeted Research Project CO1X1511 – which is developing risk assessment frameworks for non-native marine organisms. A component of CO1X1511, led by Ms Kelly Ratana at NIWA, is investigating how biosecurity risks might be assessed against a background of uniquely Māori knowledge and values. The project has undertaken a preliminary review of cultural assessment frameworks that could be adapted to biosecurity.

We will also seek to align the project with work being undertaken by regulatory agencies and other researchers who are developing tools for use in the assessment of potential risks and impacts to Māori interests. These include tools developed by the Environmental Protection Authority, University of Otago, and MBIE project CO1X1511. To facilitate this, we have proposed an initial workshop with Māori regulatory policy advisors and key researchers to help refine the scope of work undertaken in Project 5.1.3 and ensure that it is informed by, and complements existing projects and frameworks.

L. VISION MĀTAURANGA (VM)

Policy decisions about the use of marine resources involve judgements about the acceptability of future risks to valued ecosystem components. As Treaty partners, Māori play a key role in these determinations, but have felt excluded from conventional risk-based decision making, which has placed emphasis on the 'technical' estimation of risk by scientific experts to well-defined endpoints (e.g., human health, valued species, economic growth)[11]. Conventional analysis has also struggled to consider potential for harm to traditional Māori values, beliefs and practices such as mauri, noa, tapu, mana, wairua, kaitiakitanga, whakapapa, tikanga, and kaupapa that are difficult to express in quantitative terms[67]. Key recommendations that arose out of consultation with Māori on risk assessment for genetically modified organisms were the need for approaches that: (i) accommodate both qualitative and quantitative expressions of risk, (ii) take account of different cultural perceptions of risk, and which (iii) give "sufficient" weight to consequences that are difficult to quantify[67]. In addition, trust in risk analysis requires greater scrutiny by Māori and stakeholders of the judgements and assumptions made in the framing of threats and their potential consequences, and in evaluating and communicating uncertainties involved in the analysis. This project will review the ways in which mātauranga Māori and science bodies of knowledge can inform a range of methods designed to encourage participation in defining the analysis and evaluation of its outcomes. We expect that tangata whenua will be represented within deliberations in the case study application of the tool(s) during the 2018-19 financial year.

M. CONSENTS AND APPROVAL

This will be determined following completion of the review. Any proposed trial of the scenario analysis tools (see Section 4 of the review) is likely to involve a panel of stakeholders, analysts and decision makers and will require ethics approval for research involving human participants.

N. DATA MANAGEMENT

Any data collected specifically by this project will be saved in the Sustainable Seas data space. All researchers and stakeholders involved in the project will have access to all information collected and the outputs from any analyses.

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Q. CURRICULUM VITA

Curriculum Vitae

PART 1

1a. Personal details					
Full name	Title Dr	First name Graeme	Second name John	Family name Inglis	
Present position	Principal Scientist				
Organisation/Employer	National Institute of Water & Atmospheric research Ltd (NIWA)				
Contact Address	10 Kyle Street				
	Riccarton				
			Post code	8440	
Work telephone	03-3438036	**Mobile**	021656773		
Email	graeme.inglis@niwa.co.nz				
Personal website (if applicable)	http://				

1b. Academic qualifications

1992 PhD, Experimental Marine Ecology, University of Sydney, Australia

1987 BSc (Hons) First Class, Zoology, University of Canterbury, New Zealand

1c. Professional positions held

2004-current Principal Scientist (Marine Ecology), NIWA

2009-current Programme Leader – Marine biosecurity, NIWA

2000-2004 Scientist, National Institute of Water & Atmospheric Research Ltd.

1999- 2000 Senior Lecturer in Environmental Science, James Cook University, Townsville, Australia.

1993- 2000 Lecturer in Environmental Science, James Cook University, Townsville, Australia.

1992 – 1993 Environmental consultant, The Ecology Lab Pty Ltd, Sydney, Australia

1d. Present research/professional speciality

Marine biosecurity, environmental monitoring and assessment, risk assessment, estuarine ecology, seagrass ecology

1e. Total years research experience	27 years

1f. Professional distinctions and memberships (including honours, prizes, scholarships, boards or governance roles, etc)

2016-2019	Science Leader – Quadrilateral Scientific Collaboration in Marine Biosecurity (MBIE International Relationship Fund, Contract C01X1527)
2015-2019	Science Leader – *What's at stake*? - Enabling decision-making through better measurement, forecasting and evaluation of the impacts of non-native organisms in NZ's changing ocean (MBIE Contract C01X1511)
2017	Member – Biosecurity 2025 Strategic Direction 2 Working Group – Toolbox For Tomorrow
2016	Co-chair – 9th International Conference on Marine Bioinvasions, 19-21st January 2016, Sydney, Australia
2009-current	Scientific Steering Committee, International Society for the study if Marine Bioinvasions
2013-current	Biofouling Management Expert Group, Institute of Marine Engineering, Science & Technology (IMarEST)
2005-current	IUCN Invasive Species Specialist Group
2004-2014	Technical Advisor to the Global Ballast Water Management Programme (GloBallast), a joint project of the International Maritime Organisation, Global Environment Facility and United National Development Programme.
2010-2011	New Zealand Biosecurity Surveillance Committee. Implementation of the *Biosecurity Surveillance Strategy 2020*
2008-2011	Cross-sectoral Advisory Group. Implementation of the Biosecurity Science Strategy for New Zealand.
2008-2011	Aquatic Advisory Group. Implementation of the Biosecurity Science Strategy for New Zealand.
2012	NIWA Applied Science Excellence Award (runner up)
1993	Jabez King Heydon Memorial Prize in Biological Science, University of Sydney
1990	Keith Sutherland Award for research in malacology, Australian Museum
1992	Commonwealth Scholarship and Fellowship Plan Award, Australia

1g. Total number of *peer reviewed* publications and patents	Journal articles	Books, book chapters, books edited	Conference proceedings	Technical & Client reports
	50+2 in review	10	25	140

PART 2

2a. Examples of research publications and dissemination

Peer-reviewed journal articles

Floerl, O., **Inglis, G.J.** & Diettrich, J. (2016) Incorporating human behaviour into the risk–release relationship for invasion vectors: why targeting only the worst offenders can fail to reduce spread. *Journal of Applied Ecology*, DOI: 10.1111/1365-2664.12609

Byers, J. E., Smith, R.S., Pringle, J.M., G. F. Clark, P. E. Gribben, C. L. Hewitt, **G. J. Inglis**, E. L. Johnston, G. M. Ruiz, J. J. Stachowicz, and M. J. Bishop. 2015. Invasion expansion: Time since introduction best predicts global ranges of marine invaders. *Scientific Reports* 5:12436.

Smith, M., **Inglis, G.J.**, Wilkens, S., McDonald, S. (2016) Emergency surveillance for marine pests after the grounding of the container vessel, MV Rena. New Zealand Journal of Marine and Freshwater Research, 50(1): 42-55. 10.1080/00288330.2015.1127828

Floerl, O., Rickard, G., **Inglis, G**., Roulston, H. (2013) Predicted effects of climate change on potential sources of non-indigenous marine species. *Diversity and Distributions*, 19(3): 257-267. 10.1111/ddi.12048

Goldstien, S.J., **Inglis, G.J.**, Schiel, D.R., Gemmell, N.J. (2013) Using temporal sampling to improve attribution of source populations for invasive species. *PLoS ONE*, 8(6): e65656. doi:10.1371/journal.pone.0065656

Read, G.B.; **Inglis, G.J.**; Stratford, P.; Ahyong, S.T. 2011. Arrival of the alien fanworm *Sabella spallanzanii* (Gmelin, 1791) (Polychaeta:Sabellidae) in two New Zealand harbours. *Aquatic Invasions* 6: 273-279

Morrisey, D.; **Inglis, G.**; Neil, K.; Bradley, A.; Fitridge, I. (2011). Characterisation of the marine aquarium trade and management of associated marine pests in Australia, a country with stringent import biosecurity regulation. *Environmental Conservation* 38(2): 1-12

Floerl, O.; **Inglis, G.**; Dey, K.; Smith, A. 2009 The importance of transport hubs in stepping-stone invasions. *Journal of Applied Ecology* 46: 37-45

Inglis, G.J., Hurren, H., Oldman, J., Haskew, R. (2006). Using habitat suitability index and particle dispersion models for early detection of marine invaders. *Ecological Applications* 16: 1377-1390.

Gust, N.; **Inglis, G.J.** (2006). Adaptive multi-scale sampling to determine an invasive crab's habitat usage and range in New Zealand. *Biological Invasions* 8: 339-353.

Hayes, K. R., Cannon, R., Neil, K., **Inglis, G.J.** (2005). Sensitivity and cost considerations for the detection and eradication of marine pests in large commercial ports. *Marine Pollution Bulletin* 50: 823-834.

Floerl, O., **Inglis, G.J.**, Hayden, B. (2005). A risk based predictive tool to prevent accidental introductions of marine non-indigenous species. *Environmental Management* 35:765-768.

Other forms of dissemination (reports for clients, technical reports, popular press, etc)

Inglis, G.J., Morrisey, D., Woods, C., Sinner, J., Newton, M. (2013) Managing the domestic spread of harmful marine organisms Part A: Operational tools for management. NIWA Client Report No. CH2013-150, Prepared for the Preparedness & Partnerships Directorate, Ministry for Primary Industries. NIWA, Christchurch. 160 p.

Inglis, G.J., Smith, M., Buckthought, D., Wilkens, S. (2013) Biosecurity Surveillance Work-stream. NIWA Client Report No: CHC2013-060, Prepared for Bay of Plenty Regional Council - Rena Long Term Recovery Programme: 34.

Inglis, G.J., Floerl, O., Woods, C. (2012) Scenarios of vessel biofouling risk and their management: an evaluation of options. MAF Biosecurity New Zealand Technical Paper No. 2012/07: 122.

Inglis, G. J., Roulston, H. & Morrisey, D. (2011) A trial of the use of seabed habitat distribution data to identify high risk sites for surveillance in Whangarei Harbour. Marine High Risk Site Surveillance Programme Innovation 5.26. MAF Technical Paper No. 2011/. Prepared for MAF Biosecurity New Zealand Research Project SOW12099., pp. 25. Ministry of Agriculture & Forestry, Wellington.

Inglis, G. J., Floerl, O., Ahyong, S., Cox, S., Unwin, M., Ponder-Sutton, A., Seaward, K., Kospartov, M., Read, G., Gordon, D., Hosie, A., Nelson, W., d'Archino, R., Bell, A. and Kluza, D. (2010). The biosecurity risks associated with biofouling on international vessels arriving in New Zealand: summary of the patterns and predictors of fouling. Biosecurity New Zealand Technical Paper No: 2008/. A report prepared for MAF Biosecurity New Zealand Policy and Risk Directorate Project RFP0811321. 182 pp.

2b. Previous research work

Research title: Proposed Kermadec & Subantarctic Coastal Plan

Principal outcome: Expert technical guidance on rules governing vessel biofouling and management of risk to native marine flora and fauna

Principal end-user and contact: Department of Conservation (Sarah Hucker)

Research title: Development of indicators for marine pests

Principal outcome: Review and development of statistics for reporting status and trends in non-indigenous species in New Zealand

Principal end-user and contact: Ministry for the Environment (Pierre Tellier)

Research title: Managing the domestic spread of harmful marine organisms

Principal outcome: Review and evaluation of operational tools for managing the transport of non-indigenous marine species by humans in New Zealand.

Principal end-user and contact: Ministry for Primary Industries (Eugene Georgiades)

Research title: Vessel biofouling as a vector for the introduction of non-indigenous marine species to New Zealand

Principal outcome: Characterisation of risk factors associated with the transport of non-indigenous marine species associated with biofouling on international vessels

Principal end-user and contact: Ministry for Primary Industries (Brendan Gould)

2c. Describe the commercial, social or environmental impact of your previous research work

1. Project Leader for a biofouling risk characterisation study of >500 international vessels that entered New Zealand between 2004 and 2007. The results formed the evidence-base for a joint delegation by the New Zealand and Australian governments to the International Maritime Organization which resulted in international guidelines for biofouling management (IMO Resolution MEPC.207(62)) and for New Zealand's vessel biofouling regulations – the Craft Risk Management Standard (2014).
2. Delivered regional training programmes in marine biosecurity on behalf of the GEF/UNDP/IMO Global Ballast Water Management Programme (GloBallast) in Asia,

Europe, the Middle East and Pacific. I have delivered this training now to delegates from >40 countries.

3. Project Leader for studies on operational tools to manage biofouling on vessels entering New Zealand and pathways for the domestic spread of marine pests. The research underpinned development of pathway management plans currently being undertaken by Regional Councils within New Zealand using new provisions within the Biosecurity Act.
4. Provided technical advice and expert evidence for the development of vessel biofouling rules for the proposed Kermadec & subantarctic coastal plan. This evidence will be put before a public hearing later in 2016.

2d. Demonstration of relationships with end-users

1. Coordinate a stakeholder Advisory Group for NIWA's marine biosecurity research programmes involving representatives from Regional Councils, MPI and Department of Conservation and convene an annual Marine Biosecurity Research Workshop that is regularly attended by ~50 stakeholders from central and regional government, industry and iwi.
2. Member – Panel of providers of biosecurity surveillance, Ministry for Primary Industries (2009-current)
3. Invited member - Biosecurity 2025 Strategic Direction 2 Working Group – Toolbox For Tomorrow
4. Invited member - New Zealand Biosecurity Surveillance Committee. Implementation of the Biosecurity Surveillance Strategy 2020 (2009-2011)
5. Invited member - Cross-sectoral Advisory Group. Implementation of the Biosecurity Science Strategy for New Zealand (2008-2011)

Curriculum Vitae

PART 1

1a. Personal details					
Full name	Ms	Kelly	Kino		May
Present position		Scientist			
Organisation/Employer		National Institute of Water and Atmospheric Research			
Contact Address		PO Box 14-901 Kilbirnie,			
		Wellington		**Post code**	6241
Work telephone		(04) 3860 361	**Mobile**		
Email		Kelly.May@niwa.co.nz			

1b. Academic qualifications

2003 Master of Science - Aquaculture, Deakin University, Victoria.

2000 Graduate Diploma - Aquaculture, Deakin University, Victoria.

1997 Diploma in Marine Studies, Bay of Plenty Polytechnic.

1c. Professional positions held

2003- Fisheries Scientist, Te Kūwaha o Taihoro Nukurangi.

1d. Present research/professional speciality

I have been involved in a wide variety of projects during my career at NIWA, undertaking research in freshwater and estuarine environments including: estuarine shellfish baseline surveys/restoration programmes, taonga freshwater species health/indicator assessments, and development of fisheries plans. I am a member of Te Kūwaha o Taihoro Nūkurangi (NIWA's Māori Environmental Research Group). Te Kūwaha is a key resource within NIWA providing expertise in environmental research with a strong Māori focus. The primary goal of Te Kūwaha is to develop robust and meaningful partnerships with hapū, iwi and Māori organisations working collaboratively with other research providers, central and local government agencies to support and respond to Māori research priorities. I have strong relationships with several hapū and iwi where we have developed and undertaken collaborative research projects of importance to Māori.

1e. Total years research experience	9 years

1f. Professional distinctions and memberships (including honours, prizes, scholarships, boards or governance roles, etc)

Ministry of Education/TVNZ QTV Production "Young Scientist" (2006). Māori TV Te Aratai Productions "Ka Hao Te Rangatahi - Young Scientist" (2005). Alumni member, Advancement

of Māori Opportunity (AMO) non profit advocacy organisation (2004). Te Ohu Kai Moana Fellowship Award Winner (2000).

PART 2

2a. Research publications and dissemination

May, K., Breen, P.A. (2009). A template for customary fisheries management in Mātaitai Reserves, Research report for Ministry of Fisheries, Project No CRM200601, February 2010. 30pp.

May, K. (2010). Māori Fisheries. Presentation to Ministry of Fisheries Deputy Chief Executive team, Wellington 17 February 2010.

May, K., Cummings, V. (2010). Restoring shellfish beds to harbours and estuaries: a guide for community groups. Project No. CRBZ093. *In Press*, February 2010.

May, K., Severne, C. (2009). 'Research – Foreshore and Seabed Act 2004', to Foreshore and Seabed Review Independent Panel, Ministry of Justice, Wellington 22 April 2009.

May, K., Breen, P.A. (2009). Alternative approaches to obtaining the relevant information needed to facilitate customary fisheries management strategies in Mātaitai Reserves. Research report for Ministry of Fisheries, Project No. CRM200601. May 2009. 23 pp.

May, K., Breen, P.A. (2009). Fisheries and biological information needed to facilitate customary fisheries management strategies in Mātaitai Reserves. Research reportfor Ministry of Fisheries, Project No. CRM200601. May 2009. 8 pp.

Breen, P.A., **May**, K., (2009). Preliminary identification and discussion of harvest strategies that could be considered by Māori to manage rohe moana and taonga species. Research report for Ministry of Fisheries, Project No. CRM200601. May 2009. 18 pp.

May, K. (2009). Case Study: Research for Customary Fisheries. Profile describing Customary Fisheries programme supplied to Across Oceania/Te Au o Te Moana RESPONSE Trust for the Charter of Human Responsibilities, Charles Leopold Meyer Foundation. February 2009.

May, K., Tipa, G., Duarte, M. (2008). Collaborative Community-Based Research and the Development of Resource Management Tools – A Pacific Water Case Study: Presentation at the 16th Hawai'i Conservation Conference: Island Ecosystems, Honolulu, Hawai'i, 29-31 July 2008.

May, K. (2008). Management options for customary coastal fisheries Mātaitai Reserve Research Presentation to the National Oceanic and Atmospheric Administration NOAA, NOAA Office of National Marine Sanctuaries, Papahanaumokuakea Marine national Monument, The Nature Conservancy, Hawai'i, Office of Hawaiian Affairs, US Fish and Wildlife Services, Department of Land and Natural Resources, Department of Aquatic Resources, Community Conservation Network, Malama Maunalua, Hawaiian Islands Humpback Whales National Marine Sanctuary, Na Hoa 'Aina, University of Hawai'i Manoa, Honolulu, Hawai'i 28 July 2008.

2b. Previous research work

Research title: Mātauranga Māori and Sustainable Management of New Zealand Fisheries (FRST funded C01X0603).

Principal outcome: The overall aim of this programme is to support customary fisheries managers with ecosystem and fisheries research to protect their kaitiakitanga values by developing an integrated customary fisheries management tool (i.e. Cultural Marine Health Index Tool) to enable increased participation in natural resource planning and management.

Principal end-user and contact: Maungaharuru Tangitū Incorportated, Marangatuhetaua, Ngāi Tatara, Ngāti Kurumokihi, Ngāi Te Ruruku ki Tāngoio (T Hopmans); Te Kupenga Whitirauroa a Maui Kaitiaki Forum (R Spooner); Ministry of Fisheries (W Ormsby).

Research title: Providing information and tools to build Māori Capability to Manage their Rohe Moana and Taonga species (MFish funded CRM200601).

Principal outcome: Reports and customary fisheries management CD to assist Māori to manage their rohe moana and taonga species.

Principal end-user and contact: Ministry of Fisheries, Maungaharuru – Tangitū Incorporated (T Hopmans) Tāngata Kaitiaki project manager (J McGregor, R Spooner).

Research title: Te Taiapure o Porangahau key kaimoana characterisation (MFish funded KAI200701).

Principal outcome: To provide Ngāti Kere with the baseline information required to monitor and adaptively manage the long term well-being of their key kaimoana taonga species.

Principal end-user and contact: Ministry of Fisheries, Ngāti Kere Rohe Trustee (J Hutcheson).

Research title: Restoration, Stewardship and Management of Harvested Taonga Freshwater Species (FRST funded, C01X0511).

Principal outcome: The overall aim of this programme is to provide essential biological knowledge (i.e., identify and address information gaps), improved methodologies to detect change, and implement technologies and frameworks that enhance the sustainable management of these taonga species.

Principal end-user and contact: Ngāti Rangi (C Wilson), Lake Waikaremoana Hapū Restoration Trust (R Waiwai), Lake Rotoaira Trust (G Konui), Te Rūnanga o Ngāti Hine (T Ashby), Te Arawa Lakes Trust (R Mihinui), Ngāti Manawa, Ministry of Fisheries Department of Conservation, King Country Energy, Environment Bay of Plenty, Meridian.

Research title: Land based, low cost aquaculture systems (FRST funded C01X0309).

Principal outcome: Development of a land based, low cost aquaculture system (polyculture system) for Māori communities.

Principal end-user and contact: Hongoeka Land Development Trust (T Williams).

2c. Describe the commercial, social or environmental impact of your previous research work

(1) As a Te Kūwaha staff member I often receive numerous enquiries from tāngata whenua and statutory authorities - ranging from provision of resources for adult and school educational

programmes, access to data, designing of environmental research studies, to scoping aquaculture business opportunities and developing strategic research plans. (2) Positive impacts of previous MFish and current FRST work ('Providing information and tools to build Māori Capability to Manage their Rohe Moana' and 'Taonga species, and 'Mātauranga Māori and Sustainable Management of New Zealand Fisheries') include enabling tāngata whenua partners to safely and fully express their mātauranga Māori to ultimately convey to decision makers how different management decisions and/or inaction can affect their cultural interests (i.e., Cultural Marine Health Index Tool). Furthermore, this research has resulted in working closely with MFish staff to increase their knowledge of Māori fisheries research challenges and opportunities. For example I was invited to specifically develop a Māori fisheries presentation for MFish Deputy Executive Managers in February 2010 and am leading a follow up workshop with Te Ohu Kai Moana staff and the MFish Deputy Chief Executive - Treaty Partnership and Obligations to Māori.

2d. Demonstration of relationships with end-users

Developed, managed and presented at the "Knowledge for Customary Coastal & Kaimoana Management" workshop (2007). Securing hapū and iwi support and key representatives successfully enabled lively discussion of issues and management regimes from the viewpoint of Māori and stakeholder groups, including a keynote address by Sir Tipene O'Regan, and Ministry of Fisheries, Department of Conservation, Te Ohu Kai Moana, Regional councils and various Māori representatives including Te Rūnanga o Moeraki, Te Rūnanga o Ngāti Awa, Te Ātiawa Manawhenua Ki Te Tau Ihu Trust, and the Te Kupenga Whiturauroa a Maui Customary Fisheries Forum. The workshop also explored scientific and cultural indicator advances that can underpin customary fisheries management. Relationships and action points from workshop participant break out groups continue to guide work within FRST project Mātauranga Māori and sustainable management of New Zealand fisheries.

Curriculum Vitae

PART 1

1a. Personal details				
Full name	*Title* Dr.	*First name* Tarek	*Second name(s)* Abdellatif Aly	*Family name* Soliman
Present position	Economist			
Organisation/Employer	Landcare Research			
Contact Address	231 Morrin Rd			
	St Johns			
	Auckland		**Post code**	1072
Work telephone	+6495744138	**Mobile**	021 294 5863	
Email	SolimanT@landcareresearch.co.nz			
Personal website (if applicable)	http://www.landcareresearch.co.nz/about/people/staff-details?id=c29saW1hbnQ=			

1b. Academic qualifications

2012, PhD, Economics, Wageningen University, Netherlands

2006, MSc, Economics, Mediterranean Agronomic Institute (CIHEAM), Greece

2001, BSc, Economics, Cairo University, Egypt

1c. Professional positions held

2016-present, Economist, Landcare Research, New Zealand.

2015-2016, Environmental Risk Scientist, NIWA, New Zealand.

2013-2015, Research Fellow, National University of Singapore.

2008-2012, Research Assistant, Wageningen University, Netherlands.

1d. Present research/professional speciality

Tarek's research has focused on the application of economic theory and analysis to problems of environmental and natural resource management, in particular, biosecurity, climate change mitigation, and water quality management. He has developed economic simulation models that assess the effects of proposed interventions to inform policy development.

1e. Total years research experience	9 years

1f. Professional distinctions and memberships (including honours, prizes, scholarships, boards or governance roles, etc)

2010, Paper of the month (June), Wageningen University, the Netherlands.

2009, Full Scholarship, Entrepreneurial boot camp, University of Wisconsin, USA.

2007-2008, Full Ph.D. scholarship, Charles University in Prague, Czech Republic

2004-2006, Full M.Sc. scholarship, Mediterranean Agronomic institute, Greece.

1g. Total number of *peer reviewed* publications and patents	Journal articles	Books, book chapters, books edited	Conference proceedings	Patents
	10 (+1 under-review)		7	

PART 2

2a. Research publications and dissemination

Peer-reviewed journal articles

Soliman, T., Lim, F. K. S., Lee, J. S. H., & Carrasco, L. R. (2016). Closing oil palm yield gaps among Indonesian smallholders through industry schemes, pruning, weeding and improved seeds. Royal Society Open Science, 3(8), 160292.

Soliman T, MacLeod A, Mumford JD, Nghiem TPL, Tan HTW, Papworth S, Corlett RT, Carrasco LR (2016). "A regional decision support scheme for pest risk analysis in Southeast Asia". Risk Analysis, 36: 904–913.

Win MK, **Soliman T.**, Lee KL, Wong CS, Chow AL, Ang B, Carrasco R., Leo YS (2015). "Review of a two-year methicillin-resistant Staphylococcus aureus screening program and cost-effectiveness analysis in Singapore". BMC infectious Diseases, 15:391.

Soliman T., Cook A., Coker R. (2015). "Pilgrims and MERS-CoV: what's the risk?". Emerging Themes in Epidemiology, 12:3.

Soliman T., Mourits M., Oude Lansink A., van der Werf W. (2015). "Quantitative economic impact assessment of invasive plant pests - What does it require and when is it worth the effort?". Crop protection, 69: 9-17.

Nghiem L., **Soliman T.**, Yeo D., Tan H., Theodore E.A., Mumford J., Keller R., Baker R., Corlett R., Carrasco R. (2013). "Economic and environmental impacts of harmful non-indigenous species in Southeast Asia". PLoS ONE, 8(8): e71255.

Soliman, T., Mourits, M. C. M., Oude Lansink, A. G. J. M. and van der Werf, W. (2013). "Economic justification for quarantine status – the case study of 'Candidatus

Liberibacter solanacearum' in the European Union". Plant Pathology, 62: 1106–1113.

Soliman T., Mourits M., van der Werf W., Hengeveld G.M., Robinet C., Oude Lansink A. (2012). "Framework for modelling economic impacts of invasive species, applied to pine wood nematode in Europe". PLoS ONE 7(9): e45505.

Soliman T., Mourits M., Oude Lansink A., van der Werf W. (2012). "Quantitative economic impact assessment of an invasive plant disease under uncertainty – a case study for PSTVd invasion into the European Union". Crop Protection 40, 28-35.

Soliman T., Mourits M., Oude Lansink A., van der Werf W. (2010). "Economic impact assessment in pest risk analysis". Crop Protection 29, 517–524.

Peer reviewed books, book chapters, books edited

Refereed conference proceedings

2017 New Zealand Agricultural and Resource Economics Society Annual Conference (NZARES), Rotorua, New Zealand. October 19-20, 2017.
"*Investing in interventions against pests – an analysis of choices made by decision makers under uncertainty"*

2017 New Zealand Association of Economists Annual Conference (NZAE), Wellington, New Zealand. July 12-14, 2017.
"*Forecasting the economic impacts of two biofouling invaders on New Zealand green-lipped mussel aquaculture"*

2017 New Zealand Marine Sciences Society Annual Conference (NZMSS), Christchurch, New Zealand. July 4-6, 2017.
"Prioritizing marine invasive species by potential impacts on environmental, economic and social values".

2016 International Conference on Marine Bioinvasions (ICMB), Sydney, Australia. January 19-21, 2016.
"Prioritizing biosecurity investments in New Zealand: A discrete choice experiment"

2013 International Pest Risk Research Group Annual Meeting (IPPRG), Raleigh, North Carolina, USA. October 14-17, 2013.
"Framework for modelling economic impacts of invasive species, applied to pine wood nematode in Europe"

2011 European Association of Agricultural Economists Annual Conference (EAAE), Zurich, Switzerland. Aug 30-September 2, 2011.
"*A risk assessment model on Pine Wood Nematode invasion in the EU*"

2006 European Association of Agricultural Economists Annual Conference (EAAE), Crete, Greece. June 29 - July 2, 2006.
"*Export changes and macroeconomic indirect effect in the Egyptian economy*"

Patents

Other forms of dissemination (reports for clients, technical reports, popular press, etc)

SELECT REPORTS AND OTHER PUBLICATIONS

Walsh P., **Soliman T.,** Greenhalgh S., Mason M., Palmer D. (2017). "Valuing the Benefits of Permanent Forests" Landcare Research Contract Report LC2788 prepared for New Zealand (NZ) Ministry for Primary Industries. 49 p.

Soliman T., Mourits M., Oude Lansink A., van der Werf W. (2012). A manual and computerized module for calculating economic, environmental and social impacts". Deliverable 2.5 of the EU Framework 7 Research Project "Enhancements of Pest Risk Analysis Techniques (PRATIQUE), Report prepared by Wageningen University for the European commission.

Bremer J., **Soliman T.**, Mourits M., Oude Lansink A., van der Werf W. (2012). "A set of written indicators and a written protocol for scoring levels of impact". Deliverable 2.3 of the EU Framework 7 Research Project "Enhancements of Pest Risk Analysis Techniques (PRATIQUE), Report prepared by Wageningen University for the European commission.

Soliman T., Mourits M., Oude Lansink A., van der Werf W. (2010). "Review of impact assessment methods". Deliverable 2.1 of the EU Framework 7 Research Project "Enhancements of Pest Risk Analysis Techniques (PRATIQUE), Report prepared by Wageningen University for the European commission.

Soliman T. and Mattas K. (2006). Development of a conceptual framework and case studies for Input-Output analysis, Deliverable 6.1 & 6.2 of the EU Framework 6 Research Project "Market and Trade Policies for Mediterranean Agriculture: The case of fruit, vegetable and olive oil (MEDFROL), Report prepared by Mediterranean Agronomic Institute (MAICh-CHIEAM) for the European commission.

2b. Previous research work

Research title: Valuing the Benefits of Permanent Forests; an Exploration of Several Afforestation Scenarios**.**
Principal outcome: Explore the benefits of permanent forests compared with plantation forests and other land uses.
Principal end-user and contact: MPI, New Zealand

Research title: What's at stake? - Enabling decision-making through better measurement, forecasting and evaluation of the impacts of non-native organisms in NZ's changing ocean**.**
Principal outcome: Provide the information base for long-term management and incursion response to non-native marine organisms.
Principal end-user and contact: MBIE, New Zealand

Research title: Impact and cost-effectiveness of respiratory disease pandemic intervention in Singapore
Principal outcome: Developed an Epidemiological-economic model that can help the government to prepare for future influenza seasonal epidemics or pandemics.
Principal end-user and contact: Ministry of Health, Singapore

Research title: Prevention, detection & control of invasive species in Southeast Asia
Principal outcome: Developed a decision support tools for pest risk analysis at the regional level
Principal end-user and contact: National University of Singapore

Research title: Enhancements of Pest Risk Analysis Techniques (PRATIQUE)
Principal outcome: Developed Bio-economic models for pest risk analysis.
Principal end-user and contact: EC-funded 7th Framework research project

Research title: Market and Trade Policies for Mediterranean Agriculture: The case of fruit, vegetable and olive oil (MEDFROL)
Principal outcome: Reports and Scientific articles
Principal end-user and contact: EC-funded 6th Framework research project

2c. Describe the commercial, social or environmental impact of your previous research work

Experienced in supra-national research projects that require the integration of biophysical processes with socio-economic systems, with major recent roles as bio-economic analyst in invasive species management (EU funded project with total funding of €2.8 million & MBIE project with a total funding of $3 million), economic impact assessment of free trade agreements (EU funded project with total funding of €1.17 million), control of emerging infectious diseases (Singaporean ministry of health with total funding of $450k), and climate change mitigation (several MPI funded projects)

During 2008-2012, the EU project PRATIQUE project was successfully able to address the following challenges: (a) to assemble the datasets required to construct pest risk analysis (PRAs) valid for the whole of the EU, (b) to conduct multidisciplinary research that enhances the techniques used in PRA and (c) to provide a decision support scheme for PRA that is efficient and user-friendly.

During 2006-2007, my research work at the EU project MEDFROL was successfully able to analyse the generated impacts on national production, employment levels and household income arising from any future changes in the relevant policy scheme covering fruits and vegetable and olive oil sectors in the EU main trading partners.

2d. Demonstration of relationships with end-users

I have worked extensively with government and non-government stakeholders in the EU, Southeast Asia, and New Zealand, and delivered a consultation activities in bio-economic modelling and impact assessment (e.g. consultation for European and Mediterranean plant protection organization (EPPO), France)

Curriculum Vitae

PART 1 – Personal and professional details

1a. Personal details				
Name	Title Dr	First name Utkur	Second name(s)	Family name Djanibekov
Present position	Economist			
Organisation/employer	Landcare Research Manaaki Whenua			
Contact address	231 Morrin Road, St. Johns, Auckland 1072			
			Post code	1072
Work telephone	+64 9 5744151	**Mobile**	+64 27 5221633	
E-mail	djanibekovu@landcareresearch.co.nz			
Personal website (if applicable)				

1b. Academic qualifications

2014, PhD in Agriculture, University of Bonn, German

2008, MSc in Management, Tashkent University of Information Technologies, Uzbekistan

2006, BSc in Management, Tashkent University of Information Technologies, Uzbekistan

1c. Professional positions held

- 2014–2017, Postdoctoral Researcher, Institute for Food and Resource Economics, University of Bonn, Germany
- 2014–2014, Full-time consultant, Economics of Land Degradation (ELD) project, University of Bonn, Germany
- 2013–2014, Part-time consultant, Federal Ministry of Education and Research of Germany
- 2013–2013, Part-time consultant, World Agroforestry Centre (ICRAF)
- 2008–2009, Research associate, ZEF/UNESCO German-Uzbek Development Project on Landscape Restructuring

1d. Present position/professional speciality

Economist researcher. Develop economic models on land use and land-use change in New Zealand and internationally.

1e. Years of research experience, if applicable (exclude periods away from research)	9 years

1f. Professional distinctions and memberships (e.g. honours, prizes, scholarships, governance roles etc)

2017–present, Member of the New Zealand Association of Economists

2012–2018, Member of the International Association of Agricultural Economists

2014–2017, Member of the European Association of Agricultural Economists

2013, Robert Bosch Foundation PhD scholarship

2012, Dr. Herman Eiselen Doctoral Program of the Foundation fiat panis for conference participations

2009–2012, International Postgraduate Studies in Water Technologies (IPSWaT) PhD scholarship

1g. Number of peer- reviewed publications and patents	Journal articles	Books, book chapters, books edited	Conference proceedings	Patents
	13	8	10	

PART 2 – Information relevant to this proposal

2a. Relevant publications and dissemination

Djanibekov U., Villamor, G.B. 2017. Market-based instruments for risk-averse farmers: rubber agroforest conservation in Jambi Province, Indonesia. Environment and Development Economics 22 (2), 133-155.

Djanibekov U., Khamzina, A. 2016. Stochastic economic assessment of afforestation on marginal land in irrigated farming system. Environmental and Resource Economics 63(1), 95-117

Djanibekov, U., Villamor, G.B., Dzhakypbekova, K., Chamberlain, J., Xu, J., (2016). Adoption of sustainable land uses in post-Soviet Central Asia: The case for agroforestry. Sustainability 8(10), 1030/1-16

Djanibekov, N., Djanibekov, U., Sommer, R., Petrick, M., (2015). Cooperative agricultural production to exploit individual heterogeneity under a delivery target: The case of cotton in Uzbekistan. Agricultural Systems 141, 1-3

Villamor, G.B., Le, Q.B., Djanibekov, U., van Noordwijk, M., Vlek, P.L.G., (2014). Biodiversity in rubber agroforests, carbon emissions, and rural livelihoods: An agent-based model of land-use dynamics in lowland Sumatra. Environmental Modelling and Software 61, 151-165

Villamor, G.B., Chiong-Javier, M.E., Djanibekov, U., Catacutan, D., van Noordwijk, M., (2014). Gender differences in land-use decisions: shaping multifunctional landscapes? Current Opinion in Environmental Sustainability 6, 128-133

Djanibekov U., Djanibekov N., Khamzina A., Bhaduri A., Lamers J.P.A., Berg E. (2013). Impacts of innovative forestry land use on rural livelihood in a bimodal agricultural system in irrigated drylands. Land Use Policy 35, 95-106

Djanibekov, U., Van Assche, K., Boezeman, D., Djanibekov, N., (2013). Understanding contracts in evolving agro-economies: Fermers, dekhqans and networks in Khorezm, Uzbekistan. Journal of Rural Studies32, 137-147

Djanibekov, N., Sommer, R., Djanibekov, U., (2013). Evaluation of effects of cotton policy changes on land and water use in Uzbekistan: Application of a bio-economic farm model at the level of a water users association. Agricultural Systems 118, 1-13

Djanibekov, N., Frohberg, K., Djanibekov, U., (2013). Income-based projections of water demand for food consumption in Central Asia: The case of Uzbekistan. Global and Planetary Change 110, Part A, 130-142

Rudenko, I., Bekchanov, M., Djanibekov, U., Lamers, J.P.A., (2013). The added value of a water footprint approach: micro- and macroeconomic analysis of cotton production, processing and export in water bound Uzbekistan. Global and Planetary Change 110, Part A, 143-151

Djanibekov, U., Khamzina, A., Djanibekov, N., Lamers, J.P.A., (2012). How attractive are short-term CDM forestations in arid regions? The case of irrigated croplands in Uzbekistan. Forest Policy and Economics 21, 108-117

2b. Previous work relevant to this proposal

Repeat and expand box below as necessary.

Project/Research title: Analysed land use strategies and policies to conserve the native agroforestry in Indonesia under conditions of agricultural risks

Principal outcome: Identified optimal land use strategies to manage risks, increase incomes and conserve ecosystem for Indonesian farmers, considering different risk aversion perception of farmers

Principal end user(s): Farmers in Indonesia, World Agroforestry Centre (ICRAF), scientific community in agricultural economics

Project/Research title: Analysing policies and management practices for German farmers planting short-rotation coppice under conditions of risk

Principal outcome: Identified optimal policies and planting and harvesting practices for German farmers to maximize incomes and manage risk

Principal end user(s): German farmers, students at the University of Bonn in Germany, scientific community in agricultural economics,

2c. Describe the commercial, social, or environmental impact of your previous work

Contributed the recommendation to the parliament of Uzbekistan on economics of afforestation of marginal croplands. According to the recommendation parliament is considering to introduce changes in sustainable use marginal lands.

2d. Demonstrate your relationships with end users

Co-organized workshop for farmers on economic and social perception of adopting afforestation on marginal croplands in Uzbekistan. Tutored PhD students on risk management in farming, and taught MSc programme course on agricultural economics and risks and on dynamic modelling at the University of Bonn, Germany. The research outputs on agricultural risks and risk management were published in peer-reviewed journal articles (e.g. Env Res Econ, Env Devel Econ) and presented at scientific conferences (e.g. International Association of Agricultural Economists).