PART I: OVERVIEW OF THE RESEARCH AND ITS BROADER IMPLICATIONS

CHAPTER 1 RATIONALE AND SUMMARY

It is ironic that agricultural development in Australia has been strongly driven by technological innovation, drawing on a strong and well supported agricultural research and development system, while innovation in sustainable natural resource management has been much more neglected.[1]

1.1 Introduction

This thesis is primarily concerned with the pursuit of innovation in natural resource governance, with three overlapping dimensions. It examines the feasibility of using a variety of approaches to improved regulation and natural resource management, to create a new, systematic approach to the control of risks to the environment. Second it is about exploring the real-world feasibility of implementing innovative governance of the potentially powerful, technologically intensive liquid biofuels industry. Third it is concerned with better approaches to the management of a long-established natural resource management problem which is likely to take on new dimensions with the development of new biofuel enterprises, the management of biofuel weeds.

The method used is simple in concept, but difficult in practice:

1. Conduct an extensive review of the relevant literatures, particularly those concerned with the developing biofuels sector and weed management, and those literatures concerned with concepts of risk and natural resource governance;
2. Identify potential directions for innovation in natural resource governance institutions and instruments. This was focused particularly upon regulatory and institutional theory, economic risk theory, and applications of these theories in practice.
3. Integrate the two streams of research, to develop a conceptual model for a particular biofuels governance issue. The selected issue was biofuels weeds governance. The governance approach integrated a variety of innovations from different fields of investigation into a single conceptual model. That model was innovative in both the instruments proposed and in the manner of their integration.

[1] S Ryan et al, 'Australia's NRM Governance System: Foundations and Principles for Meeting Future Challenges' (Australian Regional NRM Chairs, 2010), 23.

4. Use depth-interview techniques with experts in a variety of relevant fields, to evaluate both the overall model and the various instruments within it. That evaluation was particularly focused upon issues of implementation.
5. From the above research steps to identify:
    a. potential directions for improved governance of the particular issue (biofuels weeds),
    b. potential implications for biofuels and natural resource governance more broadly, and
    c. frameworks that are likely to be useful for future evaluation of regulatory and other governance innovations.

Biofuel weed risk has received increasing attention in research reports, as will be identified in the following discussion. This research suggests that whilst it is possible to design more innovative regulatory responses to complex environmental risks such as biofuel weeds, the adoption of more sophisticated environmental risk regulations faces various challenges. It also suggests that law and policy analysis could benefit from additional perspectives upon implementation feasibility. While these go beyond the traditional ambit of environmental law scholarship, if the goal of this scholarship is to achieve substantial, tangible improvement in environmental outcomes, new implementation knowledge will be required alongside innovation in the legal and other instruments which are applied.

The first paper in the series of publications forming the bulk of this thesis is provided at the end of this Chapter. The draft paper, which has been submitted for publication in a forthcoming book on biofuels law and policy, provides a synthesis and 'framing' of the overall thesis.

1.2 Why is governance innovation essential

The Bruntland Report[2] suggests that the concept of sustainable development (SD) requires a balance between human development and environment protection. This

[2] World Commission on Environment and Development, 'Report of the World Commission on Environment and Development: Our Common Future', transmitted to the General Assembly as an Annex

concept emerged to reflect the increasing societal concern about the depletion of natural resources and threats to environmental services. To achieve the goal of sustainable development, a series of principles were adopted and mechanisms suggested. These included the polluter pays principle (and the beneficiary pays principle), the precautionary principle and biodiversity conservation principles. New institutional arrangements (including laws) are needed to implement these principles. However, while the concept of SD is expressed in policies, laws and regulations, the effectiveness of traditional instruments often falls short of what is needed for sustainability. The concept of sustainable development implies that institutional change is required to modify or alter unsustainable behavioural patterns, but effective reform requires an understanding of effective social change strategies.

There are various perspectives on the problem of the depletion of natural resources and environmental services. In this thesis, the researcher frames the sustainability challenge as a resource-consumption problem.[3] This perspective postulates that unsustainable consumption patterns jeopardise the prospect of a sustainable future. Therefore, the sustainability challenge has a strong behavioural component. Laws can help achieve sustainability by shaping the behaviours that trigger unsustainable patterns of consumption. By creating enforceable legal rights and obligations, the law can be a powerful social tool to influence behaviours, provided that legislation and regulations are well designed, implemented and enforced.

1.3 Limitations of established models

NRM laws and policies are influenced by two paradigms of behaviour. The command-and-control approach (or prescriptive measures) intends to achieve environmental and natural resources protection by controlling what people do. It revolves around

to document A/42/427 - Development and International Co-operation: Environment' (UN Doc A/42/427, 1987). In Australia, the Ecologically Sustainable Development principle was adopted in various policy documents and legislative acts. See, for, example the key policy document National Strategy for Ecologically Sustainable Development ('NSEDS') adopted in 1992 by the Ecologically Sustainable Development Steering Committee. It was then complemented in the same year by the Intergovernmental Agreement on the Environment ('IGAE'). For key references, see footnotes 27–30 in Garry Bates, *Environmental Law in Australia* (LexisNexis Butterworths, 7th ed, 2010) 206.

[3] This is also the view adopted in Paul Martin and Miriam Verbeek, *Sustainability Strategy* (Federation Press, 2006).

mechanisms such as conditional licensing[4] and permit-based systems, prohibition and enforcement mechanisms. These can be associated with 'uniform technology-based environmental standards'.[5] This model relies extensively on deterrence mechanisms such as penalties and prosecutions.

The market-based approach, informed by neo-classical theories, assumes that market participants can achieve environmental and natural resources protection largely through pricing and trading. It also assumes that markets efficiently allocate resources (including natural resources) among people who value them the most through the pricing mechanism which balances supply and demand. It assumes that market participants behave in a rational way to maximise their utility and this suggests that they will protect what they own (including natural resources). It surmises that markets operate best in a world of perfect information.

Both approaches can generate political, social, economic and environmental spillovers which compromise their effectiveness, efficiency and/or political 'acceptability'.[6] Implementation of each faces substantial impediments, notably the insufficiency of economic and human resources, and the powerful social pressures to consume natural resources, against which NRM strategies must contend. The sufficiency of government expenditure for environmental and natural resources protection is brought into further question by projected fiscal imbalances arising with an ageing population.[7] Subsidies can also have economic distortive effect, with limited positive behavioural effects.[8]

[4] Described as 'the backbone of environmental law' in Bates, above n 2, 174.
[5] Neil Gunningham and Peter Grabosky, *Smart Regulation: Designing Environmental Policy* (Oxford University Press, 1998) 42.
[6] Paul Martin and Jacqueline Williams, 'Policy Risk Assessment' (Technical Report N°.03/10, CRC for Irrigation Futures, 2010). For an illustration of policy risks associated with biodiversity regulations and native vegetation, see Productivity Commission, Australian Government, 'Impacts of Native Vegetation and Biodiversity Regulations: Productivity Commission Inquiry Report' (N° 29, Productivity Commission, 8 Avril 2004). The researcher has adopted the definition of effectiveness and efficiency as stated in Jacqueline Williams, *Success Attributes of Regional NRM Systems in Australia* (PhD Thesis, University of Queensland, 2007) 46. The author defines effectiveness 'as delivering the objectives or desired outcomes' and efficient 'as cost effective, resource effective, coordinated and integrated'.
[7] Treasury, Commonwealth of Australia, 'Intergenerational Report 2007' (2007).
[8] The International Institute for Sustainable Development's Global Subsidies Initiatives (GSI) identifies, for example, the perverse effects of subsidies on economic development and the environment. International Institute for Sustainable Development, *Global Subsidies Initiatives*.

As reported in a plethora of governmental research reports, natural resources such as water, minerals and fisheries, and the environmental services provided by natural ecosystems are being degraded[9] despite substantial investments made within the Australian context. At the international, regional and national levels, institutional arrangements including prescriptive measures, voluntary action, government expenditure and market-based instruments[10] have had an insufficient impact upon environmental degradation. This suggests the need for innovations to more effectively change resource consumption patterns, which rely upon less (rather than more) public funding.

The command-and-control regulatory approach is often criticised because of problems of asymmetry of information that favours polluters and other harm-doers.[11] It often generates high transaction costs, particularly information costs. The public sector has to finance monitoring and compliance to ensure that it can access sufficient information to enforce these standards. Prescriptive measures also suffer from a lack of flexibility to adjust to contextual factors, such as biophysical variations, specific behaviours involving different levels of risks and uncertain events.

Market-based instruments reflecting the principle[12] of 'improved valuation, pricing and incentive mechanisms'[13] harnessing the economic 'law' of supply and demand[14] to

[9] These include Australian State of the Environment Committee et al, 'Australia State of the Environment 2011' (2011); Australian State of the Environment Committee, 'Australia State of the Environment 2006' (2006); Australian State of the Environment Committee, 'Australia State of the Environment 2001' (2001); Commissioner for Environmental Sustainability Victoria, 'State of the Environment Victoria 2008 - Living Well Within our Environment - Are We? - Can We?' (Commissioner for Environmental Sustainability Victoria, 2008); Productivity Commission, Australian Government, above n 6.

[10] This classification relies on Neil Carter, *The Politics of the Environment - Ideas, Activism, Policy* (Cambridge University Press, 2001) 284.

[11] See ibid 288-9.

[12] In Australia, the ESD principle was adopted in 1992 in the key policy document *National Strategy for Ecologically Sustainable Development* ('NSEDS') AGPS, 1992, adopted by the Ecologically Sustainable Development Steering Committee. It was then complemented the same year by the *Intergovernmental Agreement on the Environment* (IGAE).

[13] See ibid s 3.5.4.

[14] Market-based instruments are widely referred to as economic instruments. The phrase 'economic instruments' is criticised for being 'a chameleon phrase' as 'policy instruments whether economic or not, have economic effects and may be analysed in economic terms' in Zada Lipman and Garry Bates, *Pollution Law in Australia* (LexisNexis Butterworths, 2002) 50. Market-based/economic instruments for environmental protection are subject to multiple categorisations which can create confusion. As noted by Lipman and Bates (p 51), the OECD distinguishes between charges, subsidies, market creation and financial enforcement mechanisms. The National Action Plan for Salinity and Water Quality (NAPSWQ) distinguishes between price-based (eg taxes, levies, subsidies) quantity-based (eg 'cap and trade' and 'offset' mechanisms) and market friction mechanisms (eg certification and eco-labeling schemes). See

achieve environmental outcomes are often seen as far more effective and efficient under the neoclassical paradigm. However market mechanisms require costly contractual or government-driven monitoring schemes. Deregulatory models,[15] when confronted with the specificities of the environmental problem and the realities of market mechanisms, can generate significant market failures.[16] Economic efficiency claims can be used as a covert pathway to substantive deregulation which may result in less effective control over excessive resource consumption.

These factors all suggest that more innovative thinking in the pursuit of sustainability will be required to meet the intersecting pressures of increased demands upon natural resources due to population, declining public funds for environmental investment due to demographics and fiscal factors and the inexorable effects of harmful dynamics.[17] This thesis argues that the legal and regulatory phenomenon, either in its command-and-control or market-based form, is generally approached with too narrow a focus upon individual instruments rather than with a focus upon the governance system.

Environmental lawyers and policy makers tend to think in terms of instruments rather than systematic management of behaviours and as a result pay insufficient attention to the social and economic context in which behaviours occur, evolve and change. Economic analysis also tends to be focused upon a narrow set of considerations. Neither legal nor economic approaches are systemic in their dealing with implementation of instruments they propose. Ad-hoc and 'patchy' policies are often driven by a short-term vision. This

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Department of Environment and Heritage, Australian Government, *Managing our Natural Resources - Can Markets Help?* 2 <http://nrmonline.nrm.gov.au/catalog/mql:231>.

Following Panatoyou's classification, Gunningham and Grabosky distinguish between property rights, market creation, fiscal instruments and charge systems, financial instruments, liability instruments, performance bonds and deposit refund systems. See Gunningham and Grabosky, above n 5, 70.

[15] Bridget M Hutter, 'The Attractions of Risk-based Regulations: Accounting for the Emergence of Risk Ideas in Regulation' (Discussion Paper N° 33, ESRC Centre for Analysis of Risk and Regulation, 2005); Cass R Sunstein, *Risk and Reason: Safety, Law and the Environment* (Cambridge University Press, 2002). Organization for Economic Cooperation and Development, 'Regulatory Policies in OECD Countries - From Interventionism to Regulatory Governance' (OECD, 2002).

[16] Robyn Eckersley, 'Free Market Environmentalism: Friend or Foe?' (1993) 2(1) *Environmental Politics* 1. The complex relationship between economic instruments, deregulation and the role of state regulatory intervention is a key issue. This is briefly discussed in Lipman and Bates, above n 14, 54-55. The authors identify two strands of economic instruments. The first strand involves re-regulation and the second, which is associated with the Coasem model, involves deregulatory regimes. The latter refers to the use of property rights to protect the environment.

[17] See Treasury, above n 7.

does not accommodate the characteristics of the sustainability challenge, which requires long-term solutions, genuine political commitment and reconciliation between conflicting imperatives: the economic imperative for consumption goals and the ecological imperative to constrain consumption.

Ideas are never detached from pre-existing concepts and theories and the intellectual surroundings they emerged from. New ideas evolve in an iterative way along with definitions, concepts, theories and methodological tools. This research therefore largely refines ideas which have been suggested in the literature to improve NRM laws and policies to achieve sustainable behavioural change. The innovations proposed in this thesis largely rely upon combinations of known elements but these combinations do result in highly novel approaches.[18] Novelty in legal scholarship can trigger intuitive rejection by academics and practitioners but given that one key objective of this research is to identify the scope for innovation, entertaining approaches that differ markedly from the received wisdom and the *status quo* is an essential part of the scholarly enquiry.

1.4 The selected case study

The effectiveness of environmental policies, laws and regulations is context dependent.[19] In order to ensure specificity in the research, a case study of anthropogenic environmental risk was necessary. The one selected was the risk that the introduction of new biofuel crops would also introduce new weed risks for which new institutional arrangements may be required. While the biofuel weeds risk has been discussed in some circles, strategies for management of this risk have not been developed.

Biofuel weeds risk is a subset of two overarching categories of environmental risk, the risk from weeds and the risks from the biofuels industry. The issues may involve common institutions and actors but may also involve distinct 'rules of the game' and different 'players' with their own beliefs, opinions and values.

[18] This thesis adopts the definition of innovation provided in Toddi A Steelman, *Implementing Innovation - Fostering Enduring Change in Environmental Change and Natural Resource Governance* (Georgetown University Press, 2010) 5. The author defines innovation as 'new program or process for the individuals adopting it'.

[19] Michael G Faure, 'Instruments for Environmental Governance: What Works?' in Paul Martin et al (eds), *Environmental Governance and Sustainability*, IUCN Academy of Environmental Law (Elward Elgar, 2012) 3.

The draft publication which follows this introductory chapter deals more exhaustively with the biofuel challenges than with the weeds component of this case study. It frames this research within its broader context so as to provide the examiner with a clear sense of the nature and magnitude of the governance challenge. Thereby it indicates the policy significance of this research.

1.4.1 Why is weeds governance challenging?

As the broader biofuels issues are canvassed in that chapter, the focus now is upon explaining the difficulties of weeds management and policy.

The weeds challenge illustrates the limitations of traditional NRM laws and policies. This will be discussed specifically with reference to Australia, which is widely considered to be a leader in weed management (reflecting the scale and impact of its weed issues). Weeds are a driver of significant harm to the unique mega-biodiversity of the Australian continent.[20] Defying man-made boundaries, they affect public and private lands, including approximately 15 million hectares of grazing lands and natural ecosystems.[21] They diminish the life-sustaining environmental services delivered by biodiversity. These include natural assets such as gene pools, rare fauna and native flora, native habitats and water quality. Beyond the fact that they endanger collectively natural heritage, biological invasions from weeds (including escaped garden plants)[22] impose a financial burden exceeding A$4 billion per year to Australian agriculture.[23] Weeds involve anthropogenic environmental risks, that is risk arising from human actions which voluntarily or unintentionally introduce new potential weedy crops into the natural environment. Examples of voluntarily introduced weedy plants include weeds imported legally or illegally into the Australian continent. Biological infestations from weeds resulting from unintentional actions include examples where weedy plants have ‘jumped the fence’ and

[20] Lee Godden, Rebecca Nelson and Jacqueline Peel, 'Controlling Invasive Species: Managing Risks to Australia's Agricultural Sustainability and Biodiversity Protection' (2006) 13(3) *Australasian Journal of Environmental Management* 166.
[21] Ibid.
[22] Andreas Glanznig, 'Weed Proofing Australia: A Way Forward on Invasive Garden Plants' (Paper presented at the 9th International Conference on the Ecology and Management of Alien Plant Invasions, Perth, 2007) <http://awsassets.wwf.org.au/downloads/sp035_weed_proofing_australia_1jan06.pdf>.
[23] For the economic impact of weeds in Australia, see J Sinden et al, 'The Economic Impacts of Weeds in Australia' (Technical Series No 8, CRC for Australian Weed Management, 2004), 6.
See also Elisa Arcioni, 'Out Damned Weeds! Weed Management in Australia - Keeping Them at Bay' (2003) 8(1) *Australasian Journal of Natural Resources Law and Policy* 75.

have been transported by natural vectors (eg air, birds) and/or human machinery (eg tractors).[24] As discussed later in this thesis, there is a distinction between weedy crops with commercial and/or social benefits and those with no value. This is because in the first scenario policy-makers will have to strike a balance between the opportunities for commercial profit and the risks of weeds invasion.

These risk concepts are developed in greater detail in Part 2 of this thesis.

Institutional arrangements to manage weeds risk are a complex mix of international, national and regional measures.[25] One feature is the increasing role of the Commonwealth with regards to Weeds of National Significance (WoNS).[26]

Traditional instruments for weeds control encompass bans against import, interdiction of hazardous species and removal orders. The effectiveness of these is constrained by bureaucracy, by the transaction costs of detection, prosecution and enforcement, and by the limited private incentives for landowners to invest in control except where the weed prejudices their economic activities. Public and voluntary programs for weed removal are constrained by limited financial and human resources, by the difficulties of coordination across multiple tenures, and by the high costs of weed detection and control.

A great deal of money and effort is consumed to combat weeds[27] but the instruments upon which governments principally rely have limited effectiveness. Even given these

[24] This is discussed in detail in Brian Sindel and Annemieke W Van Der Meulen, 'Appendix 3 – Identifying and Exploring Pathways of Weed Spread within Australia: A Literature Review' in *Pathway Risk Analysis for Weed Spread within Australia - Final Report* (Land and Water Australia, Project N° UNE61, 2008) <http://lwa.gov.au/projects/2566>.

[25] An overview of international and regulatory instruments and institutions related to alien invasive species is provided in Clare Shine, Nattley Williams and Lothar Gündling, *A Guide to Designing Legal and Institutional Frameworks on Alien Invasive Species* (Environmental Policy and Law Paper N° 40, IUCN, The World Conservation Union, 2000) 87-113; See also Sophie Riley, *Invasive Alien Species and the Protection of Biodiversity: The Role of Quarantine Laws in Resolving the Inadequacies in the International Legal Regime* (PhD Thesis, University of New South Wales, 2008); and Paul Martin et al, 'Developing a Good Regulatory Practice Model for Environmental Regulations Impacting on Farmers' (Australian Farm Institute, 2007) 18-9, 48-52; Senate Environment Communications Information Technology and the Arts References Committee, Parliament of Australia, 'Turning Back the Tide - the Invasive Species Challenge - Report on the Regulation, Control and Management of Invasive Species and the Environment Protection and Biodiversity Conservation Amendment (Invasive Species) Bill 2002' (2004). A summary of past Australian weeds initiatives is reported in Rural Industries Research and Development Corporation, 'National Weeds and Productivity Research Program - R&D Plan 2010 to 2015' (2010) 6-10.

[26] For further information see Department of the Environment Water Heritage and the Arts, Australian Government, 'Weeds of National Significance (WoNS)' (2011) <http://www.weeds.gov.au/weeds/lists/wons.html>.

problems, the obvious structural inefficiencies, inadequate public resources and private incentives, and the overwhelming size of the weeds challenge, there is little apparent interest among weeds professionals and policy makers to pursue radical policy change.

Weeds risk is a real challenge for policy makers. Once introduced, plants may establish, naturalise and invade natural ecosystems. Conversion of an introduced species from a benign status with only a contingent risk to being a harmful weed, results from a complex causal chain of contributing and interacting processes and events, including ecological factors and human-induced activities. Intersecting causal agents are frequently responsible for the spread of weeds along different possible pathways. Deliberate and accidental spread by humans as well as by natural spread vectors, such as birds and air, account for the biological invasions of weeds.[28]

This raises problems of determining clear cause and effect in the propagation and distribution of weeds. Climate change is an aggravating factor increasing the likelihood of the distribution of weeds.[29] Land use changes induced by agricultural production, natural resources extraction and land development adversely impact ecological processes and amplify the vulnerability of natural environments to the spread of weeds.

Weeds risk involves geographic and time considerations with which the policy, legal and regulatory framework struggles. A plant with invasive features may become invasive on a specific location or remain – temporarily or permanently – harmless. The invasive traits of a plant do not necessarily result in biological invasions. As concisely articulated, 'the definition of a weed is both time and location specific'.[30] The identification of the invasive trait of a plant relies on scientific knowledge, which relies on incomplete information and is subject to scientific discoveries. The weediness potential of a plant is

[27] This is illustrated with the five-year National Weeds and Productivity Research Program R&D 2010 to 2015. For the first two years of the Program, the Australian Government has provided up to $12.4 million. See Rural Industries Research and Development Corporation, above n 25.The plan retraces the history of Australian weeds' initiatives and the history of R&D to respond to this unique challenge.
[28] A risk-focused weeds pathway approach is reported in Sindel and Van Der Meulen, above n 24. Weeds pathways can be represented in diverse ways.
[29] The Allen Consulting Group, 'Repairing the Country - Leveraging Private Investment' (2001) <http://www.ecosystemservicesproject.org/html/publications/docs/Repairing_the_Country.pdf>, 70.
[30] B M Sindel (ed), *Australian Weed Management Systems* (RG & FG Richardson, 2000), 4.

affected by subjective judgments and community awareness[31] and, therefore, human error. In addition, the difficulty in determining whether a species has the potential to become invasive generates 'a profound lack of complete or coherent law and policy'.[32]

In summary, the chronic problem of weeds demonstrates many fundamental challenges of NRM risk management. Traditional regulation, markets and social action fall well short of sufficiency to control the problem. The reasons for failure include insufficient public funds and insufficient private incentives, institutional fragmentation and high transaction costs, and reliance on non-systemic strategies that incorporate contemporary understanding of risk management to only a limited extent.

1.4.2 Second-generation biofuels weeds

There is an entrenched paradigm for weeds governance in Australia. New challenges are emerging with 'second-generation' biofuels. It is possible that these will result in new weed invasions, for which existing institutions are ill-prepared. This provides a window of opportunity to discuss alternatives to the traditional model for weed governance.

Climate change and increasing production costs due to high oil prices require alternative energy sources to fossil fuels to achieve a low-carbon economy and national goals such as energy security and environmental protection. Worldwide and in Australia, these concerns attract the attention of the public and private sectors,[33] resulting in supportive bio-fuels policies intended to harness new energy markets and incentivise investment in new clean energy technologies.[34] As reported by the Australian Energy Resource

[31] Australian Biosecurity Group, *Invasive Weeds, Pests and Diseases: Solutions to Secure Australia* CRC for Pest Animal Control, CRC for Australian Weed Management and WWF-Australia (2005) <http://www.feral.org.au/wp-content/uploads/2010/03/InvSp-web3.pdf>.

[32] Marc L Miller and Lance H Gunderson, 'Biological and Cultural Camouflage: The Challenges of Seeing the Harmful Invasive Species Problem and Doing Something About It' in Marc L Miller and Robert N Fabian (eds), *Harmful Invasive Species: Legal Responses* (Environmental Law Institute, 2004) 1.

[33] Strategic national directions were released in Department of Resources Energy and Tourism, 'Energy White Paper - National Energy Policy - Framework 2030 ' (Strategic Directions Paper, RET, 2009) <http://www.ret.gov.au/energy/Documents/Energy%20Security/Strategic%20Directions%20for%20Energy%20White%20Paper%20March%202009.pdf>. See also Department of Resources Energy and Tourism, Australian Government, 'Draft Energy White Paper - Strengthening the Foundations for Australia's Energy Future' (RET, 2011) <http://www.ret.gov.au/energy/Documents/ewp/draft-ewp-2011/Draft-EWP.pdf>.

[34] See Giovanni Sorda, Martin Banse and Claudia Kemfert, 'An Overview of Biofuel Policies across the World' (2010) 38(11) *Energy Policy* 6977. For example in Australia under the *Renewable Energy (Electricity) Amendment Act* 2009 (passed on 20th August 2009 by the Senate) 20 per cent of the Australian electricity supply will have to be sourced from renewable energy through the national

Assessment, the use of bio-fuels, including biodiesel and ethanol, is projected to increase by 60 per cent from 2007–2008 to 2029–30.[35] The construction and operation of bio-fuels plants and biomass plantations on marginal agricultural lands could strengthen regional economic resilience of rural Australia.[36] They may result in new commercial opportunities with valuable intellectual rights including for the management of risk (eg such as quality assurance schemes, legal and regulatory compliance audits and environmental certification schemes). The production of biofuels could also generate a set of positive social outcomes including the creation of new jobs opportunities.[37]

Bio-ethanol can be produced from second-generation biofuels crops[38] that include native species and exotic crops such as woody or grassy plants. This also encompasses species modified by plant breeding or genetic manipulation.[39]

While biofuel plantation crops could represent significant economic and social opportunities, some have strong invasibility traits.[40] Depending on intertwined and uncertain factors (eg climate change, biophysical variation) biofuel plantations could result in costly weed infestations that may endanger public goods and services. The

Renewable Energy Target (RET scheme). New South Wales has already adopted in its *Biofuels Act 2007* (NSW) a 10 per cent mandated target biofuels (ethanol) for commercial fuels by 2011.

[34] Sam Keam et al, 'Guidelines on Biofuels and Invasive Species' (IUCN, 2009) <http://cmsdata.iucn.org/downloads/iucn_guidelines_on_biofuels_and_invasive_species_.pdf>; The Global Invasive Species Programme, 'Biofuels Run the Risk of Becoming Invasive Species ' (2008) <http://www.gisp.org/publications/reports/BiofuelsReport.pdf.pdf>.

[35] Organisation for Economic Co-operation and Development and Food and Agriculture Organization of the United Nations, 'Biofuels' in *OECD-FAO Agricultural Outlook 2011-2020* (OECD-FAO, 2011) 77; Geoscience Australia, Australian Bureau of Agricultural and Resource Economics and Sciences, 'Bioenergy' (2010), 309-334

[36] Biofuels Taskforce, Australian Government, 'Report of the Biofuels Taskforce to the Prime Minister (2005), 114, 115.

[37] Deborah O'Connell et al, 'Biofuels in Australia – An Overview of Issues and Prospects' (RIRDC Publications N° 07/071, Rural Industries Research and Development Corporations, 2007), 26-7.

[38] The House of Representatives Standing Committee on Primary Industries and Resources reports that, Second-generation technology [...] represents a step change in technology – it has been physically been demonstrated but is not yet commercial due to scale-up issue, or it is not commercially viable due to very high conversion costs'. (House of Representatives Standing Committee on Primary Industries and Resources and Parliament of Australia, 'Farming the Future: The Role of Government in Assisting Australian Farmers to the Impacts of Climate Change' (Australian Parliament House, 2010), 72 <http://www.aph.gov.au/Parliamentary_Business/Committees/House_of_Representatives_Committees?url=pir/australianfarmers/report.htm#chapters>.

[39] Katja Rath, 'The Potential for Green Gene Technology in Biomass Production – a Legal Examination' in Broder Breckling, Hauke Reuter and Richard Verhoeven (eds), *Implications of GM-Crop Cultivation at Large Special Scales. Theorie in der Ökologie* (Peter Lang, 2008) 163.

[40] The Global Invasive Species Programme, above n 34.

second-generation biofuel risk is an example of anthropogenic risks to the environment with commercial and/or social values.

Recent analysis suggests that biofuels weeds risk could be one 'downside' of this potential major industry.[41] In 2007, the Invasive Species Council issued a report on the weeds risk associated with 18 proposed biofuels crops.[42] For example, the Prosopis species (generically Mimosa),[43] which have been imported in Australia, Asia and Africa for second-generation biofuels production, is reported to have impacted 'millions of acres in many countries in Africa'.[44]

Beyond the risk of biological pollution, the production of bio-fuels is a capital-intensive activity which requires major infrastructure investment and land use changes. The trade price trend of bio-ethanol reflects that of most emergent commodities, reducing as new technologies and increasing production scale allow for greater price competition.[45] It is argued by some that the fledging biofuels industry is not economically robust with a limited capacity to internalise all risk management requirements.[46]

The existing Australian NRM model for weeds control relies extensively on a traditional structure of avoidance (by bans) and command-and-control approaches for remediation. Crops with demonstrated weed potential characteristics may be banned from importation and/or prohibited from being planted or grown. The third paper constituting this thesis, *Concepts for Industry Co-Regulation of Bio-fuel Weeds,* details the rationale for an alternative approach as well as outlining what such an approach might be.[47]

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[41] Keam et al, above n 34.

[42] Tim Low and Carol Booth, 'The Weedy Truth about Biofuels' (The Invasive Species Council, first published 2007, 2008) <http://www.invasives.org.au/documents/file/reports/isc_biofuels_revised_march08.pdf>.

[43] The literature cites the Prosopis species as an example of biofuels crops that may become invasive. The term 'Propopis' refers to the genus and 'Prosopis species' could refer to several or all the plants belonging to the Prosopis genus.

[44] Keam et al, above n 34, 7.

[45] For a discussion of barriers to first and second generation biofuels, including production and investment costs and technological improvements, see Ralph Sims et al, 'From 1st– to 2nd– Generation Biofuel Technologies – An Overview of Current Industry and RD&D Activities' (International Energy Agency, 2008).

[46] Stoel Rives LLP, 'The Law of Biofuels - A Guide to Business and Legal Issues' (Stoel Rives LLP, 2008).

[47] Paul Martin and Elodie Le Gal, 'Concepts for Industry Co-Regulation of Bio-Fuels Weeds ' (2010) (1) *IUCN Academy of Environmental Law eJournal* <http://www.iucnael.org/en/e-journal/previous-issues/97-issue-2010-1.html>.

There is a strong economic (and, some would argue, environmental) imperative to facilitate the use of new biofuel plantation species. In this context a naive precautionary ban against potentially useful but potentially weedy crops has the potential to impose significant opportunity costs. The application of the traditional model for weeds control/weed management could generate higher direct costs and/or lost biofuels opportunities than those associated with potential biological pollution arising from their use.[48] This could result in significant opportunity costs for primary producers and delay effective strategies for fossil fuel and carbon emissions reductions.[49] Second-generation bio-fuels could also address some of the spillovers from first-generation bio-fuels, particularly competition with human and livestock uses for food-grade feedstocks.

Compounding the above issues, the current NRM model – based as it is on direct investment by all levels of governments and by landowners, and substantial volunteer efforts – continues to be insufficient to protect the unique mega-biodiversity of the Australian continent. Ultimately, the costs of failures of weeds control and biodiversity restoration are borne by taxpayers and the future generations. If biofuels-related land uses increase the vulnerability of natural environments to the spread of weeds, existing institutions will be ill prepared to cope with the new pressures. Such a policy context highlights the need to explore whether innovative institutional arrangements could maximise the benefits of energy crops while minimising the risks associated with them.

[48] For further developments, see Kerry Puddle, 'Unilateral Trade Measures to Combat Climate Change: A Biofuels Case Study' (2007) 11 *New Zealand Journal of Environmental Law* 99; Jane Earley and Alice McKeown, 'Smart Choices for Biofuels' (Worldwatch Institute Sierra Club, 2009), 3-6 <http://www.worldwatch.org/files/pdf/biofuels.pdf>; Almuth Ernsting, *Can Large-Scale Biofuels Be Sustainable?* (Biofuelwatch, 2008) <http://www.biofuelwatch.org.uk/docs/SGR_article.pdf>; Jonathan Lewis, 'Leaping Before They Looked - Lessons from Europe's Experience with the 2003 Biofuels Directive' (Clean Air Task Force, 2007) <http://www.catf.us/publications/reports/Leaping_Before_They_Looked.pdf>.

[49] Eg Daniel De La Torre Ugarte et al, 'Economic and Agricultural Impacts of Ethanol and Biodiesel Expansion' (University of Tennessee Agricultural Economics, 2006) <http://beag.ag.utk.edu/pub/Ethanolagimpacts.pdf>; International Energy Agency, *Biofuels for Transport: an International Perspective* (IEA, 2004) <http://www.iea.org/press/pressdetail.asp?PRESS_REL_ID=127>; Barney Foran and Chris Mardon, 'Beyond 2025: Transitions to a Biomass-Alcohol Economy Using Ethanol and Methanol' (CSIRO Working Paper Series 99/07, CSIRO Wildlife and Ecology, 1999).

CHAPTER 2 BIOFUELS GOVERNANCE

2.1 Publication 1

Paul V Martin and Elodie Le Gal, ‘‘Biofuels Governance: Insufficient Legal Instruments or Innovative International Governance?’ (Forthcoming Chapter in *The Law and Policy of Biofuels to be published by Edward Elgar* in 2013.)[50]

Submitted for publication

This draft book chapter discusses natural resource governance innovation in the biofuel industry context. The two main issues that were raised in the introductory Chapter of this thesis revolved around design ineffectiveness of NRM governance models. The purpose of the book Chapter publication below is to emphasise the significance of this study by exploring the real-world feasibility of implementing innovative governance of the potentially powerful, technologically intensive liquid biofuels industry. The first part of the book Chapter discusses the significance of adopting new systemic legal and regulatory strategies for improving biofuels governance and explores whether new institutional arrangements could maximise the benefits of energy crops while minimising the risks associated with them. As innovations, including institutional (or legal and regulatory) innovations carry high rate of failure, the second part of the book Chapter summarises the institutional and political impediments to the implementation of the proposed approach for biofuel weed risk control (as identified in the in-depth interview process). The book Chapter also provides a summary version of the entire research project discussed in this thesis.

[50] The support of the Australian Research Council is gratefully acknowledged.

CHAPTER 3 METHODOLOGY

3.1 Publication 2

Elodie Le Gal, 'Methodological Approach for Testing a Co-Regulatory Bio-Fuels Weeds Risk Management Model' in *Proceedings of the 5th Annual Postgraduate Research Conference* (University of New England, 5-9 July 2010) 85.

Published

There is a significant difference between research methods depending upon the fundamental purposes of that research, the nature of the data and analytic methods which are available for answering the particular questions implicit in that purpose, and the context variables that dictate the validity of the results.

In this thesis, the goal is to propose and evaluate potential innovations in governance strategies in a very complex and rapidly evolving field of human endeavour. The number of variables impacting upon potential effectiveness is enormous and this poses significant methodological challenges for the research method. None of the 'traditional' social sciences methods explored for this study were suited to meeting the challenges – a situation which is representative of many public policy research problems. In response, policy research has evolved towards the concept of 'pragmatic' methods. This perspective is paradigm independent, in response to the inability of any particular research paradigm being sufficient to the multi-faceted challenges of real-world policy-making.

This paper was prepared early in the process of the thesis. Due particularly to the inability to recruit as large a population of technical experts as originally intended, some modifications to the approach were subsequently made. Notably, there was a shift from attempting to secure reliable indicators of acceptability of the conceptual model and its elements, towards using expert interviews to point towards theoretical frameworks from other disciplines which would be useful for predicting likely impediments to risk governance innovation.

PART II: INNOVATIONS IN THE DESIGN OF A NEW CO-REGULATORY MODEL

This part outlines the conceptual design of an innovative model for biofuel weed regulation. This is principally detailed in the paper *Concepts for Industry Co-Regulation of Bio-Fuels Weeds*.'[114] (Chapter 5). Because a number of the concepts embedded in this model reflect sophisticated ideas drawn from a number of fields, a substantial amount of additional explanatory material is provided. In particular, risk concepts are discussed in some depth, as the use of these lie at the heart of the proposal for consideration of alternatives to traditional 'ban' or 'approve for release' approaches to potential biological contaminants of natural ecosystems or farming systems.

[114] A fuller version of this paper was made available for interviewees. This is provided in Appendix 5.

CHAPTER 4 DESIGN CONCEPTS

4.1 Introduction

The innovative governance model which is outlined in the published paper *Concepts for Industry Co-Regulation of Bio-Fuels Weeds* (reproduced in Chapter 5) depends upon concepts drawn from a variety of disciplinary and applied sources. Some of these (such as traditional regulation and the use of market instruments) are largely understood among environmental law scholars and, therefore, need little if any explanation. However others may be less familiar and, therefore, require further development within the body of this thesis. These concepts include those associated with regulatory innovation such as 'smart regulation', 'responsive regulation' and 'co-regulation'. Others are concepts derived from systems thinking and institutional theory.

The chapter expands substantially upon concepts of risk and risk instruments as the potential basis for regulatory innovation. This is because risk-based market instruments are the most radical and challenging component of the innovative model developed and examined in this thesis. In this chapter the conceptual and practical underpinnings of the proposals contained in the model which is discussed to highlight that the potential for risk-based innovation is far from exhausted by the (relatively) basic approaches to risk-pricing, accounting and management that have been incorporated in that model.

4.2 Elements of an alternative approach

Concepts that could lead to more sophisticated natural resources risk management include informing instrument design with commercial concepts, taking a transacting systems approach, the use of co-regulation and adoption of a 'smart' 'responsive' design institutional approach.

The design of a risk accountability approach ought to be informed by an understanding of the socio-economic system within which the relevant environmental risk arises.[115] This can be done by mapping the transactions occurring between and within social institutions

[115] On the combination of the concepts of systems theory and risk, see Klaus P Japp and Isabel Kusche, 'Systems Theory and Risk' in Jens O Zinn (ed), *Social Theories of Risk and Uncertainty: An Introduction* (Wiley-Blackwell, 2009) 76.

and the natural environment, taking into account direct and indirect transactions and the actors who drive them to further reduce the risks of poor decisions.[116] Then, it becomes possible to target specific institutions/people and decide – on a political or economic basis – how and whether they should bear the risk associated with their actions.

The following diagram (Figure 4.1)[117] illustrates the bio-fuel weeds pathway. This is an extension of the weeds pathway approach[118] used in weed science. This approach has been described to support proposals for control strategies for weeds in general.[119]

The map presents a linear sequence of transactions and events that are likely to form the chain of events through which biofuel weeds may become established. These include transactions where a human actor (or actors) makes and implements a decision that contributes to weed establishment or diffusion, such as the decision to introduce a new species, or modify a species. The map also encompasses autopoietic events,[120] where weed establishment and spread does not require human decisions. An example is evolutionary acclimatisation leading to plants that are more able to spread. The diagram traces the pathway of plant genetic material from its first scientific evaluation (entry), through identification of its bio-energy crop potential, establishment as a commercial crop, acclimatisation, naturalisation and spread in the natural environment. The diagram highlights the key transactions and the decisions that drive them, as well as pointing out risk considerations along this pathway and the actors involved with this pathway. The analysis identifies possible focii for risk-management interventions[121] to improve risk accountability.

[116] The methods used are described in Martin and Verbeek, above n 3; Martin et al, above n 108, 4-5.
[117] Martin and Le Gal, above n 47, 7.
[118] Risk-focused weed pathways can be represented in diverse ways. See Sindel et al., above n 24.
[119] An industry weed pathways analysis has been used in Victoria as part of the *Tackling Weed Spread on Private Land Initiative*. This is reported in ibid 11-12. See also Paul Martin, 'Cross Pollination or Cross-Contamination? Directions for Informing the Management of Invasives with Market-Economy Concepts' in R D Van Klinken et al (eds), *Hot Topics in the Tropics* (16th Australian Weeds Conference Proceedings, 2008) 6**,** 10.
[120] Autopoesis is a term for the processes self-generated within a system, eg the evolution of abstract representation in art or performance, or evolution of species within natural systems.
[121] Martin, above n 119, 6**,** 10.

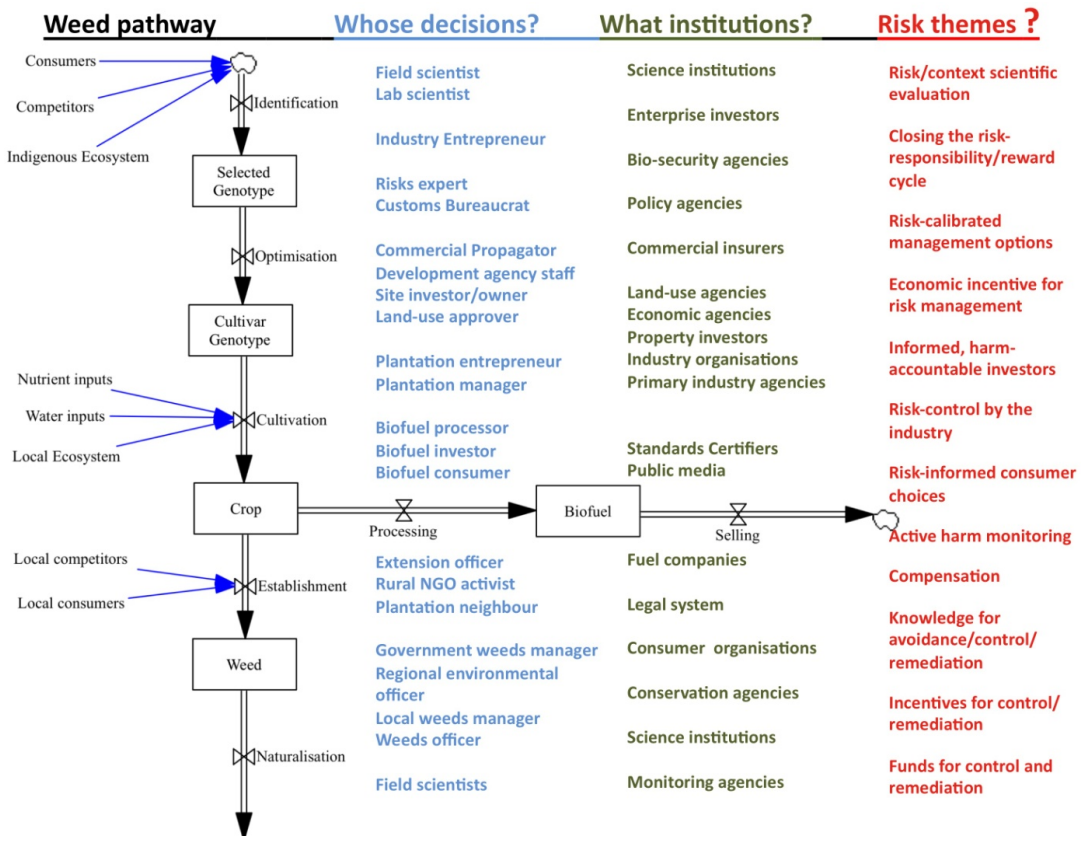


Figure 4.1: The biofuel weeds pathway[122]

Using this systematic approach,[123] it is possible identify many possible policy, legal and regulatory points of intervention. These points include the evaluation, importation, propagation, distribution, plantation operation and hazard control stages to which different types of market social and regulatory instruments can be then located.

Economic and regulatory actions can help alter the pattern of decisions of humans, to either contribute to the spread of the weed or to control this spread. Because different human actors are responding to varied incentives and institutional settings, the instruments that may be most effective are likely to vary throughout the system. This reflects the 'smart regulation' view that an approach that uses different instruments to

[122] Martin and Le Gal, above n 47, 7.
[123] A weeds pathway has been used to discuss the broader weed challenges. It shows that: - the weed risk is managed using fragmented interventions creating only limited accountability for the consequences of decisions; There are few economic/market instruments used; and few points of intervention are targeted: See Martin, above n 119, 6**,** 10. Even given a plethora of rules, weeds pathways are still perceived by weeds experts as under-regulated, perhaps reflecting ineffectiveness rather than an insufficiency of laws. This is reported in Sindel et al, above n 96, 57.

reshape the behaviour of a variety of people carrying out diverse transactions throughout the weeds pathway is more likely to be effective than a strategy exclusively relying on one instrument, at one point of intervention.[124]

This descriptive model is further explained in Chapter 5, which is the basis for the journal article published as 'Concepts for Industry Co-Regulation of Bio-Fuels Weeds' in the *IUCN Ejournal*. A new model reflecting the principles and issues discussed in this chapter is discussed in this publication.

4.3 The risk dimensions of the challenge

Concepts of risk are discussed in more detail in Chapters 5 and 6. The discussion here is provided to 'frame' a broad discussion of the approach taken.

New processes and technologies necessitated by human development are often a source of new risks to the environment. This is illustrated with the possible use of second-generation biofuel crops to produce bio-ethanol as a source of clean energy, where the biofuel crop has weed potential due to its hardiness, adaptability and fertility or propagation characteristics. These crops may become invasive, contribute to biological infestations and biodiversity loss.

This is an example of anthropogenic environmental risk, arising from human actions which voluntarily or unintentionally introduce new risks to the environment. A distinction can be made between anthropogenic risks to the environment with or without commercial and/or social value. This distinction is important from a policy-making perspective. If there is a potentially offsetting gain, policy makers have to balance the benefits/opportunities against the potential impacts (environmental, economic and social) that the risk introduction may generate. Interpretation will necessarily involve subjective judgments on how to balance environment protection against human development and the trade-off between private gains and public costs. This balancing exercise is reflected in economics through the concept of opportunity costs. Policymakers' decisions will often be guided by cost-benefit analysis. When anthropogenic risks to the environment involve

[124] Gunningham and Grabosky, above n 5, 15-20.

no commercial or social benefits, the policy debate is likely to be framed differently, with a focus upon least-cost control or avoidance.

Under the broad term 'environment risks', risks to the environment (with and without commercial/social values) are distinguished from those that relate to risks from the environment. Risks from the environment result from the occurrence of natural events, such as floods and earthquakes, which can prejudice human values such as production and consumption. This distinction is less clear in cases such as climate change, an anthropogenic phenomenon which catalyses natural environmental hazards.

The scope of this thesis is limited to a particular human-induced environmental risk, namely the weed and biofuel weed risk. The biofuel weed risk involves exclusively anthropogenic risks to the environment. It will be demonstrated that by using private markets for risk as part of a broader legal and regulatory strategy, the control of anthropogenic risks to the environment can in part occur through the protection of private interests, including the creation of interests in more effective risk control for those responsible for risk creation.[125] However, the protection of private interests is not a sufficient condition for effective governance, and so a combination of instruments within a systematic governance framework is required. Central to this framework is the need to find efficient mechanisms to create strong accountability without undue reliance upon the limited supervisory capacity of government.

The distinction between anthropogenic risks to the environment and risks from the environment is important when identifying potential legal liabilities and discussing accountability and pooled responsibility issues. For example, when dealing with risks from the environment (provided these have no direct anthropogenic causes), it is impossible to trace individual legal liabilities and to assign accountability. However, it is conceptually possible to create legally-binding mechanisms whereby legal entities (eg individuals, companies, states) pool their risk exposure to be able to collectively address the environmental, economic and social costs generated by the occurence of

[125] This is particularly the case for civil liability regimes and tort law.

environmental hazards. These entities can be private and/or public actors[126] and can form partnerships to create and implement various forms of regulation and risk-management strategies. Insurance against flood is a conventional example of a risk pooling strategy and flood zoning is an example of a regulatory approach to the same risk.

Commercially effective mechanisms can also be created for managing anthropogenic risks to the environment for which it is impossible to trace responsibility to those who introduced the hazard or aided its spread. These are detailed later.

The core distinction between anthropogenic risks to the environment and risks from the environment is also relevant when discussing the polluter pays principle and the beneficiary pays principle. In relation to anthropogenic risks to the environment, the polluter pays principle postulates that any entity conducting an activity that may cause environmental degradation should entirely meet the costs of harm and of restoration. The beneficiary pays principle suggests that any person benefiting from a risky activity (commercial or non commercial) should meet the financial costs associated with providing this benefit. This may encompass environmental costs. For risks with no anthropogenic element, these two principles have no significance as no polluter or benefitor is involved.

This brief introduction to the complex issues of risk suggest that the nature of the governance tasks varies significantly depending on the character of the risk itself. In some instances the challenge is merely to find the most efficient way to accommodate the economic or social costs. In others the challenge is to create clear accountability for those who create or benefit from the risk to the environment or to other people's values. In some situations the concern is to sharpen financial accountabilty, and in others it is to spread the load of cost and to 'smooth' stochastic uncertainty. Such considerations are central to the design of more effective and efficient environmental risk governance arrangements.

[126] For a discussion on natural catastrophe risk and insurance, see Alberto Monti, *Policy Issues in Insurance - Environmental Risks and Insurance No.6: A Comparative Analysis of the Role of Insurance in the Management of Environment-Related Risks* (OECD 2003) 67-88.

4.4 The institutional dimension of the challenge

Institutional theories encompass various schools, including those with an economic focus.[127] They have the common attribute of considering that institutions and institutional arrangements shape the world we are in.

The concept of institutions is complex.[128] North, as part of the 'new institutional economics' movement, distinguishes between formal and informal institutions

> [i]nstitutions are the humanly devised constraints that structure human interaction. They are made up of formal constraints (rules, laws, constitutions), informal constraints (norms of behaviour, conventions, and self-imposed codes of conduct), and their enforcement characteristics. Together they define the incentive structure of societies and specifically economies.[129]

What is implied is that institutions are systems which interact with one another to shape human behaviour. North's definition particularly emphasises the importance of enforcement (implementation) mechanisms to transform informal and formal rules from mere instruments into institutions. Also contained in this definition is the key concept of incentives to stimulate behavioural change.

The concept of institutions has also been defined as encompassing 'shared beliefs.'[130] Both formal and informal rules shape behaviours. Formal rules encompass legal rules (e.g. statutory, civil, contractual) for which there are defined processes of formation and reform. However, as informal rules are anchored in belief systems, these are likely to be more difficult to change than formal rules. North's institutional theory also distinguishes between the concept of institutions and organisations

[127] Bernard Chavance, *Institutional Economics* (Routledge, 2008) 1. In relation to the environment and natural resource matters, see also, Söderbaum, above n 102; Peter Söderbaum, *Understanding Sustainability Economics: Towards Pluralism in Economics* (Earthscan, 2008); Spash and Villena, above n 102; Jouni Paavola and Neil Adger, 'New Institutional Economics and the Environment: Conceptual Foundations and Policy Implications' (Working Paper EDM 02-06, CSERGE, 2002).
[128] For key references, see Rosalinde Klein Woolthuis, Maureen Lankhuizen and Victor Gilsing, 'A System Failure Framework for Innovation Policy Design' (2005) 25(6) *Technovation* 609, 610-11.
[129] Douglass C North, 'Economic Performance Through Time' (1994) 84(3) *The American Economic Review* 359, 360.
[130] For a discussion, see Chavance, above n 127, 55-8.

> It is the interaction between institutions and organizations that shapes the institutional evolution of an economy. If institutions are the rules of the game, organizations and their entrepreneurs are the players.[131]

This suggests that institutions incorporate formal and informal rules of a game which is being played by the actors of the socio-economic system. For North, power rather than (economic) efficiency shapes institutions:

> Institutions are not necessarily or even usually created to be socially efficient; rather they, or at least the formal rules, are created to serve the interests of those with the bargaining power to create new rules.[132]

This suggests that power issues which often underpin conflicts and coordination issues are likely to shape the type of governance models that will be used for natural resources management.

For Söderbaum, institutional arrangements are '[…] organization, rules of the game, power relationships, entitlements and other types of control over resources'.[133] For some, the concept of institutional arrangements is to be distinguished from the 'institutional environment'.[134]

Adopting an institutional perspective on natural resource governance suggests that the effectiveness problem is rooted in how institutions are shaped and how they interact within a complex world. It postulates that institutions drive natural resource users towards (too often unsustainable) patterns of consumption. This thesis uses some of concepts from the institutional literature for the purpose of proposing new laws and institutional arrangements.

By approaching the law through the lens of economic tools, understanding of economic behaviours informed by institutional economic theories can support the design of better institutional arrangements. Contrasting with the neo-classical approach which narrowly focuses on the concept of markets to explain economic behaviour, institutional economic thinking explores the role of institutions, including organisations (firms) to shape

[131] North, above n 129, 361.
[132] Ibid 360–1.
[133] Söderbaum, above n 102, 131.
[134] Chavance, above n 127, 46.

economic behavioural patterns. It also acknowledges the key role that beliefs and values play in shaping institutions. This is reflected in the gradual shift from cost-benefit analysis (predominantly underpinned by neo-classical thinking) to multi-criteria decision-making models into the policy-making process.[135]

Thus, within this thesis, the term institutions encompasses the formal and informal rules and organisational structures which create, apply and enforce them. These direct the socio-economic system towards particular paths of action including unsustainable patterns of consumption. Institutional arrangements are therefore key mechanisms for creation and implementation of natural resource governance including the complex array of interactions within and across institutions. The rules of the game played by NRM actors are determined by hard (laws and regulations) and soft (norms, values, perceptions) elements. These complex sets of rules are underpinned by beliefs and values. As proposed by some environmental law scholars, institutional thinking therefore implies systemic thinking,[136] particularly about social/behavioural systems. This also implies contextualisation and interdisciplinary investigations.

4.5 A systems-based conceptualisation of the challenge

Laws and regulations are the result of complex interactions within the socio-economic and natural systems where human behaviours, institutional and organisational structures are influenced by a wide range of factors, including beliefs, values and perceptions. These can become indirect sources of law by influencing the policy-making process and supporting or thwarting legal and regulatory change.[137] The exploration of social relationships through social science methodologies can unravel 'more informal and unobservable' artefacts,[138] an organisational iceberg,[139] to identify the social norms which

[135] See Murat Köksalan, Jyrki Wallenius and Stanley Zionts, *Multiple Criteria Decision Making: From Early History to the 21st Century* (World Scientific, 2011).
[136] Martin and Gunningham, above n 88, 139-41.
[137] Detailed in Elodie Le Gal, 'Methodological Approach for Testing a Co-Regulatory Bio-Fuels Weeds Risk Management Model' in *Proceedings of the 5th Annual Postgraduate Research Conference* (University of New England, 5-9 July 2010) 85, 92-3.
[138] Ray W Cooksey, Organisational Research Methods - UNE Course 2010S1 - ECON589/ECON587/NEBS305/405 - Powerpoint Presentation (University of New England, 2010).
[139] See Figure 1-1 'Organizational Iceberg' in Don Hellriegel and John W Jr. Slocum, 'An Introduction to Organizational Behaviour' in *Organizational Behaviour* (West Publishing, 1979) 7.

influence the policy-making process.[140] Such a perspective contrasts with the traditional positivistic approach to the legal phenomena, where the goal is to uncover what the law is[141] as part of a positive statement.

Holism is rooted in the interpretative research paradigm. It invites exploration of the interconnectedness between the many institutions (formal and informal) that form an open dynamic system of governance. This approach contrasts with reductionism, historically rooted in the positivistic research paradigm. The neo-classical economics approach is positivist and predominantly focuses on market mechanisms without considering the broader context.

Adopting an institutional perspective echoes a shift towards using social sciences methods (such as behavioural economics) to help to discern what the law could or should be.[142] An institutional perspective suggests going beyond discussion predicated on the acceptance that command-and-control regulatory models and market-based approaches are oppositional. The methods used for such explorations can be drawn from many disciplines, including economics, political science and (in a more specialist form) regulatory theory. From an ontological perspective, the law – conceived under the positivistic approach as a sort of meta-phenomenon existing in an objective doctrinal vacuum'[143] and dictating how social relationships are shaped and regulated – is, through the lens of the social sciences, seen to be, at least in part, created out of social norms, political dynamics and the operation of the market.

4.5.1 Systems thinking

To simplify discussion of the complexities of socio-economic systems, the researcher adopted a heuristic model, the Resource Consumption Decision Making Model (RCDM model).[144] It takes into consideration that 'design [of institutions for environmental and

[140] The one that informs the present research is embedded in Luhmann's social theory which is rooted from an epistemological standpoint in the constructivist paradigm. See Niklas Luhmann, *Law as a Social System* (Oxford University Press, 2003).
[141] Terry C M Hutchinson, *Researching and Writing in Law* (Lawbook Co, 2nd ed, 2006), 33-5.
[142] Ibid 87-118; Christine Jolls, Cass R Sunstein and Richard H Thaler, 'A Behavioral Approach to Law and Economics' in Cass R Sunstein (ed), *Behavioral Law and Economics* (Cambridge University Press, 4th ed, 2004) 13.
[143] Hutchinson, above n 141, 87.
[144] Adapted from Martin and Verbeek, above n 3, 33.

resource management] concerns how the agents are to be linked by information flows and resource allocation decisions'.[145] It considers that within the intertwined natural and socio-economic systems, three key elements impact the decision-making process which can contribute to achieve sustainable behavioural change: a flow of resources (eg financial, human, natural resources), a flow of information (data or signals) and the decision-making structure (organisational structure and belief system). Such a representation suggests that communication channels and coordination mechanisms are needed to ensure that these three key elements interact to achieve the intended outcomes.[146]

The key concepts associated with the RCDM model are represented in Figure 4.2. Information, belief systems and resource allocation mechanisms have been identified as relevant variables mediating natural resources law effectiveness.[147] On this basis it can be expected that a more effective approach to the management of environmental risks (at least for anthropogenic risks) should re-align the flows of resources (including human and financial resources) and the flows of information (including information on environmental risks and the socio-economic system). Such a perspective implies that a sufficient level of interaction and communication between these elements. Intervention that improves these key flows ought positively affect NRM decision-making process, policies and laws.

[145] Edna Tusak Loehman and D Marc Kilgour, 'Introduction: Social Design for Environmental and Resource Management' in Edna Tusak Loehman and Marc Kilgour (eds), *Designing Institutions for Environmental and Resource Management* (Edward Elgar 1998) 15.

[146] For example, the national innovation system literature, which revolves around the key idea that innovation is the key goal of any research system, is historically rooted in a system-based approach. It adopts an institutional perspective to explain the innovation process and emphasises coordination problems between institutions as potential constraints obstructing the adoption of innovation. It has inspired various systems of innovation approaches which have been transposed for within the policy arena. This is illustrated with the 'system failure framework for innovation policy design' which identifies and classifies four categories of potential system failures associated with innovation policy. These include infrastructural, institutional, interaction and capabilities failures. Such an approach situates institutional failures in the broader context which surrounds the innovation process and potential system failures are put into perspective with the actors who are in a position to address them. See Klein Woolthuis et al, above n 128, 609-11.

[147] Figure 4.2 is adapted from Martin and Verbeek, above n 3, 33.

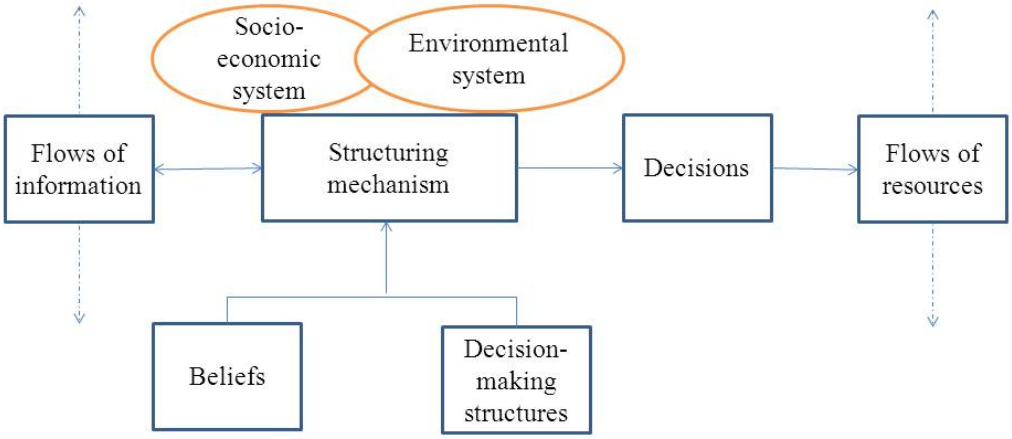


Figure 4.2: The Resource Consumption Model and key associated concepts[148]

An approach based upon a systems thinking[149] helps to focus upon the multiple interactions occurring within the environmental-socio-economic system, the complexity of NRM and environmental issues.[150] This can help counteract the institutional and regulatory fragmentation of the traditional model of NRM. [151]

[148] Adapted from ibid, 33.
[149] Systems theory originated in the natural sciences and has been transposed to the social sciences. It holistically considers the dynamic interaction of the structures composing a system rather than taking a reductionist approach to components. See Donella Meadows, *Thinking in Systems – A Primer* (Chelsea Green Publishing, 2008). For its application in agriculture, see Hugo Fjelsted Alrøe and Erik Steen Kristensen, 'Towards a Systemic Research Methodology in Agriculture: Rethinking the Role of Values in Science' (2002) 19(1) *Agriculture and Human Values* 3. The adoption of a whole-of-system-thinking is reported as a key innovation in the management of water scarcity within the Australian context. See John Williams, Kathleen H. Bowmer and Hester L. Gascoigne, 'Healthy Rivers and Catchments ' in Kathleen H Bowmer (ed), *Water Innovation: A New Era for Australia* (Carlen Barripp, 1st ed, 2004) 84. This is also the approach adopted in S Ryan et al, above n 1, 14-21 (stating at page 14 that 'The challenge that this way of thinking presents for policy setting has been recognised by the Australian Public Service Commission (2007)'.
[150] See Graham P Harris, *Seeking Sustainability in an Age of Complexity* (Cambridge University Press, 2007), 1-68.
[151] For an illustration see Martin and Verbeek, above n 3; Martin et al, above n 108.

4.6 The effects of transaction costs

The theory of transaction costs suggests factors which generate constraints (costs) upon the flows of information and resources within a socio-economic system. Transaction costs are present in all institutional arrangements which shape individual and societal behaviours – analogous to the presence and significance of friction in the operation of mechanical systems. These costs can inhibit the effectiveness of environmental and NRM policies[152] including regulation, market instruments and social transactions.

Transactions are 'the means though which information and resources flow', [153] and can involve costs which can dramatically affect the efficiency of legal institutions for risk management as well as other aspects of natural resource management. The theory, rooted in Coase's work,[154] helps to explain how institutions are developed and structured, partly explaining how institutional settings impact upon behaviour within firms and marketplaces.[155]

Transaction costs can be defined in various ways. For example, these can be defined as '[…] all the costs associated with a particular institutional mechanism, including monitoring and enforcement, administrative costs, waste […]'[156] or as

> The costs arising from finding a trading partner, negotiating an agreement about the price and other aspects of the exchange, and of ensuring that the terms of the agreement are fulfilled.[157]

These costs include those incurred by governments and corporations to develop and implement new markets, including environmental markets. The concept is useful to

[152] For a discussion of transaction costs within the context of the Australian water reform, see Martin et al, ibid.
[153] For an exploration of the notion of transaction costs see Martin and Verbeek, above n 89, 42-44.
[154] Ronald H Coase, 'The Relevance of Transaction Costs in the Economic Analysis of Law' in Francesco Parisi and Charles K Rowley (eds), *The Origins of Law and Economics: Essays by the Founding Fathers* (Edward Elgar, 2005) 199; Ronald H Coase, 'The Nature of the Firm' (1937) 4 *Economica* 386.
[155] For a brief criticism of the theory of transaction costs, see. Economics for Equity and the Environment Network E3, *Real People, Real Environments, and Realistic Economics* <http://www.e3network.org/resources/E3%20Network%20Real%20People%20Real%20Environments,%20and%20Realistic%20Economics.pdf>
[156] William K Jaeger, *Environmental Economics for Tree Huggers and Other Skeptics* (Island Press, 2005) 125, 139.
[157] Douglas McTaggart, Christopher Findlay and Michael Parkin, *Microeconomics* (Addison-Wesley, 3rd ed, 1999), G7.

explain why markets, including environmental markets, fail to efficiently allocate resources, including failures to properly value and protect public goods.[158]

4.7 Innovations in regulatory theory

New directions for thinking about NRM laws and regulations are provided by new regulatory and compliance theories, particularly concepts of 'smart regulation' and 'responsive regulation.'[159] These emphasise innovative forms of social control to improve NRM outcomes with more flexibility and cost-efficiency. As defined by the European Commission, '[s]mart regulation is not about more or less legislation, it is about delivering results in the least burdensome way'.[160]

The concept of 'smart regulation' is described by Gunningham and Grabosky.[161] It is based upon the idea that any instrument for environmental management (regulatory or economic) has strengths and weaknesses.[162] Instead of a single instrument approach, the authors emphasise using a mixture of instruments 'tailored to specific policy goals'[163] whilst avoiding 'dysfunctional combinations'.[164] This implies the need to overcome the traditional 'market-state'/[165]regulation-deregulation dichotomy.[166] A smart regulatory approach can involve a variety of instruments combined in different ways. Such a multi-targeted intervention involving regulatory and economic instruments is illustrated in the Figure 4.3 concerned with pollution control and waste management.

[158] Martin et al, above n 108.
[159] The concepts of 'smart regulation' and 'responsive regulation' contribute to what has been described as a new regulatory capitalistic order. See David Levi-Faur, 'The Global Diffusion of Regulatory Capitalism' (2005) 598 *Annals of the American Academy of Political and Social Science* 12, 13.
[160] Directorate for Better Regulation Evaluation and Impact Assessment, Secretariat General, European Commission, 'Stakeholder Consultation on Smart Regulation' (2010) <http://ec.europa.eu/governance/better_regulation/smart_regulation/docs/smart_regulation_consultation_en.pdf>, 1.
[161] Gunningham and Grabosky, above n 5.
[162] Ibid 14.
[163] Ibid 15.
[164] Ibid 20.
[165] Ibid 10.
[166] Ibid 11. As explained by the authors, such a multi-instrumental approach is embedded in the legal pluralism tradition which 'focus upon the interrelationship between state law and private forms of social control and conflict resolution' in Ibid, 12.

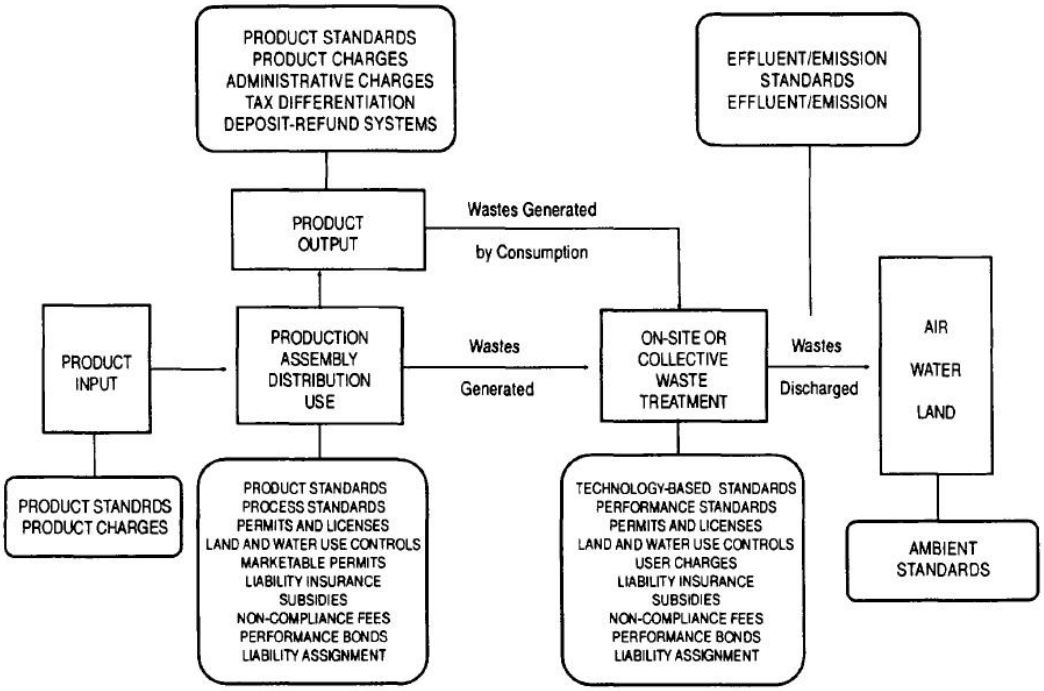


Figure 4.3: Alternative locations for regulatory and economic instruments[167]

To improve compliance with laws and regulations, Ayres and Braitwaite suggest 'responsive regulation',[168] represented by a responsive regulatory enforcement pyramid. They argue that the degree and nature of regulatory enforcement intervention should be relative or 'responsive' to the degree of compliance to regulatory requirements and the type of infringement committed. This can be achieved through a subtle combination of incentives and disincentives. This contrasts with more traditional regulatory strategies which often exclusively rely on deterrence mechanisms to punish harmful social behaviours.

[167] Janis D. Bernstein, 'Alternative Approaches to Pollution Control and Waste Management - Regulatory and Economic Instruments' (World Bank, 1993) <http://documents.worldbank.org/curated/en/1993/03/699087/alternative-approaches-pollution-control-waste-management-regulatory-economic-instruments>, 20.

[168] Ian Ayres and John Braithwaite, *Responsive Regulation: Transcending the Deregulation Debate* (Oxford University Press, 1992).

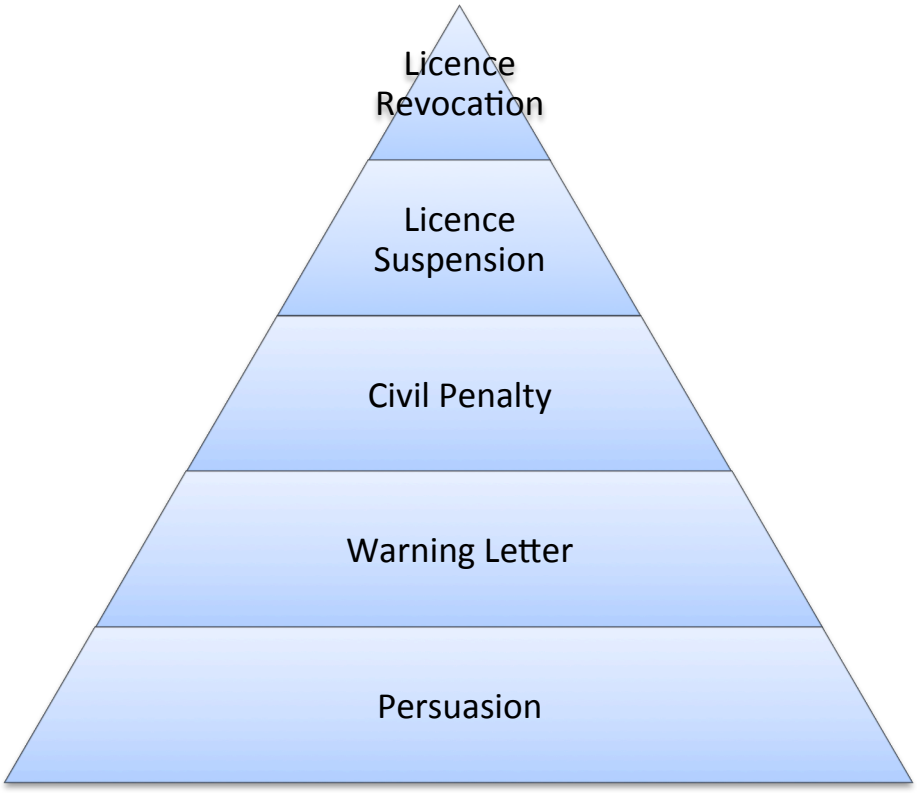


Figure 4.4: An example of a regulatory pyramid of enforcement strategies[169]

4.7.1 The potential for new forms of governance partnership

Both the concepts of 'smart' and 'responsive regulation' suggest that public and private actors can act together to regulate harmful social behaviours and find innovative ways to respond to their own needs and interests.[170] A co-regulatory approach is a form of partnership between government as regulator and an industry or community body to achieve regulatory objectives at least costs to the industry and government. Arguably, such an approach could contribute to a 'hybrid form of governance' which could reconcile free market approaches with social justice considerations.[171]

[169] Adapted from figure 2.1 in ibid 45.
[170] For a historical perspective on the evolution of environmental policies in Anglo-Saxon countries, see Neil Gunningham, 'Environment Law, Regulation and Governance: Shifting Architectures' (2009) 21(2) *Journal of Environmental Law* 179.
[171] Ryan et al, above n 1, 10; Paul Martin, 'Embedding Social Justice in the Design of Environmental Regulation' in Yves Le Bouthillier et al (eds), *Poverty Alleviation And Environmental Law* (IUCN Academy of Environmental Law Series, Edward Elgar, 2012).

The combination of co-regulatory and risk pooling approaches can generate innovations in the management of environmental (or other) risk. Co-regulation is distinguishable from the concept of pooled responsibility within risk-market arrangements, but the two approaches can intersect. 'Pooling' responsibilities for managing anthropogenic risks to the environment (as well as risks from the environment) can reduce stochastic uncertainty for each individual within the pool.[172] It can also reduce transaction costs for the management of anthropogenic risks to the environment if responsibility only has to be causally connected to a class of citizens rather than to an individual within that class.

A private sector collective (eg industry group) can decide that its members should pool capacities to manage risks. Such risk pooling mechanism can occur with or without the intervention of the public regulator. Within a co-regulatory framework, the public sector can monitor the enforcement of the private sector risk pooling mechanism. As pointed out by Martin and Gunningham, 'the distinction [between self-regulation and co-regulation is that self-regulation does not involve external parties, whereas co-regulation involves a partnership between government and those being regulated or between those being regulated and other parties'.[173]

'Pooling' of responsibility for managing anthropogenic risks to the environment is particularly relevant when:

- There is no mechanism or very limited mechanism to trace responsibility to the individual who introduced it or aids its spread. Information transaction costs impede potential accountability for spillovers.[174] The history with GMOs, where traceability and accountability ought to be relatively easy, demonstrates that creating civil responsibility for the introduction of unwelcome plants is complex and difficult.[175]

[172] 'Pooling of risk' is at the heart of insurance.
[173] Martin and Gunningham, above n 88.
[174] We note particularly the observation of Bromley that without transaction costs there could be no externalities. This reflects the view that if there were perfect knowledge of the consequential costs of harms from a transaction, these would be priced into the original transaction. See Daniel W Bromley, *Environment and Economy: Property Rights and Public Policy* (Basil Blackwell, 1991).
[175] For further references on the GMOs' legal issues, see Mark Lunney, 'What Australian Courts Might Say about 'Damage' from Cross-Pollination by a GMO' (2004) <http://www.une.edu.au/aglaw/research/aglaw_papers_3.pdf>, 27-54; Michael G Faure and Andri Wibisana, 'Liability in Cases of Damage Resulting from GMOs: An Economic Perspective' in Bernhard A. Koch (ed), *Economic Loss Caused by Genetically Modified Organisms - Liability and Redress for the Adventitious Presence of GMOS in Non-GM Crops*, (Tort and Insurance Law Series, Springer, 2008) vol

- The person responsible for introducing the anthropogenic risk to the environment does not have the resources to control or remediate the environmental hazard. There might also be no efficient mechanism to oblige him/her to do so.

These considerations suggest that an effective environmental risk management strategy should involve collective responsibility by the industry, if the industry as a whole benefit from the risk, to minimise problems of proving and enforcing accountability by particular individuals. This can reduce both the burden on the public purse, and information transaction costs.

Many industries use collective responsibility programmes to protect themselves and the public against identifiable risks, including risks to the reputation and the social license of the industry.[176] Self-regulatory strategies are advocated to maximise innovation and optimise data collection through self-monitoring. Embedded within a systemic approach to design of a risk management strategy, self-regulation or co-regulation may also show where oversight and audit will improve the reliability of industry risk governance. Industry certification and accreditation schemes, risk analyses, environmental management systems (EMS), voluntary standards and training programs and other institutional arrangements may form part of such a novel approach to manage environmental risks.[177]

There are many forms of co-regulation. These encompass institutional arrangements which involve, to varying degrees, governmental intervention, including self-regulatory

24, 531; Mark Lunney and Robert Burrell, 'A Farmer's Choice? Legal Liability of Farmers Growing Crops ' (Research Paper, Department of Agriculture, Fisheries and Forestry, 2006) <http://www.daff.gov.au/__data/assets/pdf_file/0010/197083/execsummaryliabilityweb.pdf>. In relation to biodiversity loss, see Lee McIntosch, 'Liability for Loss of Biodiversity Caused by the Release of Genetically Modified Organisms' (2002) 4 *National Environmental Law Review* 40. The limitations of tort law to manage environmental risk is discussed in section 6.8 of Chapter 6.

[176] Examples include the horse racing industry, various professions, industry codes of practice of conduct (in Australia including mandatory codes of conduct under the Trade Practices Act) or industry mandatory insurance under the American Oil Spill Disaster Recovery legislation. On the concept of social license, see Neil Gunningham, Robert A Kagan and Dorothy Thornton, 'Social cand Environmental Protection: Why Businesses Go Beyond Compliance' (2004) 29(2) *Law & Social Inquiry* 307.

[177] For example ISO 14040 for lifecycle evaluation. See International Organization for Standardization, *Environmental Management - Life Cycle Analysis - Principles and Framework* (ISO 14040:2006).

strategies.[178] Examples include industry certified compliance systems, the enforcement of animal welfare standards through the RSPCA, or the use of professional standards alongside mandatory certification to practice as a doctor, lawyer, dentist, psychiatrist or any of a vast array of professions.

Environmental and social impact accreditation in markets can create competitive pressure to improve social performance and reduce spillover risks.[179] This is illustrated, for example, in the cotton industry's best management practices accreditation scheme in Queensland. This type of innovation aims to improve water use efficiency for irrigation and land management.[180] Another example is the *Product Stewardship Act 2011* (Cth) which enhances product stewardship activities for managing waste.[181] Disciplined analysis carried out by the industry ought aid understanding of the impacts of different inputs, production methods and supply sources.

However self-management or co-management is not yet proven to be fully trustworthy.[182] It is likely that strong institutional arrangements backed by government oversight will be necessary in order to ensure effectiveness and credibility. This is demonstrated by the examples that follow that legislated accountability can trigger effective industry strategies to cost-effectively deliver public-good performance.

[178] For a discussion of the notion of co-regulation and self-regulation, see Gunningham and Grabosky, above n 5, 50-6. Citing Rees, the authors report three main forms of self-regulation (voluntary/total self-regulation, mandated self-regulation and mandatory self-regulation).

[179] The Bache Commodity Green Index^{SM} (BCGI^{SM}) suggests the potential for credible performance assessment for the bio-fuels industry. This is discussed later in this thesis.

[180] This co-regulatory framework is embedded in a complex set of institutional arrangements. For a critical analysis of this innovative approach, see Toni Darbas et al, 'Co-regulation and Cotton: Governance of Natural Resource Management in the Australian Cotton Industry' (2008) 12(2) *Australasian Journal of Natural Resources Law and Policy* 87.

[181] See Australian Government, *National Waste Policy – Fact Sheet – Product Stewarship Act 2011*. For example, televisions and computers fall under this legislative framework.

[182] For a discussion of the conditions for effective co-regulation and self-regulation schemes, see European Economic and Social Committee, 'The Current State of Co-Regulation and Self-Regulation in the Single Market' (EESC Pamphlet Series, 2004) <http://www.eesc.europa.au/resources/docs/2018_cahier_en_smo_def.pdf>, 19-21. On self-regulation, see Robert Baldwin and Martin Cave, *Understanding Regulation - Theory, Strategy and Practice* (Oxford University Press, 1st ed, 1999) 125. See also Anthony Ogus, 'Rethinking Self-Regulation' (1995) 15 *Oxford Journal of Legal Studies* 97. For an analysis of the interconnectedness between soft law, self-regulation and co-regulation, see Linda Senden (ed), 'Soft Law, Self-Regulation and Co-Regulation in European Law: Where Do They Meet?', *Electronic Journal of Comparative Law* (2005) <http://www.ejcl.org/91/art91-3.html>. See also Edward J Balleisen and Marc Eisner, 'The Promise and Pitfalls of Co-Regulation: How Governments Can Draw on Private Governance for Public Purpose' in David Moss and Cisternino (eds), *New Perspectives on Regulation* (The Tobin Project, 2009) 127. The authors highlight five factors for ensuring effective co-regulation (pages 131-138).

The 'Green Dot' recycling system introduced in Germany in the early 1990s arose from a proposed packaging ordinance imposing corporate responsibility for recycling. In response industry developed a collective programme that was endorsed as satisfying the legal requirement. Manufacturers pay a membership fee for this service, and are licensed to use the certification trademark. Members are deemed to have met their recycling obligations (with government monitoring the overall success of the scheme relative to public policy goals). This sophisticated model of co-regulation backs a 'voluntary' industry arrangement with legal elements of regulation, statutory intellectual property rights and contractual commitments.[183]

The strategic justification for industry to embrace responsibility for social and environmental risks is to preserve public support from which it tangibly benefits, and to avoid the potential inefficiencies of naïve regulation if risk responsibility is left to government alone. Not all voluntary schemes have integrity, of course. 'Greenwash' and other forms of deception, and the use of voluntary codes that are largely ineffective, is a risk to the effectiveness of co-regulatory or self-regulatory programs.

A hypothesis in this thesis is that credible co-regulation is associated with the existence of a credible monitoring system and industry mechanisms to ensure integrity in the industry regulatory scheme. It is not likely to be a covert pathway to substantive deregulation, which may be the result of unsupervised self-regulation. For effective co-regulation, industry is likely to need strong mechanisms to avoid corporate 'free-riders' undermining the industry programme by failing to carry their share of responsibility and cost. Without a meaningful contingent cost to members of the industry should self-regulation fail, the probability of successful co-regulation is likely to be reduced.[184] Effective supervision and sanctions are also likely to be politically useful to convince a sceptical public that government will ensure reliable risk governance transparency to effectively protect the public interest.

[183] See for details *Der Grüne Punkt* (2012) <http://www.gruener-punkt.de/?L=1>.
[184] With the *Green Dot* recycling system, the credible likelihood of higher costs to industry should the industry fail to achieve agreed targets provides a powerful incentive for industry to align its diverse interests behind the industry programme.

The Green Dot scheme demonstrates that a co-regulatory mechanism can engage the public and private sectors provided that there is a clear sanction structure. This provides a rationale for everyone in the industry to 'lock in' to binding obligations and provides an incentive for everyone to respond to potential threats to the success of the programme. Having contingent 'blunt' pressures on the industry that will cause pain to all should co-regulation outcomes fall short of government requirements has proven to be in the interests of both government and industry. Should flexible regulatory and co-regulatory schemes not achieve predetermined performance standards, more prescriptive/prohibitive measures could be substituted, acting effectively as a collective penalty. Within the bounds of these assumptions it is reasonable to assume that co-regulation can achieve effective risk supervision and accountability, potentially with lower transaction costs than for individual accountability. Empirical testing of the conditions for effective co-regulation is beyond the intent of this thesis.

4.8 Risk theory and commercial management

As discussed by Bernstein and suggested in the title of his book, *Against the Gods*, the concept of risk is associated with the idea that humans, as individual entities have powers to control their destiny.[185]

Risk is a complex concept. Its management has evolved to encompass 'risk management with risk assessment as an integral component [...] a central organising paradigm [...]'.[186] The development of new technologies with high economic returns/risks such as nuclear power, has triggered innovative solutions in the management of potential anthropogenic risks to the environment with catastrophic consequences. These are supported by

[185] Peter L Bernstein, *Against the Gods: The Remarkable Story of Risk* (John Wiley & Sons, 1996) 1.
[186] Lee Godden and Jacqueline Peel, 'Environmental Law and the Changing Role of Science' in *Environmental Law: Scientific and Regulatory Dimensions* (Oxford University Press, 2010), 228. The authors quote Carlo C Jaeger et al, *Risk, Uncertainty and Rational Action,* (Risk, Society, and Policy Series, Earthscan, 1st ed, 2001). For a sociological approach to the concept of risk, Ulrich Beck, *Risk Society - Towards a New Modernity* (Sage, 1992). See also Jens O Zinn, ' Introduction: The Contribution of Sociology to the Discourse on Risk and Uncertainty' in Jens O Zinn (ed) *Social Theories of Risk and Uncertainty: An Introduction* (Wiley-Blackwell, 2009) 1.

sophisticated institutional arrangements in the commercial and financial sectors.[187] Some of these are summarised in this section and expanded upon later in the thesis.

The probabilistic dimension of the concept of risk suggests that it is possible to predict and control future events, including risks to the environment (as well as environmental risks from the environment) by using risk probability-based assessment techniques. Economic risk instruments which use risk techniques (risk pricing, risk sharing, risk pooling, risk accountability loops) can help manage the adverse environmental and economic consequences of these risks. This will be developed further in this thesis. In this research, these economic risk instruments can also be designated under the term of 'environmental risk instruments'[188]

As pointed out by Martin et al,[189] a risk-based approach for managing NRM issues encompasses various complex and interrelated aspects.

Within the NRM context, the term 'risk-based regulation' is distinct from the concept of 'environmental risk instruments'. It refers to legal and regulatory frameworks which incorporate risk assessment methodologies[190] to predict the occurrence of a potential risk to the environment (and risks from the environment). One of the rationales for using a risk-based approach is to allow better prioritisation in resource allocation. This includes guidance in the consideration of the precautionary principle, one of the key ESD principles.[191]

Examples of risk-based regulation for the control of invasive alien species include the Australian Commonwealth biosecurity and quarantine measures and post-border control

[187] For a general discussion see Monti, above n 126, 13; Michael G and Ton Hartlief, *Insurance and Expanding Systemic Risks,* (OECD, Policy Issues in Insurance N° 05, 2003).
[188] Whilst the term 'economic' risk instruments emphasises the behavioural component that they aim to foster, the term 'environmental' risk instruments emphasises the type of issue that these intend to address. 'Environmental risk instruments' can refer to institutional arrangements that aim to manage both anthropogenic risks to the environment and risks from the environment.
[189] Martin et al, above n 25, 33.
[190] See Bridget M Hutter, 'Risk Management and Governance' in F Pearl Eliadis, Margaret M Hill and Michael Howlett (eds), *Designing Government: From Instruments to Governance* (McGill-Queen's University Press, 2004) 303.
[191] In this context, risk-based regulations are designed and implemented to control a certain type of first-order risk (eg. anthropogenic risk to the environment with or without commercial/social values).

strategies.[192] Should an imported crop/plant be declared invasive or potentially invasive under the Pheloung system,[193] decision-makers will apply the precautionary principle in the form of a ban.

This approach, whilst significant as a protective mechanism suffers from a number of limitations, suggesting the desirability of exploring alternatives that may provide more optimal decision outcomes.[194]

4.9 The potential for risk management innovation

The precautionary principle is a legal prescription specifying the weight to be attached to uncertainty and possible impacts upon the environment.[195] The scientific justification for precaution lies in responding to a lack of empirical evidence of causal connections – or demonstrated proof of causality – between an environmental risk and its adverse impacts upon a risk target.[196]

The difficulties of applying the precautionary principle are illustrated when there are scientific uncertainties that surround the potential anthropogenic risk to the natural environment.[197] The limitations of pre-border quarantine weeds risk assessment system are illustrated by the long history of private and public bodies introducing plants that become weeds. The rationale for past introductions of weeds include improved pasture

[192] J G Virtue et al, *National Post-Border Weed Risk Management Protocol. HB 294:2006* (ANZ Standards 2006). See also J G Virtue and F Panetta, 'A National Protocol for Post-border Weed Risk Management' in C Preston, JH Watts and N D Crossman (eds), *15th Australian Weeds Conference: Managing Weeds in a Changing Climate* (Weed Management Society of South Australia, 2006). For a cover review, see Paul O Downey et al, 'Assessing Risk across the Spectrum of Weed Management' (2010) 5(38) *CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources* 1.

[193] It is detailed in Department of Agriculture Fisheries and Forestry, Australian Government, *Weed Risk Assessment System of New Plant Imports* (2012) <http://www.daff.gov.au/ba/reviews/weeds/system/weed_risk_assessment>.

[194] The Pheloung system was reviewed in 2005. See NWRAS Review Group, 'Review of the National Weed Risk Assessment System' (NRMSC 12: OOS Item 05, Natural Resource Management Standing Committee and Primary Industries Standing Committee Subcommittee, 2005) <http://www.weeds.org.au/docs/Review_of_the_National_Weed_Risk_Assessmt_System_2005.pdf>.

[195] Incorporated in a series of statutes (eg *Environmental Protection and Biodiversity Conservation Act 1999* (Cth)), policies and international agreements to which Australia is party.

[196] For a discussion of the precautionary principle and causation, see Michael Head and Scott Mann, *Law in Perspective - Ethics, Society and Critical Thinking* (University of New South Wales Press, 2nd ed, 2009) 93-114.

[197] For a discussion of risk-based regulations in relation to the precautionary principle, see Hutter, above n 15, 4, 8-10.

for livestock, land stabilisation, food plants, cultural ties and the desire for greater varieties of garden plants.[198]

The well-regarded Australian biosecurity system (which substantially relies on scientific risk assessment tools) does not address the long-tail residual risk associated with legally introduced crops which still have the potential to become a source of biological pollution. If the controls fail, resulting in a weed being introduced, then the result is effectively a wealth transfer from the public who will bear the cost of the failure to the private interest (who has gained economically from the risk). Even in the case of GMOs, there has been very limited consideration of risk management techniques other than physical containment (eg creation of buffer zones) proposed to deal with the residual risks should the environmental risk crystallise turning from an uncertain contingency, to a demonstrated hazard to be managed. The residual accountability in such instances remains with the public.

The institutional arrangements for management of potential invasive species are centred on a simplistic 'avoidance/acceptance' concept. The multiple uncertainties are mostly approached through the lens of the precautionary principle[199] using a 'go/no go' binary'[200] approach coupled with limited biophysical containment and monitoring. Options mainly consist of avoiding the risk or accepting the risk whilst relying on bio-physical risk-containment measures.

Introducing new risks to the environment raises interrelated environmental, social and economic challenges. These include uncertainties about evolutionary change, future management regimes or capacity, monitoring arrangements and economic capacity to

[198] Among the 20 declared Australian Weeds of National Significance (WoNS), some have been imported for agricultural purposes (eg Pond Apple, Chilean Needle Grass). Others were introduced as ornamental plants (eg Prickly Acacia, Rubber Vine). See Department of Water, Environment, Heritage and the Arts, above n 26. See also footnotes 9, 10, 22 and 12 in Arcioni, above n 23.

[199] For a discussion of the application of the precautionary principle (and specifically within the licensing of releases of genetically modified organisms) see A Weier and P Loke, 'Precaution and the Precautionary Principle: Two Australian Case Studies ' (Productivity Commission Staff Working Paper, 2007) <www.pc.gov.au/research/staffworkingpaper/precautionaryprinciple>.

[200] Common law legal liability regimes rely on a similar binary approach to establish causation in negligence actions. This 'can support only two possible conclusions; a finding of liability of a finding of no liability' Sarah Green, 'The Risk Pricing Principle: a Pragmatic Approach to Causation and Apportionment of Damages' (2005) 4(3) *Law, Probability and Risk* 159. However shared causation can trigger shared liability.

respond to a crystallised threat. Existing arrangements do not consider management options such as pooled responsibility, insurance or bond arrangements, or risk governance structures such as co-regulation.

Another hypothesis of this thesis is that NRM laws and policies could be more creative in their treatment of risk. A risk sharing mechanism, the *Emergency Plant Pest Response Deed* (EPPRD) has recently been adopted by the Commonwealth, States and territories and the plant-related industry,[201] to fund emergency responses[202] to weeds infestations and development of other risk sharing mechanisms are reported to be 'underway'[203] for the management of weeds. However, this is a 'one-off' step into the field of innovative risk governance. For example the *New South Wales New Incursion Plan for Invasive Species 2009-2015* does not mention commercial risk management strategies[204] though at least two of recent national weeds conference research papers have pointed explicitly to such potential innovations.[205] In a parallel situation in the mining industry, environmental performance bonds (required before undertaking a risky activity) are the only commercial option applied to manage anthropogenic risks to the environment with a commercial value.[206] The sophistication of commercial approaches to risk management has not yet informed resource risk management.

4.10 Commercial risk management techniques

Commercial risk management techniques such as risk information systems, risk pricing, risk pooling, risk transfer and risk sharing, have been developed by the private sector to protect itself against business risks (eg commercial, financial and technological risks) that environmental contingencies may generate. Private actors can use these risk-based

[201] Signatories are listed at the Emergency Plant Pest Response Deed (EPPRD) <http://www.planthealthaustralia.com.au/index.cfm?objectid=5BF0BFAA-C997-F983-53D4ECF9CEB6F1B5>. These encompass a wide range of organisations, including for example the horticulture industry.
[202] See Ibid.
[203] Rural Industries Research and Development Corporation, above n 25, 9.
[204] Available at NSW Department of Primary Industries, *NSW New Incursion Plan for Invasive Species 2009-2015* <http://www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds/legislation/state/nsw-new-weed-incursion-plan>.
[205] Martin, above n 119, 6; Paul Martin, 'Weeds: New Strategies for an Old Problem' in C Preston, J H Watts and N D Crossman (eds), *Managing Weeds in a Changing Climate* (Weed Management Society of South Australia 15th Australian Weeds Conference, 2006) 118.
[206] For example, in Queensland, mining bonds are regulated under the *Environmental Protection Act 1994 (QLD) ss 364-367.*

techniques to protect themselves by transferring – in exchange for the payment of a premium – through contractual arrangements onto insurers.[207] Risk transference, along with risk avoidance, risk reduction and risk retention, is a commercial risk management strategy that can be used for the purpose of transferring the legal and financial consequences of hazards onto a third party through the use of contractual techniques.

Risk financing mechanisms, such as risk retention through self-insurance and risk transfer through contractual arrangements are alternatives to simple strategies such as risk avoidance and physical risk mitigation. These approaches rely upon careful consideration of probability. Probabilistic reasoning aims at calculating the likelihood of the occurrence of an event and of the value of its effects. Risk-based instruments based on probabilities can inform corporate decision-making and allow risks to be undertaken without exposing the risk-taker to catastrophic loss should the low-probability contingency arise. Some commercial risk instruments calibrate responses contingent on the likelihood of the hazard or harm, differentiating within the spectrum of risky behaviours and price risks accordingly, thereby converting risks into commercial opportunities. The modern insurance industry and the array of derivatives and securitisation or pooling arrangements, reflects this sophisticated thinking. The essential element of risk management is embracing the uncertainties at the heart of risk and building the management of uncertainty into the methods used for its control, in a variety of ways. This contrasts with risk avoidance, where the orientation is to replace uncertainty with certainty even at the price of foregone opportunities.

Notwithstanding the global financial crisis – partly attributable to misuse of financial risk instruments – [208] innovation in the management of risk in commerce has delivered substantial benefits. It is hard to imagine a modern economy without insurances, futures and hedging contracts, options, derivatives, swaps and other mechanisms of risk management. The thinking which has unlocked this potential is the deconstruction of

[207] Corporations can also decide to partly retain these risks while transferring a portion of them through insurance.

[208] For a discussion on the failure of risk management, see Alliance of Liberals and Democrats for Europe, *The International Financial Crisis: its Causes and What to Do About it?* (2010) <http://www.alde.eu/fileadmin/webdocs/key_docs/Finance-book_EN.pdf>; Organisation for Economic Co-operation and Development, 'Corporate Governance and the Financial Crisis: Key Findings and Main Messages' (OECD, 2009) <http://www.oecd.org/dataoecd/3/10/43056196.pdf>, 31-40.

transactions to target carefully delimited hazards, their likelihood and impacts, leading to the selection of the optimal risk management strategy. Where there is significant potential gain from undertaking risk, avoidance is only one option, not the strategy of first resort. The calculus of risk and reward is adjusted first by seeking other management methods and, only if these are unavailable, is the choice made not to proceed with risk-taking.

With their focus on risk financing and risk information mechanisms, some commercial risk management techniques, if transposed within the NRM context, might be more effective and efficient at managing environmental risks than avoidance or physical management. They could transfer the costs and responsibilities of monitoring and managing environmental risks onto those who benefit from them, so that they are more likely to adjust their behaviours. If these techniques can create an accountability loop between the source of the risk and its control, there should be less need for government to use risk-avoidance (bans) because the economic accountability would be primarily addressed within the private sector. Government would unavoidably remain the risk-underwriter of last resort but with a residual rather than primary role given the use of more comprehensive market mechanisms.

At the national and international levels, some innovative economic mechanisms to internalise environmental costs are being explored. Relying on market forces, sometimes underpinned by commercial risk management concepts, they involve private contractual arrangements which aim at transferring the financial responsibility for environmental management onto the private sector. These trigger new institutional arrangements in which the law is conceived as a driver of innovation and the development of commercial opportunities.

Using risk 'as a lever of change'[209] is underpinned by the idea of maximising the commercial opportunities from undertaking or managing environmental risks while mitigating the risks themselves. Market mechanisms are an artificial means through which buyers and sellers can negotiate, discuss and exchange, trade natural resources-related interests, risk-related information and the commercial and financial risks generated by the existence of environmental risks.

[209] Martin and Verbeek, above n 3, 65.

This thesis argues that whilst there is increasing sophistication in risk assessment tools used to evaluate weed risk and to design on-ground strategies,[210] more sophisticated risk-based strategies, such commercial risk management techniques, are needed in NRM to manage the residual risks of introducing new anthropogenic risks to the environment with commercial/social values. Alternative mechanisms could ensure more private resources to fund control and restoration for environmental costs resulting from misguided intentional introductions of anthropogenic risks to the environment with commercial/social values.

4.11 The public cost of excess precaution

Another limitation of existing legal and institutional arrangements is that they do not consider that anthropogenic risks to the environment can have economic and social outcomes.[211] This is illustrated with quarantine pre-border and post-border risk assessments processes.[212]

Reliance upon a ban approach is not 'risk-free'.[213] Economic interests argue that to eschew an enterprise with economic, environmental and social benefits because of an uncertain hazard is not economically efficient and that competitiveness and economic public good concerns should prevail. Permitting a profitable risky activity is not a bad thing if the biophysical risk-management safeguards prove to be effective. The greater the array of mechanisms available to manage risk, the more likely it is that risk-

[210] These include, for example, the identification of species' properties in weed risk assessment, the use of risk assessment models along with statistical tools to predict invasiveness, the identification of factors contributing to biological invasions. See F Koike and H Kato, 'Evaluation of Species Properties Used in Weed Risk Assessment and Improvement of Systems for Invasion Risk Assessment' in F Koike et al (eds), *Assessment and Control of Biological Invasion Risks* (SHOUKADOH Book Sellers and The World Conservation Union (IUCN), 2006) 73; Michio Otani, 'Important Vectors for Marine Organisms Unintentionally Introduced to Japanese Waters' in F Koike et al (eds), *Assessment and Control of Biological Invasion Risks* (SHOUKADOH Book Sellers and The World Conservation Union (IUCN), 2006), 92.

[211] For example, The Pheloung WRA system has been criticised for being too risk adverse and disregarding cost-benefit analysis. See NWRAS, above n 194,17-18.

[212] Peter Williams, *Guidelines for Weed Risk Assessment in Developing Countries* (Food and Agriculture Organization of the United Nations, 2003) <http://www.fao.org/docrep/006/y5031e/y5031e05.htm>. For example, The Pheloung WRA system has been criticised for being too risk adverse and disregarding cost-benefit analysis. See NWRAS Review Group, above 194, 17-18 <http://www.weeds.org.au/docs/Review_of_the_National_Weed_Risk_Assessmt_System_2005.pdf>.

[213] Ken Cussen, 'Handle with Care: Assessing the Risks of the Precautionary Principle' (2009) 16(2) *Australasian Journal of Environmental Management* 66.

management will be applied, avoiding the possibility the only options available will be a simple ban (with resultant loss of opportunity) or a simple approval (with the consequent ecological risk). In this instance, political vagaries and the market for economic power may determine an outcome that is less optimal than it might otherwise have been.

The precautionary principle is criticised for being a vacuous[214] or unworkable principle. It potentially '[...] could delay crucial scientific advancement and thereby produce new economic risks rather than securing our ecological future [...]'[215] Innovation is by essence risky. In some cases, a simple risk avoidance strategy resulting from an 'absolutist' interpretation[216] of the precautionary principle could be more costly than alternative risk mitigation strategies and could paralyse innovative processes.

This thesis argues that whilst the precautionary principle should remain a guiding principle[217] it may be better articulated using sophisticated risk management strategies adapted from the commercial and financial sector. This would promote entrepreneurship, maximise economic opportunities and at the same time minimise the risks attached to anthropogenic risks to the environment.[218] Alternative institutional arrangements such as risk pooling or insurance could respond proportionately to environmental risks while maintaining a precautionary balance based on science.

However this improved outcome is only feasible if innovations in the design and implementation of risk governance can be made effective. A number of theories suggest that often this will not be possible, in which case a less sophisticated approach will be the inevitable result.

[214] Ibid.
[215] Zinn, above n 186.
[216] Phrase used in Per Sandin et al, 'Five Charges against the Precautionary Principle' (2002) 5(4) *Journal of Risk Research* 287.
[217] Roberto Andorno, 'The Precautionary Principle: A New Legal Standard for the Technological Age' (2004) 1(1) *Journal of International Biotechnology Law* 11.
[218] In Robert J Shiller, *The New Financial Order : Risk in the 21st Century* (Princeton University Press, 2004), the author argues that risk-taking is a modern value in contemporary societies.

CHAPTER 6 THE COMPLEX CONCEPT OF RISK

The revolutionary idea that defines the boundary between modern times and the past is the mastery of risk: the notion that the future is more than a whim of the gods and that men and women are not passive before nature.[219]

Risk is a broad, complex and vitally important topic that touches on virtually all aspects of modern corporate operation.[220]

6.1 Introduction

The chapter provides an overview of innovations in instruments being used to manage environmental risks. These innovations are part of a new strategy for environmental governance. They result from an evolution in the regulatory process where the law can 'legitimate and regulate new market-driven actions.[221] New institutional arrangements support market-based instruments.[222] Regulations and private contractual arrangements which are legally enforceable interact in complex ways to create these new markets.[223]

[219] Bernstein, above n 185, 1.
[220] Eric Banks, *Alternative Risk Transfer: Integrated Risk Management through Insurance, Reinsurance, and the Capital Markets* (John Wiley & Sons, 2004) 3.
[221] Paul Martin, 'The Changing Role of Law in the Pursuit of Sustainability' in Michael I Jeffery et al (eds), *Biodiversity Conservation, Law + Livelihoods – Bridging the North-South Divide* (Cambridge University Press, 2008) 49, 53.This aspect is often overlooked in the specialised environmental economics literature.
[222] As discussed later, this is illustrated with statutory strict liability regimes to overcome the limitations of the common law. These have triggered the development by commercial operators of new insurance-based products.
[223] Two examples illustrate how legislative and regulatory instruments can create a legally defined tradable interest through contractual arrangements between private operators:
In Victoria, the Bushbroker program, a native vegetation credit trading system, was developed as part of the *Victoria's Native Vegetation Management Framework* released in 2002. The *Flora and Fauna Guarantee Act 1998* (Vic) provides the legislative structure for the conservation of Victoria's native flora and fauna. See Department of Natural Resources and Environment, State of Victoria, 'Native Vegetation Management - A Framework for Action' (State of Victoria, 2002) <http://www.dse.vic.gov.au/__data/assets/pdf_file/0016/102319/Native_Vegetation_Management_-_A_Framework_for_Action.pdf>.
In the US the *Endangered Species Act, 7 USC § 136, 16 USC §§ 1531-1544 (1973)* requiring the mitigation or minimisation of the unavoidable impacts to listed species generated the conservation banking scheme, a market-based instrument. In this example, the environmental risks of harming listed endangered species are transferred onto the economic beneficiaries/polluters of the undertaken developments. See Deborah L Mead, 'History and Theory: The Origin and Evolution of Conservation Banking' in Nathaniel Carroll et al (eds), *Conservation and Biodiversity Banking – A Guide to Setting Up and Running Biodiversity Credit Trading Systems* (Earthscan, 2008) 9, 9-10.

The risk management strategies and instruments discussed in this chapter target different behaviours and motivations. They are underpinned by varied institutional arrangements and can be applied in many combinations and permutations in the commercial management of risk. They are characterised by their heterogeneity and varied policy goals. Combined with a 'smart' regulatory strategy, they could leverage private investment for environmental management by:

- stimulating risk-reduction technologies;
- financing protection and compensation of biodiversity directly (eg environmental funds) or indirectly (through the protection of private interests); and
- improving information on corporate risk activities, processes and products.

An exhaustive list of risk-based instruments relying on market forces is probably impossible because of their ever-expanding variety. However, those which have specifically informed the design of the conceptual risk management strategy for biofuel weed risk control are specifically discussed in this exegesis.

6.2 Origins and dimensions of risk

Originally an abstract construct, risk evolved to practical applications in a variety of disciplines including in the environmental sciences. A pivotal development was the invention of probability-based methods to analyse risk.

Its scientific conceptualisation originates with the mathematical law of probability, a scientific discovery in the late 17th century by the French mathematician and philosopher Pascal. He resolved, with the assistance of Fermat, the probable outcomes of an unfinished game of chance. As reported by Bernstein, 'the [t]heory of probability] provided a measure of probability in terms of hard numbers, a climactic break from making decisions on the basis of degrees of belief'.[224] This set the foundations for the development of '[...] a systematic method for calculating the probabilities of future events'[225] based upon quantitative scientific-based tools.[226]

[224] Bernstein, above n 185, 58.
[225] Ibid 71.
[226] Under probability theory there is a certain number of mathematical laws that predict the likelihood of occurrence of an event. These include, for example, the law of large numbers and the probability game theory. These various laws are explained in plain English in ibid 185, 5, 14, 100, 122-123, 141, 170, 204, 226.

For the Canadian philosopher Hacker, this discovery was the foundation for the decision-making theory for 'deciding what to do when it is uncertain what will happen'.[227] Sampling theory, discovered by Graunt, is another key step in the maturation of risk science. It enabled analytical approaches to predicting events by generalising results from a limited set of data (sample). This contributed to improving the quality of information for risk decision-making.[228] Sampling techniques are (for example) now used to predict biological invasions on the basis of heuristic models.[229]

As noted by Bernstein: '[...] The use of sampling methods and the calculation of probabilities [underpins] [...] every method of risk management, from insurance and the measurement of environmental risks to the design of the most complex derivatives'[230]

The meanings of 'probability'

The concept of probability has a dual dimension.[231] As a statistical concept, it can be defined as 'the statistical frequency (or relative frequency) with which an event is expected to occur ... describes a chance process [which] exists, independent of our knowledge of it'.[232] Within the weeds context, this suggests that statistical tools can predict the chance of occurrence of biological invasions by looking into past data relying on known probability.

The second dimension of the concept relates to 'the degree of belief warranted by evidence'.[233] The probability of weeds infestations may be unknown but under Bayesian

[227] Ian Hacking, *The Emergence of Probability: A Philosophical Study of Early Ideas about Probability, Induction, and Statistical Inference* (Cambridge University Press, 1975), 64.
[228] Bernstein, above n 185, 73-96.
[229] Climate change is a driver of weeds infestations. The limited quantitative data available and the level of scientific uncertainty limits the effectiveness of sampling techniques to predict weeds infestations. Alternative techniques such as scenario planning are therefore used. As noted by Professor Yihong Du, contrary to models developed in physics which are based on first principles, those applied in ecology rely on heuristic thinking. In most cases useful field data in ecology requires the coverage of wide geographical areas over long-periods of time. Yihong Du, 'Mathematics and Ecological Invasion' (Paper presented at the Speech delivered at the 2010 Inaugural Lecture, Armidale 24 November 2010).
[230] Bernstein, above n 185, 75. It also underpins the choice of different sampling methods in empirical research design.
[231] Mark Burgman, *Risks and Decisions for Conservation and Environmental Management* (Cambridge University Press, 2005) 1.
[232] Ibid 6-7.
[233] Ibid 6.

statistics rules there may be (based on inference) a 'reasonable degree of belief'[234] that events such as biological invasions should 'follow the rules of probability'.[235]

However, the subjective foundations of risk ought not to be discounted. Burgman adds the term 'subjective probability' which conveys two meanings.[236] It can either refer to an expectation reflecting 'a lack of knowledge about a process or bias,'[237] the 'purely personal degrees of belief'[238] or 'the approvability of an opinion',[239] which, within the risk context, refers to its acceptability as a risk. Ultimately risk is concerned with judgments about uncertain future events having indeterminate impacts upon things that are valued. Statistics provides a tool for more precise understanding, but does not remove the subjectivity inherent in risk itself.

As a result of such considerations, the evaluation of risk poses challenges rooted in the dual significance of the concept. Risk can be assessed quantitatively and/or qualitatively. A quantitative approach involves statistical methods, whilst a qualitative approach relies on 'subjective' methods. Recent methodological developments in natural resource management encompass quantitative and qualitative approaches to better evaluate phenomenon[240] and events,[241] including environmental risks.

The multi-faceted concepts of risk and probability contribute to what Burgman has characterised as an 'epistemic uncertainty' and 'linguistic uncertainty'.[242] This is shown in the Table 6.1 developed by Zinn.[243] These variables can affect the choice of a specific risk management method.

The multi-dimensional concept of risk explains the array of definitions of 'environmental risk' in the academic literature. This variation creates a difficulty in selecting a consistent

[234] Ibid 7.
[235] Ibid 7.
[236] Ibid.
[237] Ibid.
[238] Ibid 7.
[239] Bernstein, above n 185, 49.
[240] N Marsland et al, 'A Methodological Framework for Combining Quantitative and Qualitative Survey Methods' <http://www.reading.ac.uk/ssc/n/resources/Docs/QQA/qqa.pdf>.
[241] The relationship between the concept of risk and research methodologies is explored in Le Gal, above n 137.
[242] Mark Burgman, above n 231, 26-39.
[243] Zinn, above n 186, 1, 8.

legal definition and underlies the divergence of risk assessment methodologies,[244] including those applicable to potential invasive crops and plants.[245]

Table 6.1: Risk epistemology in different disciplines and approaches[246]

Risk as...	***Perspective***	***Approaches***
Real and objective	Objective calculation of events	Technical risk assessment, insurance, epidemiology, toxicology
Subjectively biased	Objective risks are subjectively perceived and calculated	Psychometric paradigm, rational choice: objective/subjective utility
Socially mediated	The subjective experience of real risks is socially mediated	Edgework
Real and socially constructed	Reality and talk about risks mutually influence and produce each other	Risk society
Socially transformed	Real threats are transformed into risks for sociocultural boundaries	Cultural theory
Socially constructed	Events are risks insofar as they are part of a calculative technology Risks are socially ascribed decisions	Governmentality

6.3 Risk and uncertainty

A fundamental distinction is established by the American economist Knight in 1921 in *Risk, Uncertainty and Profit*, between risk and uncertainty:

[244] See Elizabeth Fisher et al, 'Maturity and Methodology: Starting a Debate about Environmental Law Scholarship' (2009) 21(2) *Journal of Environmental Law* 213, 224. See also Elizabeth Fisher, 'Risk and Environmental Law: A Beginner's Guide' in Benjamin J. Richardson and Stepan Wood (eds), *Environmental Law for Sustainability: A Reader* (Hart Publishing, 2006) 97-125. For an overview of risk-related terminologies, see the annexes in Ortwin Renn, 'Risk Governance – Towards an Integrative Approach' (IRGC White Paper No1 International Risk Governance Council, 2005) <http://www.irgc.org/The-IRGC-risk-governance-framework,82.html>. For a comparative summary of some risk assessment methods, see Martin and Williams, above n 6, 50-52.

[245] For an understanding of the Australian quarantine weed risk assessment, see Department of Agriculture Fisheries and Forestry, *Weed Assessment of New Plant Imports* <http://www.daff.gov.au/ba/reviews/weeds>. For another weeds risk assessment methodology, see John M Randall et al, 'The Invasive Species Assessment Protocol: A Tool for Creating Regional and National Lists of Invasive Nonnative Plants That Negatively Impact Biodiversity' (2008) 1(1) *Invasive Plant Science and Management* 36. For a general discussion about weed risk assessments, see Williams, above n 212.

[246] Zinn, above n 186, 1, 8.

> …**Uncertainty must be taken in a sense radically distinct from the familiar notion of Risk**, from which it has never been properly separated. The term "risk," as loosely used in everyday speech and in economic discussion, really covers two things which, functionally at least, in their causal relations to the phenomena of economic organization, are categorically different. ... **The essential fact is that "risk" means in some cases a quantity susceptible of measurement**, while at other times it is something distinctly not of this character; and there are far-reaching and crucial differences in the bearings of the phenomenon depending on which of the two is really present and operating. ... **It will appear that a measurable uncertainty**, or "risk" proper, as we shall use the term, is so **far different from an unmeasurable one that it is not in effect an uncertainty at all. We ... accordingly restrict the term "uncertainty" to cases of the non-quantitative type**.[247] [author emphasis]

Under Knight's distinction, the concept of risk relates to a 'measurable uncertainty' as opposed to the concept of uncertainty which stands for an 'unmeasurable uncertainty'.[248] This fundamental distinction has implications for policy-makers. Whilst risk can (at least in theory) be objectively measured, uncertainty is amenable only to subjective evaluation which involves beliefs, values and preferences.

6.4 Risk perception

Social sciences, including psychology and economics, have developed different theories and models[249] to unravel the complex linkages between risk perception, risk knowledge, risk attitude (underpinned by values and beliefs) and risk behaviour (what people really do). Psychology and sociology have contributed to understanding how people react to risks and uncertainties. For example, Prospect Theory, developed by Kahneman and Tversky, shows that – under conditions of uncertainty – people's decision making is underpinned by subjectively-driven behaviour patterns leading to inconsistent choices.

[247] Frank H Knight, *Risk Uncertainty and Profit* (University of Chicago Press, Chicago, 1971 - originally published in 1921 by Houghton Mifflin Company) 19-20.
[248] Ibid 19-20.
[249] For a concise overview, see Annemarie Breukers et al, 'Phytosanitary Risk Perception and Management: Development of a Conceptual Framework' (Report 2009-078, LEI Wageningen UR, 2009) <http://edepot.wur.nl/14635>.

People's responses to risks are contingent on the way risk problems are framed[250] and the level of certainty associated with a specific outcome: people become risk-adverse when the chance of a small gain is more certain than the one of a large gain.[251]

From a policy perspective:

> [...] success of a range of agricultural and natural resource management policies and programs that are designed to increase productivity and sustainability is clearly dependent on understanding how farmers' (and rural communities) perceive risk and how those perceptions vary among individuals, groups and communities'.[252]

Cognitive and perceptual biases, underpinned by values and beliefs, contribute to what has been described as the 'pathology of risk perception'[253] affecting people's judgments and their reactions to risk and uncertain events.

The socio-cultural context influences individual and collective risk perception, enhancing or thwarting legal and regulatory change. [254] A subjective assessment of risk may affect its objective evaluation.[255] The context-dependence of risk perception and its impact on the adoption of scientific innovations is illustrated with the introduction of path-breaking technologies within the American and European legal systems. GMO introduction showed that due to 'a very early difference in the framing of the technology for regulatory purposes'[256] the USA and Europe adopted significantly different risk evaluation methods within their legal regimes, resulting in significant differences in risk management.[257] In the USA the regulatory response to risk was driven by quantitative

[250] Kahneman and Tversky (1984), above n 105.
[251] Kahneman and Tversky (1979), above n 105.
[252] Botterill and Mazur, above n 105.
[253] Burgman, above n 232.
[254] John Tullock, above n 105; Ferrari, above n 105. Within the weeds context, see Margaret Friedel et al, 'Benefits and Costs of Buffel Grass: Understanding Perceptions can Contribute to Policy Development' (LWA Project Code CSE52, 2009) <http://lwa.gov.au/files/products/defeating-weed-menace/pn22374/pn22374.pdf>.
[255] Scott R Baker, 'Regulating and Managing Risk: Impact of Subjectivity on Objectivity' in Richard C Cothern (ed), *Handbook for Environmental Risk Decision Making – Values, Perceptions, and Ethics* (CRC Press, 1996) 83.
[256] International Risk Governance Council, *An Introduction to the IRGC Risk Governance Framework* (International Risk Governance Council, 2008) <http://www.irgc.org/IMG/pdf/An_introduction_to_the_IRGC_Risk_Governance_Framework.pdf>, 10.
[257] Tait, above n 106; Levidow et al, above n 106.

technical risk assessment whereas in Europe greater emphasis was placed on qualitative social perceptions of risk (leading to a more risk-averse regulatory regime).

When discussing risk perception, 'value' is also a pivotal concept. As with risk, the subjective element of 'values' is frequently converted in apparently objective economic 'value' (through the process of valuation). Value is distinct from the concept of pricing. For example, 'valuing' the biodiversity potentially impacted by weeds will encompass non-economic/monetary components as well as economic losses.[258]

The assessment of the bio-fuel weeds risk is subjective to at least some degree. It relies partly on how the loss of value is assessed by the people and organisations facing the possibility of losing the benefit of an asset due to the occurrence of the weeds hazard. Different interests will perceive the likelihood of an adverse event and the potential loss of value differently. For a primary producer weeds infestations will be perceived as a potential source of economic hardship resulting from loss of crop productivity. From an environmental scientist perspective, the same hazard will be perceived as a potential loss of biodiversity. The type of regulatory responses, including penalties, will vary depending upon the interests that laws and policies intend to protect (eg economic interests versus environmental interests) and the policy goals they aim to achieve. This relates to the broader challenge of framing the weeds risk from a policy and regulatory point of view.[259]

The valuation of biodiversity that might be adversely impacted by biological invasions challenges traditional economic valuation methods.[260] This can impact upon regulatory decision-making.[261] One of the challenges consists in assessing the value of the natural

[258] For a discussion on valuation and environmental risks, see Molly K Macauley, 'Issues at the Forefront of Public Policy for Environmental Risk' ' (Comments for the American Meteorological Society's Annual Policy Colloquium 2006, Resources for the Future, 2006) 9 <http://www.rff.org/rff/documents/rff-dp-06-01.pdf>.

[259] Amos Tversky and Daniel Kahneman, 'The Framing of Decisions and the Psychology of Choice' (1981) 211(4481) *Science* 453.

[260] For a discussion of valuation and environmental services, see Pushpam Kumar, 'Market for Ecosystem Services' (2005) 6-14 <http://www.iisd.org/pdf/2005/economics_market_for_ecosystem_services.pdf>.

[261] In Gail Bingham et al, 'Issues in Ecosystem Valuation: Improving information for Decision-Making' (1995) 14(2) *Ecological Economics* 73, the authors provide an overview of the general problems arising out of the valuation of the environment. Although it may not be possible to develop a single unifying definition of value – as much information cannot be obtained – the goal may be to understand how

resource in its original state,[262] in its impacted state and in its recovered state (if any) once the environmental hazard has occurred. Another key challenge is to determine what constitutes environmental harm, how it can be defined and how it can be measured.[263] *In fine*, the literature illustrates that the economic valuation of the environment brings into consideration many technical and social matters, extending even to include issues of ethics.[264]

As pointed out by Renn, integrated approaches to the risk phenomenon must span a wide range of disciplines and sciences,[265] as illustrated in Figure 6.1. The integration of all these aspects is a challenge from a policy-making perspective.

concepts of value are structured, how they relate to each other, and how they can guide decision makers toward a more integrated valuation process and valuation protocols.

[262] This can be done through an environmental impact assessment (EIA) when projected activities are planned. However, for unpredictable catastrophic environmental risks, EIA are limited. For a general overview of the EIA within the Australian context, see Bates, above n 2, 299.

[263] Michael Bowman, 'The Definition and Valuation of Environmental Harm: An Overview' in Michael Bowman and Alan Boyle (eds), *Environmental Damage in International and Comparative Law - Problems of Definition and Valuation* (Oxford University Press, 2002) 1; Nick Hanley, 'The Economic Value of Environmental Damage' in Michael Bowman and Alan Boyle (eds), *Environmental Damage in International and Comparative Law – Problems of Definition and Valuation* (2002), 27.

[264] Stefan Hajkowicz, 'Can We Put a Price Tag on Nature? Rethinking Approaches to Environmental Valuation' (2007) 14(1) *Australian Journal of Environmental Management* 22; Michael Bowman, 'Biodiversity, Intrinsic Value, and the Definition and Valuation of Environmental Harm' in Michael Bowman and Alan Boyle (eds), *Environmental Damage in International and Comparative Law – Problems of Definition and Valuation* (2002) 40.

[265] Renn, above n 244, 15.

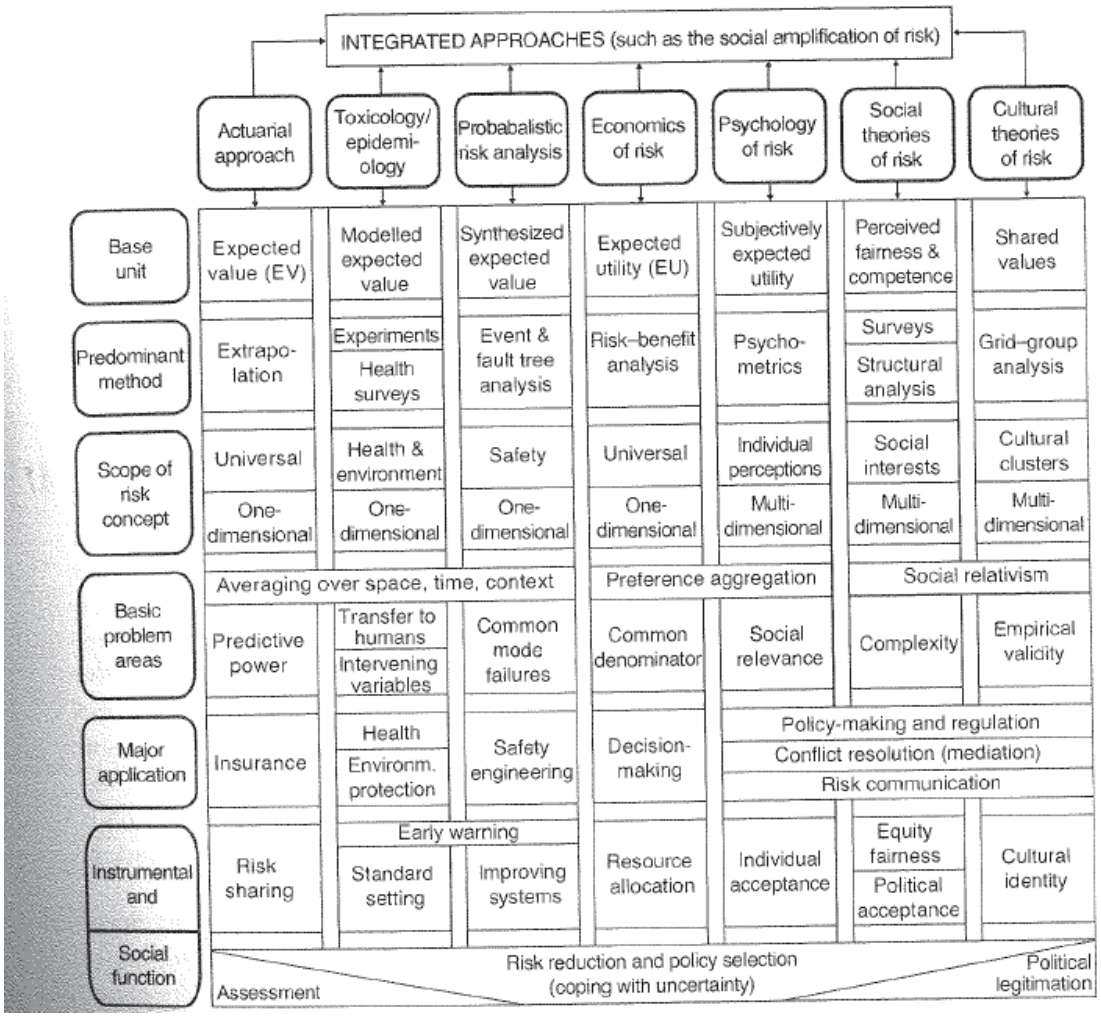


Figure 6.1: Systemic classification of risk perspectives[266]

6.5 Some key risk enquiries

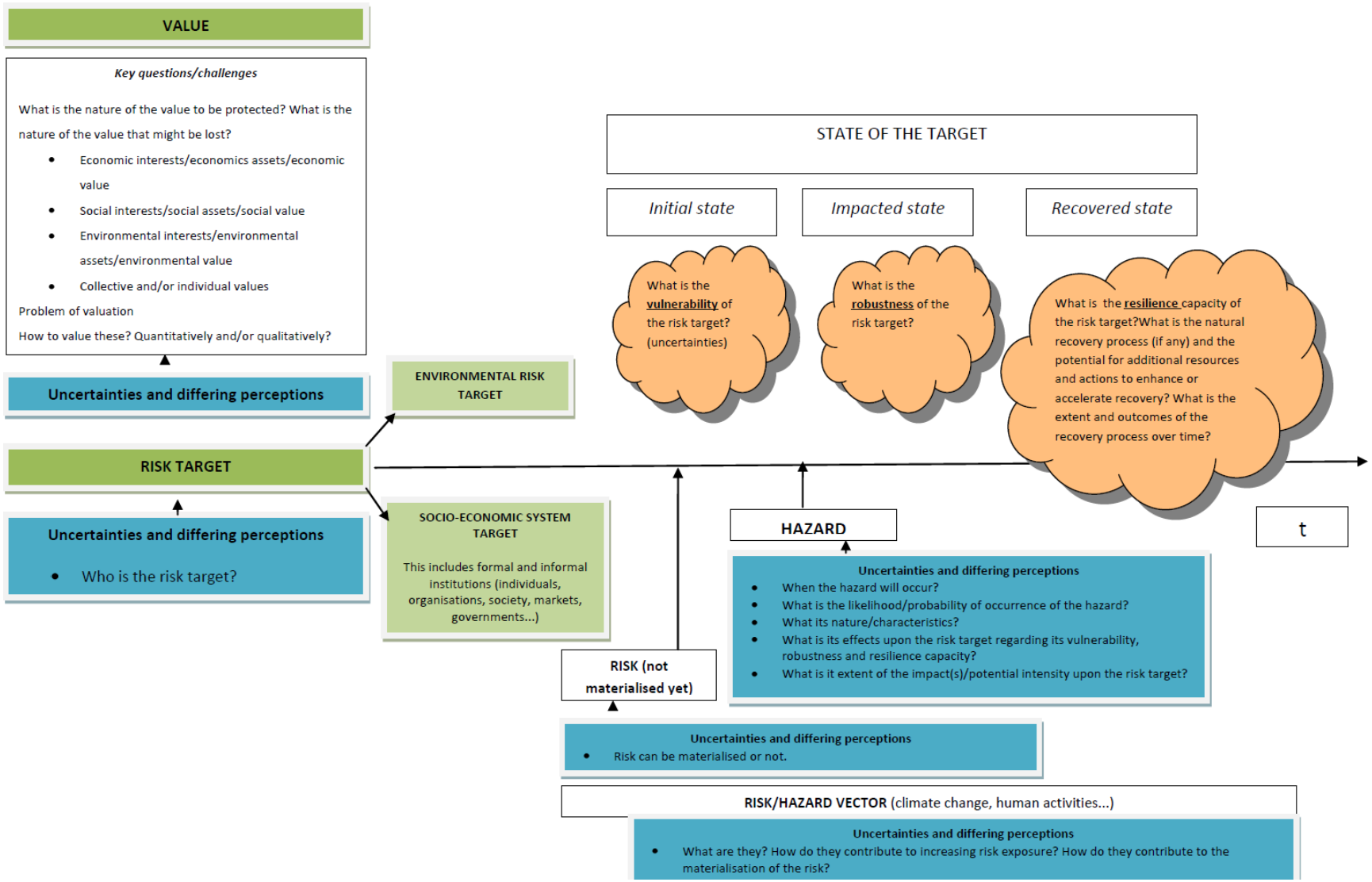
The different uses of the term risk or its derivatives (value, hazard, risk target, impact, recovery, resilience, vulnerability, robustness) have different meanings across disciplines[267] and are context-dependant. Mirroring the variables embedded in concept of risk, they also generate multiple linguistic and epistemological uncertainties. Figure 6.2 summarises key risk-related concepts, their relationships and significance within the bio-fuels weeds context, highlighting some uncertainties associated with bio-fuels weeds risk.

[266] Ibid.

[267] For example, 'in economics, risk is conceptualised not as physical harm or other objective effect but as an expected utility' in Zinn, above n 186. This quote is reported to be attributable to Renn, 'Concepts of Risk: A Classification' in Sheldon Krimsky and Dominic Golding (eds), *Social Theories of Risk* (1992) 53, 61.

It suggests key elements to consider in the design of a risk management strategy.[268] It should be noted that such a framework is transposable to any other type of environmental risk.

[268] Martin and Williams, above n 6, 12.


VALUE
Key questions/challenges
What is the nature of the value to be protected? What is the nature of the value that might be lost?
Economic interests/economics assets/economic value
Social interests/social assets/social value
Environmental interests/environmental assets/environmental value
Collective and/or individual values
Problem of valuation
How to value these? Quantitatively and/or qualitatively?
Uncertainties and differing perceptions
ENVIRONMENTAL RISK TARGET
RISK TARGET
Uncertainties and differing perceptions
Who is the risk target?
SOCIO-ECONOMIC SYSTEM TARGET
This includes formal and informal institutions (individuals, organisations, society, markets, governments...)
STATE OF THE TARGET
Initial state
Impacted state
Recovered state
What is the vulnerability of the risk target? (uncertainties)
What is the robustness of the risk target?
What is the resilience capacity of the risk target?What is the natural recovery process (if any) and the potential for additional resources and actions to enhance or accelerate recovery? What is the extent and outcomes of the recovery process over time?
t
HAZARD
Uncertainties and differing perceptions
When the hazard will occur?
What is the likelihood/probability of occurrence of the hazard?
What its nature/characteristics?
What is its effects upon the risk target regarding its vulnerability, robustness and resilience capacity?
What is it extent of the impact(s)/potential intensity upon the risk target?
RISK (not materialised yet)
Uncertainties and differing perceptions
Risk can be materialised or not.
RISK/HAZARD VECTOR (climate change, human activities...)
Uncertainties and differing perceptions
What are they? How do they contribute to increasing risk exposure? How do they contribute to the materialisation of the risk?

6.6 Risk and general sustainability policies

Environmental risk-based policies differ from general sustainability policy as they seek internalise the subjective and/or objective components of the concept of risk.

Although equally aimed at protecting 'vulnerable' values, they involve differe perspectives on value and uncertainty:

> The value that is the core of most sustainability policy is a collective interest in the maintenance of future environmental benefits ("environmental services") [At] the heart of policy are political choices about whose values are to be given priority. … [T]he treatment of value [in a risk-based approach] tends to be more specific than in general policy methods, which tend to be based on macro-economic and regulatory design considerations. Risk-strategy generally requires identification of specific risks to specific interests, simply because of the nature of the discipline and the instruments used.[270]

Environmental risk-based strategies are designed to counteract the vulnerability and/ strengthen the robustness and resilience capacity of the risk target (impacted ecosyste and/or impacted individual and/or impacted actors/organisations) against the occurren of an external environmental hazard. They internalise the uncertainty associated with t existence of environmental risks, in order to adapt to or adjust the possible outcom from the realisation of the external environmental hazard.

6.7 Theoretical superiority of economic instruments

A body of literature discusses the theoretical superiority of environmental market-bas instruments over traditional regulatory approaches for environmental management terms of effectiveness and efficiency.[271] Free market environmentalism advocates the u of liability mechanisms, property rights and private contractual arrangements to regula within the private sphere environmentally harmful behaviours. The creation of priva property rights over common resources is often advocated to correct environmen

[270] Paul Martin – Personal communication

[271] The researcher has adopted the definition of effectiveness and efficiency as stated in Williams, above 6, 46. The author defines effectiveness 'as delivering the objectives or desired outcomes' and efficient ' cost effective, resource effective, coordinated and integrated'.

externalities. Property rights can create scarcity and generate a price signal which in turn can create a financial incentive to conserve.[272] The underlying assumption is that people better protect what they own, overcoming the commons problem illustrated by Hardin in his article, *The Tragedy of the Commons*.[273] As a consequence, property rights are considered to often be an effective tool 'in defense of nature'.[274]

The neo-liberal economist, Coase, proposed that negative environmental externalities and environmental market failure could be overcome through the use of private contractual transactions underpinned by strong property rights.[275]

Environmental market mechanisms underpinned by property rights are arguably more flexible than prescriptive measures which revolve around environmental standards, prohibition and licensing systems.[276] They should enable firms to achieve environmental performance while taking into consideration their own resources and constraints, and adjusting their decisions accordingly. Using the market pricing mechanisms,[277] which stimulate self-interest, should encourage private operators to go beyond what can be achieved by compliance with prescriptive measures.[278]

In economic arrangements for managing risk, the theory of probability is additionally associated with the law of supply and demand. Behavioural changes for environmental protection can be triggered through risk-based techniques which rely extensively on risk information and private incentives to act on that information by avoiding or mitigating risk, or by using contracts to better allocate or share that risk.

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[272] For the relationship between property rights and public resources, see Leigh Stafford Raymond, *Private Rights in Public Resources: Equity and Property Allocation in Market-based Environmental Policy* (Resources for the Future, 2003).
[273] Garrett Hardin, 'The Tragedy of the Commons' (1968) 162 *Science* 1243.
[274] Elizabeth Brubaker, *Property Rights in Defence of Nature* (Earthscan, 1995).
[275] Ronald H Coase, 'The Problem of Social Cost' (1960) 3 *Journal of Law and Economics* 1.
[276] Bates, above n 2, 174.
[277] Such instruments are directed to implement the 'improved valuation, pricing and incentive mechanisms', a key principle of Ecologically Sustainable Development (ESD).
[278] For an economics discussion of environmental market-based instruments, see Stuart Whitten, Van Bueren and Drew Collins, *An Overview of Market-Based Instruments and Environmental Policy in Australia* (CSIRO Sustainable Ecosystems, 2003) <http://www.ecosystemservicesproject.org/html/publications/docs/MBIs_overview.pdf>.Three levers for behavioural change are identified. These include price-based (eg taxes, levies, subsidies), rights-based/quantity-based (eg 'cap and trade' and 'offset' mechanisms) and market friction mechanisms (eg eco-labeling schemes).

The principles of risk management within the commercial context are underpinned by probability-based reasoning. The market can also:

- Inform market participants about the level of risk involved in undertaking a specific activity (risk information). This information can have economic value,
- Price activities and products differentially based on the valuation of risks (risk pricing).
- Pool certain types of risk – independent probabilities – (risk pooling) and spread them over a larger number of people. As the probability of an uncertain harm impacting simultaneously all members of a 'spread' of people is relatively low, the risk of a given harm is better able to be managed if a large number of people agree to share responsibility (risk sharing – risk spreading) for compensating any individual against a risk to which all are potentially exposed.
- Transfer the costs of risk through techniques including:
  - Risk securitisation – the transformation process of 'illiquid financial assets into tradable instruments'[279] – to transfer risks and raise capital to finance potential losses; and
  - Hedge risks through financial and contractual techniques (risk hedging)[280] through which one party contracts to protect another (economically) against the occurrence of an undesired contingency.

Sophisticated commercial strategies often combine various of these elements and use statistical methods to underpin these strategies.

The following example illustrates a practical market-risk based approach.

> A primary producer is exposed to the risk of financial loss due to the potential occurrence of a destructive storm. Markets can provide innovative instruments, supported by institutional arrangements, to protect this individual against economic costs resulting from such environmental hazards. A producer can hedge the price risks to which he is exposed on agricultural commodities markets through

[279] R 'Tee' Williams, An Introduction to Trading in the Financial Markets : Trading, Markets, Instruments, and Processes (Academic Press, 2011) 151, 154.
[280] For an introduction to risk management techniques in financial markets, see Robert Shiller, *Yale Econ 252 – Universal Principles of Risk Management - Pooling and the Hedging of Risks* (Yale University) <http://videolectures.net/yaleecon252s08_shiller_lec02/> .

> contractual techniques like 'forward selling' or he can take out crop insurance. The environmental uncertainty is converted into an economic uncertainty which is priced and internalised onto the marketplace.

Environmental contingencies generate a wide range of commercial, financial and technological risks (business risks) and can generate legal liabilities. A risk-market based approach uses the marketplace as a means for buyers and/or sellers to negotiate, discuss and exchange their risks using a range of instruments. An important distinction between the example given and the subject matter of this thesis is risks **from** the environment and risks **to** environmental values. Traditional commercial risk instruments are commonly used to protect against risks from the environment. This thesis seeks to expand their use to address risks to the environment.

In a risk market approach to environment protection, the emphasis shifts from putting a price on the environment towards determining and assessing the probability of the occurrence of risks and the economic valuation of the impacts of risks to the environment so that they can be priced. This concept is reflected in the model that was discussed in Chapter 5.

6.8 Liability rules as a market-based mechanism

Also in the model are arrangements to create civil liabilities for environmental and economic harm from weeds spread.

Liability rules enforced by the judiciary are an incentive mechanism for corporations to adopt risk-reduction measures to avoid costly litigation.[281] As discussed below, their deterrent effects can contribute to environmental protection.[282]

Tort law focuses on the protection of private rights including property interests. It provides different causes of action (eg trespass, public and private nuisance and negligence) with specific legal requirements – to compensate victims of anthropogenic harms. Its use is not dependent upon government action (other than in the sense of

[281] Gunningham and Grabosky, above n 5, 78.
[282] One aim of tort of law is to achieve deterrence and compensation. Some theorists consider that tort law revolves around the idea of justice. For a brief overview of this complex discussion, see Mark Lunney and Ken Oliphant, *Tort Law : Text and Materials* (Oxford University Press, 3rd ed, 2008) 18-22.

institutional governance) but is contingent on civil action between citizens (and corporations as citizens). It can be a social mechanism for environmental protection whereby common law judges assign liabilities to potential polluters/natural resource users.[283] Civil law remedies can include both damages to compensate for and injunctions directed to stop harmful behaviours. Civil remedies are targeted to the protection of private interests. To this extent, civil law can be considered as a private market instrument[284] though it is infrequently considered as such in the environmental economics literature.

The doctrines of trespass, public and private nuisance, and negligence may be applied to address certain types of environmental risks provided that suitable institutional and evidentiary conditions apply to satisfy the legal prerequisites for their use.

The role of private nuisance[285] to control the weeds risk has recently been investigated in an unpublished report by Philip Blackmore.[286] He concluded that due to reasons including the legal prerequisites for a private nuisance action and the costs of legal action, command and control action by government[287] would be more effective and appropriate than civil nuisance to manage weed spread.[288] The proposal in Chapter 5 would help to circumvent this limitation.

[283] For a discussion of the effectiveness of legal liability for environmental protection, see Kathleen Segerson, 'An Assessment of Legal Liability as a Market-Based Instrument' in Jody Freeman and Charles D Kolstad (eds), *Moving to Markets in Environmental Regulation – Lessons from Twenty Years of Experience* (Oxford University Press, 2007) 250.

[284] This intellectual construction is rooted in the American law and economics movement which has contributed to model accidental law. Under this doctrine, the main functions of tort law are to ensure that risky behaviours can be deterred and compensated. The underlying assumption is that the adoption of risk-reduction measures – before the occurrence of any hazard – might be more efficient than the compensatory damages in reducing social costs generated by accidental damage. Through tort, driven by economic considerations, risk takers (polluters) can be incentivised to modify their risky behaviours. As opposed to contractual risk instruments which rely on agreement to generate an ex-ante price signal, judges can generate similar price signals post damage.
See for example Steven Shavell, 'Strict Liability versus Negligence' (1980) 9(1) *The Journal of Legal Studies* 9 (1) 1. For a mathematical model of the social costs of accident, see Faure and Hartlief, above n 187, 35.

[285] Defined as 'an indirect interference with a person's land or enjoyment of it' in Bates, above n 2, 55.

[286] Philip J Blackmore, 'Can the Common Law of Nuisance Effectively Manage Weed Spread?'(NSW Industry and Investment, unpublished).

[287] Such as the *Noxious Weeds Act 1993* (NSW) which imposes the obligation upon landowners to control weeds on their properties.

[288] In Blackmore, above n 286, 4, he notes:

The doctrine of negligence[289] may be a basis for legal responsibility provided that causal connection is established between the plaintiff's damage/injury and the defendant's act or omission considered to be a breach of a general duty of care. For tort liability to work for the environment, it requires demonstrated causality of harm to humans or economic loss, not merely harm to the environment. In the instance of weeds, the causation challenge is accentuated if the hazard arises from natural genetic diversification or cross-breeding with indigenous species.[290] One of the technological advances which will impact upon the economics and the potential weed effects of biofuels is the use of genetically modified organisms (GMOs) as biofuel crops. The use of GMOs in other contexts has generated attempts to use civil action to either prevent the establishment or spread of GMO weeds, or to seek compensation or remediation of harms caused through undesirable spread of these crops.

Actions in nuisance to seek damages for the spread of weeds of minor significance are likely to fail. Even in the case of more serious weeds, for a claim to be successful the required tests are reasonably onerous for a claimant to establish:

1. The defendant's knowledge of the hazard.
2. The defendants ability to foresee the consequences of not checking or removing it, and
3. The defendants ability (both physically and financially) to abate the hazard,

Furthermore, a claim for damages can only be brought for harm that has already occurred, not for potential harm. An injunction may be sought to prevent potential damage to the neighbour's property by the spread of weeds, but such an injunction might only be granted if there is proof that the potential damage is:

i. Imminent or likely to occur in the near future, and
ii. is very substantial or almost irreparable (*Robson v Leischke*).

This would be very difficult to establish in relation to most weeds.'

[289] The main three elements of negligence are a duty of care, a breach of that duty and the causing of damage.

[290] For a discussion of the relevance of tort-based actions to control GMOs spread, see Will Hardy, 'Preparing the Law for GMO Outbreak' (2008) <http://willhardy.com.au/legal-essays/gmo-liability/view/>. See also Michael Migus, 'GMO Statutory Liability Regimes: An International Review' (Canadian Institute for Environmental Law and Policy, 2004) <http://www.cielap.org/pdf/GMOLiability.pdf>. This difficulty could be potentially reduced if the liability framework reflects an industry rather than (or perhaps as well as) individual accountability. However within the context of invasive species from ballast water, it has been reported that 'the causation hurdle is rapidly weakening'. See Read D. Porter and Jordan Diamond, 'New Tools for Responsible Shipping in the Great Lakes - Using Financial Responsibility Policies to Prevent Ballast-Borne Biological Pollution ' (Environmental Law Institute, 2009) <http://www.elistore.org/reports_detail.asp?ID=11355&topic=Biodiversity_and_Invasive_Species>, 35.

Statutory strict liability regimes, such as pollutant emission liability and contaminated site liability regimes are alternative strategies to address the limitations of tort-based actions for environmental protection.[291]

For contaminated sites, the challenge of causation has been overcome by the adoption of a strict joint and several liability regime in the US *Comprehensive Environmental Response Compensation and Liability Act of 1980* ('CERCLA Superfund Act').[292] The act imposes clean up obligations and financial responsibility on a broad category of potentially responsible parties involved in ownership and control of contaminated sites. Some countries have adopted statutory liability regimes combining private and public liability for GMO-related damage.[293]

[291] Alternative theoretical proposals have been suggested to overcome the limitations of the common law. In 1993 a position paper by the Australian and New Zealand Environment and Conservation Council (ANZECC) exploring the potential of financial responsibility mechanisms for contaminated site remediation, defined 'risk-based' liability as a mechanism where 'anyone posing a threat to the environment or deriving a benefit from it should, by that fact alone, bear a share of the risk'. It added that 'it is irrelevant under a risk-based scheme whether or not any care or responsibility was displayed or expected, or whether the liable party knew of the actions which resulted in liability being imposed.' In Australian and New Zealand Environment and Conservation Council, 'Financial Liability for Contaminated Site Remediation: A Discussion Paper' (AGPS, 1993) 16.
The following references consider the integration of risk-based techniques:
Two distinct situations are envisaged. The first considers the application of the risk pricing principle to cases involving indivisible injuries caused by multiple wrong-doers. Conceived as an alternative to the traditional binary method for establishing causation and apportioning damages, this solution applied within the weeds context means that the plaintiff would have to demonstrate that the defendant's breach of duty has materially increased the risk of biological infestations, but not necessarily caused the damage. An economic analysis of the legal duty of care would apportion damage relative to the contributions of identified harm-doers following an equation which would incentivise possible defendants to take risk preventative measures. See Green, above n 200. The second proposal argues that the application of finance theory to increased risk exposure could provide the rationale for recognising 'freedom from increased risk' as a 'legally cognizable interest, the violation of which [would] give rise to an independent cause of action'. See Robert Rhee, 'The Application of Finance Theory to Increased Risks Harms in Toxic Tort Law Litigation' (2004) 23 *Virginia Environmental Law Journal* 111. This would mean that the simple exposure to the risk of biological invasion could be sufficient for a tort action even where the plaintiff has suffered no physical injuries nor financial losses or property damage. Securities and derivatives risk pricing techniques would be applied to evaluate damage.
These proposals would require that common law judges shift from a deterministic towards a probabilistic conception of causation. For a discussion of the problem of causation within the climate change debate and the potential of a probabilistic approach, see Joseph Smith and David Shearman, *Climate Change Litigation - Analysing the Law, Scientific Evidence & Impacts on the Environment, Health & Property* (Presidian Legal Publications, 1st ed, 2006) 105, 111-117.

[292] 'With some modifications, the United States legislation has served as the conceptual basis for legislation in other countries, including Australia' in Garry Bates and Zada Lipman, *Corporate Liability for Pollution* (LBC/Thomson, 1st ed, 1998), 239.

[293] This includes Austria, Germany, Nigeria, Norway and Switzerland. This is reported in Migus, above n 290, 14.

To summarise, civil liability works only in a limited way as a risk management tool because it is directed only to the protection of personal interests (eg physical harm, economic loss, damage to property). It does not address situations where environmental public goods have been affected.

A constraint on the use of environmental liability mechanisms is the potential of harm-doers to use corporate structures (such as an asset-poor operating subsidiary that can be liquidated if liability arises)[294] to minimise effective accountability.[295] Arguably, financial responsibility mechanisms (later described in this chapter) can mitigate the corporate insolvency risk. These difficulties can also be reduced by designs that lift the corporate veil, including personal liability for directors, or 'tracing' through corporate structures to holding and partner corporations.[296]

A further limitation is the transaction costs (including delays) of civil litigation.[297] This could be reduced by the use of alternative dispute resolutions mechanisms.[298] A concurrent administrative liability system with clean up orders by public authorities might also overcome the problem of long-delay in civil procedures.[299]

The limitations of civil law suggest that a collective industry accountability based upon a statutory scheme might facilitate compensation and remediation, and provide an incentive

[294] The James Hardie 'asbestos liability' case illustrates the limitations of civil liability when applied against multinational corporations. See *Australian Securities and Investments Commission v Macdonald* (No 11) [2009] NSWSC 287 (23 April 2009). The Enron scandal, which led to the American *Sarbanes-Oxley Act of 2002* illustrates the use of complex corporate structures.

[295] Financial responsibility mechanisms, such as environmental performance bonds, insurance and risk pooling techniques can overcome this challenge.

[296] For example, under the *Tax Laws Amendment (2012) Measures No 2 Act 2012* (Cth), directors of companies can be held personally liable for a company's tax liabilities. For a discussion on the draft legislation released in 2011 by the Australian federal government to regulate Phoenix activities, see Helen Anderson, 'The Proposed Deterrence of Phoenix Activity : An Opportunity Lost?' (2012) 34 (3) *Sydney Law Review* 411.

[297] The costs and delays of litigation are well documented. The evidentiary problems noted speak of the economic value of collective responsibility rather than individual accountability.

[298] Alternative dispute resolutions mechanisms such as neutral evaluation sessions are integrated within the functioning of the specialised Land and Environment Court of New South Wales. See *Land and Environment Court Rules 2007* (NSW) r 3.8.

[299] This is the solution adopted in *Contaminated Land Management Act 1997* (NSW), to manage pollution risks from contaminated land in New South Wales. See Monti, above n 126, 27. For an overview of how land-based and marine sources of pollution, waste risks and contaminated sites are managed within Australia, see Bates, above n 2, 527-602.

for industry to implement mechanisms to minimise avoidance of accountability by unscrupulous industry members. This is the approach adopted in the proposed model.

Given that damage from bio-fuel weeds is likely to be to the environment or the public, consideration might be also be given to enabling civil action by representative plaintiffs for the environment.[300] Industry may resist such a strong emphasis on the environment as this may increase their costs. The public advantage would be principally to encourage weed detection by those not directly affected who may be prepared to act in the public interest. The potential private advantage is the protection of the reputation and social license of the industry.

6.9 Commercial risk financing techniques

To counteract environmental contingencies, corporations can adopt different risk-based strategies. Beyond risk control (eg risk avoidance and risk mitigation), risk financing is an alternative strategy:[301]

In general terms, the normal approach to risk management is to control all those risks that management feels it can control within the physical resources of the firm and finance the remainder. Effectively, risk financing funds those losses that remains after the application of risk control techniques, including both those risks accepted as not being able to be controlled and those where controls proved inadequate to contain the risk.[302]

Private operators might self-fund risks using self-insurance and reliance on reserves.[303] As opposed to *ex ante* financial guarantees discussed later, reserves are used to cover the costs of environmental damage once it has already occurred.

[300] For an illustration of the relaxation of restrictions of legal standing in common law courts see Robyn Glindemann, 'Standing to Sue for Environment Protection: a Look at Recent Changes' (1996) 24(3) *Australian Business Law Review* 246. For an extended standing for judicial review and the correlated extension of the meaning of 'person aggrieved', see *Environment Protection and Biodiversity Conservation Act 1999* (Cth) s 487.

[301] For further developments see Banks, above n 220. See also Christopher L Culp, *The Art of Risk Management – Alternative Risk Transfer, Capital Structure, and the Convergence of Insurance and Capital Markets* (John Wiley & Sons, 2002).

[302] UNEP FI Australasian Advisory Commitee on Insurance, 'Risk, the Environment and the Role of the Insurance Industry' (2003) 3 <http://www.unepfi.org/fileadmin/documents/risk_environment_insurance_epavic_2003.pdf >.

[303] Self-insurance can also be combined with risk transfer mechanisms. This is illustrated later. For a discussion on self-insurance, see Faure and Hartlief, above n 187, 145-146.

Some self-insurance arrangements cross over into risk pooling techniques. This can occur when corporations 'join forces via mutuals'.[304] Self-insurance can also occur through the creation of captives[305] which can take different forms and may be combined with other risk financing techniques.[306]

The potential for collective approaches to risk control and risk financing is historically demonstrated. Particularly in the 1970s in the USA, high-risk industries expanded the application of 'Factory Mutual' insurance approaches.[307] Companies aggregated their insurance needs within a strong risk-management framework. Firms wishing to have the benefit of the lower premium based on collective good practice were required to adopt mandated practices and undergo regular risk inspection. One result was an improvement in the relative cost competitiveness of the firms within the insurance mutual, converting risk management best practice into competitive premiums reflecting their lower total costs and risks of losses.

A form of industry self-insurance can be created using bonds or guarantees or other instruments as illustrated with the following examples.

This example considers particularly corporate environmental risk liability:

The US federal mechanism for maritime oil spill disaster risk management is a complex scheme. The *Oil Pollution Act* of 1990 (33. U.S.C 2701-2761) imposes a statutory strict liability regime upon potential responsible parties (RPs), including vessels for oil removal

[304] Ibid 145.

[305] '[A] captive is a closely held risk channel that is used to facilitate a company's insurance/reinsurance program and retention/transfer activities. It is generally formed as a licensed insurance/reinsurance company, controlled either by a single owner or multiple owners (often referred to as the sponsor(s). The owner/sponsor(s) provide upfront capital to commence the operation (initial capital levels of approximately $250 000 are common, but this has to be increased in relation to the amount of business written); in exchange for the provision of capital, the captive generally pays the owner(s) periodic interest and/or dividends.' In Banks, above n 220, 89. And for an explanation of how captives can contribute to self-insurance, see Banks, above n 220, 89-101. See also Culp, above n 301, 362-379.

[306] These can be combined with risk transfer mechanisms such as insurance and reinsurance to 'insure the insurers.'

[307] This approach is rooted in early 19th Century New England schemes. Mutuals required third-party inspections before fire policy contracts for factories were entered into and during the time of the policy coverage. See Paul K Freeman and Howard Kunreuther, 'Managing Risk through Insurance' in Paul K Freeman and Howard Kunreuther (eds), *Managing Environmental Risks through Insurance* (Kluwer Academic Publishers, 1997) 21, 22-3; John Bainbridge, *Biography of an Idea: The Story of Mutual Fire and Casualty Insurance* (Doubleday & Co., 1952); Finley J Lee, 'The Competitive Role of the Associated Factory Mutuals' (1969) 36(4) *Journal of Risk and Insurance* 401.

costs and damages. To ensure that these can meet their financial obligations up to the limit of liability,[308] RPs have to provide a certificate of financial responsibility (COFR) which acts as a licence to operate.[309] Self-insurance or insurance are accepted as proof of financial capacity. When RPs cannot be identified or do not pay, the insurance pool, the *Oil Spill Liability Trust Fund* (OSLTF) operates as a social insurance scheme to compensate victims of oil spill for uncovered claims. It also covers emergency clean-up restoration costs.[310] It is funded by an excise on insurance premiums arising from petroleum and petroleum products. The National Pollution Funds Centre ('NPFC') is a public authority in charge of managing this fund and certifying vessels to navigate in US waters.[311] As a result, the scheme is underpinned by a risk sharing mechanism between the funds and RPs.

A parallel scheme has been implemented in California under the *Lempert-Keene-Seastrand Oil Spill Prevention and Response Act of 1990* (*LKS Act*, 1990, California). Under this legislation tankers can be required to provide up to US $ 1 billion worth of liability protection. The scheme creates a risk-pooling fund for oil spill preparation, response and habitat restoration.[312]

[308] An adjustment of liability limits has been recommended to ensure a long-term viability of the funds. See United States Coast Guard and National Pollution Funds Center, 'Oil Liability Act (OPA) Liability Limits – Annual Report to Congress - Fiscal Year 2009' (2009) <http://www.uscg.mil/npfc/docs/PDFs/Reports/Liability_Limits_Report_2009.pdf>.

[309] Any regulated oil tanker must provide $US 100 million in liability protection. In Porter and Diamond, above n 290, 49. Further information about the certification program can be found at <http://www.uscg.mil/npfc/About_NPFC/osltf.asp>.

[310] For an overview of the structure of the fund, see National Pollution Funds Centre, *The Oil Spill Liability Trust Fund (OSLTF)* <http://www.uscg.mil/npfc/About_NPFC/osltf.asp#fund_uses>. Following the Deepwater Horizon Oil Spill in 2010 which impacted the American Gulf Coast, the Mabus report recommended that penalties from responsible parties for the oil spill should be directed to ensure the recovery of the affected region. See Ray Mabus, 'America's Gulf Coast – A Long Term Recovery Plan After the Deepwater Horizon Oil Spill' (2010) <http://www.americaswetland.com/photos/article/092810GCRPv10.pdf>. For a discussion of the implications of the Deepwater Horizon Oil Spill for environmental pollution liability and insurance law, see Kyriaki Noussia, 'Environmental Pollution Liability and Insurance Law Ramifications in Light of the Deepwater Horizon Oil Spill' (Paper presented at the 2010 Hamburg Lectures on Maritime Affairs Series, Hamburg, 27th October 2010).

[311] Water pollution can result from oil spills (regulated by the OPA) or the discharge of hazardous waste (regulated by the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA)). The latter organises its own funding mechanism through the Superfund. The NPFC administers both the Oil Spill Liability Trust Fund and the Superfund.

[312] Porter and Diamond, above n 290.

A form of collective self-insurance has been adopted by the International Oil Pollution Compensation Funds (IOPC Funds) to compensate victims of oil pollution damage caused by from spills from persistent oil from tankers.[313] This international regime is rooted in the International Convention of Civil Liability for Oil Pollution Damage 1969 (CLC).[314] As explained 'The IOPC Funds are financed by levies on certain types of oil carried by sea. The levies are paid by entities which receive oil after sea transport, and normally not by States.'[315] Under the CLC regime, ships designated by regulations have to subscribe to mandatory insurance to cover their liabilities.[316]

To mitigate land and marine pollution spills risks, similar industry-based risk pooling strategies have been proposed in British Columbia as a mandatory preliminary requirement before constructing a major oil pipeline project.[317] Voluntary risk pooling schemes are also implemented to fund environmental restoration costs.[318]

A levy system imposed on industries has been suggested as a potential international risk-pooling mechanism to improve the protection of biodiversity from invasive alien species. Such a scheme would require that developed countries contribute collectively to such a fund. This could be combined with the adoption of industry codes of conduct. [319]

Another proposed industry self-insurance scheme would require the creation of deposit reserves to protect farmers against the risk of loss of income as a result of the occurrence of an environmental hazard.[320] Such a strategy might be adapted to ensure that private

[313] See International Oil Pollution Compensation Funds, *Introduction* <http://www.iopcfund.org/intro.htm>.
[314] For a detailed overview see Simon Baughen, *Shipping Law* (Routledge-Cavendish, 4th ed, 2009) 339-347.
[315] See International Oil Pollution Compensation Funds, above n 313.
[316] For further information about how shipping law creates risk pooling mechanisms to fund marine pollution, see Baughen, above n 314, 339-347.
[317] Scott Simpson, *B.C. Sets Out Conditions for Oil Pipeline Support* (23 July 2012) Times Colonist. <http://www.timescolonist.com/touchthe/technology/story.html?id=6977866>.
[318] See Voluntary funds created following the Deepwater Horizon Oil Spill in National Park Foundation, *National Park Foundation Launches Disaster Recovery Fund* (24 May 2010) <http://www.nationalparks.org/connect/npf-news/national-park-foundation-launches-disaster-recovery-fund>.
[319] Riley, above n 25, 363-366.
[320] See Myong Goo Kang, 'Innovative Agricultural Insurance Products and Schemes' (AGS Occasional Paper 12, Food and Agriculture Organization of the United Nations, 2007) <http://www.fao.org/docrep/010/a1162e/a1162e00.htm>, 27-29.

operators have sufficient funds for environmental restoration costs, perhaps through the creation of an environmental savings account.[321]

These examples provide support for the proposal that self-insurance and similar techniques, such as risk-pooling, could be used to fund control or remediation costs of biofuels weeds invasions.

6.9.1 Risk transfer mechanisms and insurance

Risk transfer is another mechanism for financing environmental risk, including catastrophic environmental risks. It consists of transferring the financial responsibilities from the occurrence of environmental hazards onto a third–party through the use of contract (risk transfer).

Risk transfer and its relationship with risk and uncertainty has been explained by Knight as reported by Ray

> The subject of uncertainty, without bearing the risk either individually or in a group, transfers it to others who specialize in uncertainty bearing. Such transfer may usually be affected through two different processes, namely, speculation and insurance.[322]

Insurance and other financial instruments 'aim at reducing uncertainty to a measured risk by the grouping of similar uncertainty',[323] but they have different functions. Insurance products 'offer protection in case of physical loss to person or property in consideration of a small stipulated sum'[324] (premium) whereas speculative instruments are 'to cover against probable loss of value'.[325] They both use a contingent mechanism to price uncertainty.

[321] See discussion in Faure and Hartlief, above n 187, 168-172.
[322] Parimal Kumar Ray, *Agricultural Insurance: Theory and Practice and Application to Developing Countries* (Pergamon Press, 2nd ed, 1981) 17, 19 (referring to Knight in footnote 4).
[323] Ibid.
[324] Ibid.
[325] Ibid.

Risk transfer mechanisms can occur within at least four possible different legal frameworks.[326] These include (primary) insurance, reinsurance, catastrophe-linked securitisation and catastrophe-linked derivatives. This section focuses on insurance (along with pooling and actuarial pricing) because it is one of the main mechanisms proposed to address the biofuel weed risk. A latter part of this chapter discusses the three other legal mechanisms for transferring risk.

Insurance involves the transfer of risk to a third party, for a fee.[327] Environmental risks can generate statutory or common law financial liabilities. Private or public operators can protect themselves by transferring them – in exchange for the payment of a premium – through contractual arrangements onto insurers (third-party).[328] These include commercial insurers, which are the specialised professional industry of risk transfer. Liability insurance covers, for example, public liability directed to protect third-party from specific risky activities (eg pollution legal liabilities), professional liability and product liability schemes.[329] Civil liability insurance which is 'parasitic' to tort law, can protect policyholders from the costs of a negligence or strict liability tort action. It can protect them from the financial costs of clean-up, restoration/remediation and/or environment protection orders issued by regulatory authorities.[330] Civil liability insurance schemes generally require a completed or anticipated judicial decision that demonstrates proof of causality of human or economic loss.

[326] Jonathan Hill, 'REGIONAL: Development of Catastrophe Risk Insurance Mechanism' (Project number:39109, 2007) <http://www.adb.org/Documents/Reports/Consultant/39109-REG/39109-REG-TACR.pdf>, 13.

[327] Insurance is defined by the FAO as:

> A financial mechanism which aims at reducing the uncertainty of loss by pooling a large number of uncertainties so that the burden of loss is distributed. Generally each policy holder pays a contribution to a fund in the form of a premium assessed by the insurer, commensurate with the risk he introduces, which is established and administered by the insurer and out of these funds are paid the losses suffered by any of the insured.

See Food and Agricultural Organization, 'Glossary of Terms for Agricultural Insurance and Rural Finance (FAO Agricultural Services Bulletin 100, 1992)' <http://www.ruralfinance.org/fileadmin/templates/rflc/documents/1080316324693_Glossary_E.pdf>, 11.

[328] Corporations can decide to retain partly these risks while transferring a portion of them through insurance.

[329] For an overview of environmental liability products, see UNEP FI, above n 302, 16-18.

[330] More specifically on the available administrative and civil remedies available to regulatory authorities, see Bates, above n 2, 655-663.

Subject mainly to the prohibition on unlawful purposes,[331] the freedom to innovate in insurance products is great. During the 17th century underwriters 'were willing to write insurance policies against almost any kind of risk, including [...] death by gin-drinking, the death of horses, and "assurance of female chastity [...]'.[332]

One underpinning idea associated with the motivational effects of insurance for environmental protection is that firms are incentivised to better control their risks by adjusting premiums should corporate management practices be improved. Premiums are set on risk pricing techniques which can encompass environmental factors (eg type of industry, environmental management systems and risk control measures, likelihood of occurrence of the risk and its probable impacts).[333]

These techniques enable risk differentiation between groups of insured, providing an economic incentive for improvement. Through insurance, the fundamental economic problem of unpriced externalities is minimised. Through commercial competition, the potential to penalise an industry by an excess of caution is also minimised. Pricing and competition can also act as mechanisms to stimulate learning about risks and their management. Risk pricing provides an economic incentive for the industry to apply this knowledge with a precautionary mindset. A commercial insurer with an economic incentive to control a hazard can generate cost-effective risk management methods. It is in their private interest to properly understand and adequately price the risks. It is also in their interest to create effective risk-management systems and to control 'free riders' who do not manage their risks well.

Insurance products for environmental management are characterised by their heterogeneity,[334] can be combined with complementary risk financing (eg self-insurance,

[331] Criminal liability cannot be transferred onto insurers. This includes liabilities of Directors and Officers of corporations for the non-disclosure of environmental risks to their shareholders. For a discussion on assigning Directors and Officers liability, see Evan Mills, 'From Risk to Opportunity: 2007 - Insurer Responses to Climate Change' (Ceres, 2007) 13 <http://insurance.lbl.gov/opportunities/risk-to-opportunity-2007.pdf>.

[332] This is reported in Bernstein, above n 185, 90.

[333] For a brief overview of the environmental risk factors used in the differentiation of insurance risk, see UNEP FI above n 302, 7-9.

[334] For example, products include environmental liability policies, also referred to as pollution legal liability policies, coverage for on-site clean-up liability, contractors' pollution legal liability, clean-up cap policy (brownfield sites), transportation coverage, and environmental coverage for landfills. The list is not exhaustive. Some are described in Monti, above n 126, 46-47. See also ibid.

risk transfer mechanisms) and may involve to various degrees both the public and private sectors.[335]

Innovative insurance schemes to protect the environment against commercial invasive species have been proposed. An example is a proposed scheme to manage the environmental risk associated with aquatic plants.[336] However, to overcome proof of causality impediments, a no-fault insurance system based on a collective responsibility approach in which all users would contribute to a liability fund could be more effective.[337] An insurance strategy was also proposed in the Australian context to better manage the risks of introduction of invasive species.[338] Importers would subscribe to an insurance policy, 'a weed remediation insurance'[339] that would cover the costs of weed control should imported species subsequently become invasive. Under the proposed model an industry collective approach requires that each private operator along the biofuel supply chain (importers, biofuel producers etc) pay their own insurance premium to a risk pooling fund to finance weeds control costs (and/or compensate victims of weeds infestations).[340]

Insurance mechanisms have been developed to cover specific environmental risks.[341] This includes coverage for on-site cleanup liability and GMO liability risks.[342] Conservation insurance policies were explored as part of the Australian National Market-based Instruments Pilot Program, to reduce the financial risk of the adoption of

[335] Insurance institutional arrangements are discussed in James Boyd, 'Financial Responsibility for Environmental Obligations: Are Bonding and Assurance Rules Fulfilling Their Promise?' (Discusssion Paper 01-42, Resources for the Future, 2001) 19-22 <http://www.rff.org/rff/Documents/RFF-DP-01-42.pdf>. Insurance products to protect against natural disasters can be state-sponsored. See Appendix A: State-Sponsored Insurance Programs in Florida and California, in Congressional Budget Office, 'A CBO Study - Federal Resinsurance for Disasters' (2002) 34-41 <http://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/37xx/doc3787/09-20-federalreinsurance.pdf>.

[336] Meinhard Doelle, 'The Quiet Invasion: Legal and Policy Responses to Aquatic Invasive Species in North America' (2003) 18 (2) *International Journal of Marine and Coastal Law* 261, 289-290.

[337] Ibid 289.

[338] Martin, above n 119, 6, 11.

[339] Ibid, 6, 10.

[340] Ibid.

[341] They have been developed as 'remedies for dealing with expanding liability for systemic risks'. This is extensively discussed in Faure and Hartlief, above n 187.

[342] Ina Ebert and Christian Lahnstein, 'GMO Liability: Options for Insurers' in Bernhard A Koch, Economic Loss Caused by Genetically Modified Organisms – Liability and Redress for the Adventitious Presence of GMOS in Non-GM Crops (Springer, Tort and Insurance Law Yearbook, 2008) vol 24 577.

conservation farming practices.[343] To protect farmers against the financial losses associated with crop damage from climate hazards, innovative insurance products have also been developed.[344] Insurance products have been advocated against a series of financial risks associated with climate change.[345] Lloyd's of London explains that

> Business leaders are also concerned about emerging environmental liabilities, in the context of growing scrutiny of corporate environmental performance and fears about the impact of climate change and industrial pollution.[346]

A report by Ceres[347] gives an overview of innovative insurance products developed by the industry and research on 'green insurance products'.[348]

6.10 Limitations of potential insurability

A fundamental condition for environmental risks to be covered by insurance is that they fulfill insurability criteria.[349] This is influenced by 'two general factors':

> …general uncertainty, which largely depends on the legal framework and informational asymmetries, which may lead to moral hazard and adverse selection problems.[350]

[343] Econsearch, 'Adoption of New Land Management Practices through Conservation Insurance' (Final Report, National Action Plan for Salinity and Water Quality, 2006) <http://www.napswq.gov.au/publications/books/mbi/round1-project8.html>.
[344] Kang, above n 320.
[345] For example, insurance products have been advocated to cover against the financial risk associated with the trading of carbon permits on domestic and international markets (*Kyoto Protocol*). They have the potential to cover corporations against liabilities that might arise from a range of carbon-related issues, such as the uncertainty derived from carbon capture and storage technologies (a technological performance risk), or contract performance in the carbon offset market (in case the carbon credits are not delivered). For a discussion of insurance mechanisms within the climate change debate, see for example Christoph Bals, Koko Warner and Sonja Butzengeiger, 'Insuring the Uninsurable: Design Options for a Climate Change Funding Mechanism' (2006) 6(6) *Climate Policy* 637.
[346] Mills, above n 331.
[347] Ibid.
[348] For example, to integrate climate change into land-use planning, the Insurance Australia Group (IAG) is reported to have developed, in 2004, 'a partnership with local government planners in New Zealand to determine the most appropriate flood planning levels for the future' and observed that 'insurers are not adequately included in the broader public policy discussion about hazard management'. In Mills, ibid,10; AIG Risk Finance insurance company has created a carbon credit delivery risks insurance product. See AIG Risk Finance, *Conceptual for Carbon Credit Delivery Insurance* <http://www.aig.com/aigweb/internet/en/files/mkt_RF_Carbon%20Credit%20Trading%209-13-07_tcm20-6913.pdf>
[349] The problem of insurability of systemic environmental risks is addressed in Faure and Hartlief, above n 187, 81.

6.10.1 Institution pre-requisites

A 2006 survey on behalf of the United Nations Environment Program identified a number of insurance issues for renewable energy projects.[351] However there are institutional challenges to be overcome (some of them are developed in Chapter 7). Statistical methods for pricing risk depend upon having reliable data. Limited historical data restricts insurers' capacity to 'accurately model future loss projections and price risk in an economic and sustainable manner'.[352]

Institutional barriers to insurance mechanisms include regulatory and legal limitations, pricing issues, demand for insurance and the capacity to provide sufficient risk transfer.[353] Legal uncertainties from under-developed liability regimes are also a potential inhibitor to effective insurance.[354]

The problem of insurability is acute for catastrophic environmental risks, such as floods, earthquakes and possibly weeds infestations. These require considerable funds to cover the resulting financial losses. The insurance market has developed creative solutions, notably, reinsurance.[355]

> [R]einsurance is [...] insurance for insurers. Reinsurance allows direct insurers [as primary risk carriers] to free themselves from the part of the risk that exceeds their

[350] Monti, above n 126, 13. For a discussion of insurability within the agricultural context, see Ray, above n 325, 20-27.

[351] This study was not concerned with the environmental risks from bio-fuel projects. Its focus was the potential for insurances to reduce financing impediments for bio-energy projects. See Marsh, 'Survey of Insurance Availability for Renewable Energy Projects - United Nations Environment Programme' (2006) <http://www.sefi.unep.org/fileadmin/media/sefi/docs/industry_reports/Marsh_Risk.pdf>.

[352] Ibid, 12.

[353] SEFI, 'Scoping Study on Financial Risk Management Instruments for Renewable Energy Projects - United Nations Environment Programme' (UNEP, 2004) <http://sefi.unep.org/fileadmin/media/sefi /docs/publications/RiskMgt_full.pdf>.

[354] Within the US context, the 'insurance crisis' of the mid-1980s has been considered by some as a result of the expansion of liability laws. This is reported in Faure and Hartlief, above n 187, 22. See also George L Priest, 'The Current Insurance Crisis and Modern Tort Law' (1987) 96(7) *The Yale Law Journal* 1521.

[355] The use of reinsurance rearrangements is particularly useful to protect insurance companies from catastrophic events, such as natural disasters. Reinsurance enables risk sharing mechanisms between direct insurers and reinsurers. Whilst the formers remain fully liable to policyholders under the policy contract, reinsurers are fully liable to direct insurers under reinsurance arrangements. See Swiss Re, *An Introduction to Reinsurance* <http://info.worldbank.org/etools/docs/library/83665/intro_reinsurance.pdf>.

> underwriting capacity, or risks which, for one reason or another, they do not wish to bear alone'.[356]

In turn, primary risk carriers (direct insurers) can transfer the risks they have accepted from policyholders through contractual arrangements onto reinsurance companies (second insurance carriers).

6.11 Risk sharing agreements

Faure and Skogh propose risk sharing agreements between nuclear plant owners through an international convention to cover against the risks of nuclear accident. Financial contributions from nuclear plant owners could be pooled into a collective guarantee funds[357] to cover third-party liability.

6.12 Environmental performance bonds

Financial responsibility mechanisms (FRMs)[358] 'require potential polluters to demonstrate – before the fact – financial resources adequate to correct and compensate for environmental damage that may arise in the future'.[359] This category includes insurance arrangements, risk pooling mechanisms and environmental performance bonds. Within the Australian context, FRMs are imposed to create a funds base to restore contaminated lands.[360] The first two types of FRMs to ensure sufficient funds have already been discussed. This section discusses the potential role of environmental performance bonds for environmental protection.

Environmental performance bonds are traditional financial guarantees (cash or bank guarantees) which are used to create a risk control and rehabilitation fund for potential harm from natural resource use projects such as mining[361] and fisheries.[362] They can also

[356] Ibid, 12. Reinsurance can be ensured by private reinsurers as well as the public sector. Under its constitutional special financial power, the Commonwealth could therefore act as a reinsurer.
[357] See discussion in Faure and Hartlief, above n 187. See also Michael G Faure and Göran Skogh, *The Economic Analysis of Environmental Policy and Law: An Introduction* (Edward Elgar, 2003) 273-276.
[358] FRMs can be classified into three categories: penalties, fees and assurance. See Porter and Diamond, above n 290, 38. As the concern is risk instruments, the focus is upon assurance.
[359] Boyd, above n 335, 1.
[360] For an overview, see Bates and Lipman, above n 292, 237-284.
[361] For example, in Queensland, mining bonds are regulated under the *Environmental Protection Act 1994* (QLD) ss 364-367.

be used by local government for the protection of iconic features on development sites (eg Great Barrier Reef).[363] The amount requested is contingently priced to internalise the uncertainty and potential cost attached to the level of the achieved restoration of the impacted site.[364] The pricing challenge consists partly in determining a conjectured value of the future uncertain harm.

Notwithstanding the apparent simplicity of bonds, there are significant difficulties. The level of the bond needs to be sufficient to 'sink' the net cost of control and remediation for unknown events at some indeterminate time.[365] The total fund is the aggregate of bonds from different operators, providing a pool of resources to manage risks that may arise (provided that the structure allows for pooled responses). It may be difficult to set a fair level of bond for later entrants, as their bond will reflect the established pool and changes to the understanding of (and methods for controlling) risk. These challenges can be minimised if the bond values are regularly risk-adjusted.[366]

[362] See *Fisheries Management Act 1994* (NSW) s 152 (2) (d) which regulates the process of aquaculture permits allocation.

[363] Debbie Brown and Lal Padma (1996) 'Using Performance Bonds as an Environment Management Tool: The Great Barrier Reef Marine Park Authority's Experience' (1996) 3 (2) *Australian Journal of Environmental Management* 86.

[364] As illustrated by Robert Costanza and Charles Perrings, 'A Flexible Assurance Bonding System for Improved Environmental Management' (1990) 2(1) *Ecological Economics* 57, 67:

> …[T]he rationale for the recommended basis [of this instrument] lies in the Knightian uncertainty that comes with incomplete information. Wherever the range and probability distribution of the future effects of present actions are not known, it is not possible to calculate an expected value for the outcome of those actions. Nor is it possible to calculate the risk of any one of a suspected number of outcomes. … The size of the bond would depend on the conjectured value of the worst case losses…

[365] Environmental performance bonds are arguably better suited to situations where the contingent cost can be reliably assessed. See Boyd, above n 335, 19-20. For a discussion on the problem of bond underpricing within the US mining industry, see Ibid, 42-44. The efficiency of environmental performance bonds (including the level of bond and environmental costs) is also discussed in Brown and Lal, above n 363.

[366] For example, *Environmental Protection Act 1994* (QLD) s 312P confers the Environmental Protection Agency (EPA) the power to 'require financial insurance if not previously required or to require a change to financial assurance' for mining projects. The calculation of financial assurance is addressed in the Code of Environmental Compliance for Exploration and Mineral Development Projects (QLD) and explained in Queensland Government and Environmental Protection Agency, *Ecoaccess - Environmental Management for Mining Activities - Financial Assurance for Mining Activities - Guideline 17* <http://www.epa.qld.gov.au/register/p00447aa.pdf>.

Moral hazard may be an issue if the bond-holder arbitrarily retains or expends the bond.[367] An onerous cash or bank financial guarantee might cause liquidity problems to the industry required to pay, making bond valuation a matter of potential concern for the industry.

In an analogy of the potential use of bonds against weeds spread, Doelle has proposed the lodging of performance bonds by purchasers of aquarium specimens.[368]

6.13 Additional risk issues

In the first part of this chapter the discussion has focused upon matters relevant directly to the model which was presented and expanded in Chapter 5. However, this is not the full extent of relevant risk concepts which could inform natural resource governance.

Whilst the concepts outlined in the balance of this chapter are not directly reflected in the model that is evaluated in Part 3, they are relevant to the broader development of risk instruments that might improve natural resource governance.

6.13.1 Reinsurance

Reinsurance has already been briefly discussed. There are examples of public-private partnerships whereby governments act as ultimate reinsurers.[369] Major financial losses associated with fire hazards in Europe in the 19th century and the San Francisco earthquake of 1906 has triggered, for example, the creation of *Swiss Re*, one of the main reinsurance companies worldwide.[370]

The emergence of new systemic risks with catastrophic consequences, such as 11th of September and weather extreme events (hurricane Kathrina, Queensland floods, Japanese earthquake...) jeopardise insurers and reinsurers' underwriting capacity to cover these risks.

[367] These limits (moral hazard, liquidity constraints and imperfect contractual enforcements) are developed in Jason F Shogren, Joseph A Herriges and Ramu Govindasamy, 'Limits to Environmental Bonds' (1993) 8(2) *Ecological Economics* 109, 114-119.
[368] Doelle, above n 336, 290.
[369] For an overview of possible private-public partnerships for disaster management, see Monti, above n 126, 69-80. See also Congressional Budget Office, above n 338.
[370] See Swiss Re, above n 355, 8.

> 'In the recent years, [...], the threat of a mega-disaster striking a major inhabited area has dramatically altered the insurance environment. Today many insurers and reinsurers indicate that they cannot continue to provide the same level of coverage against hurricanes, floods and earthquakes, without incurring an excessive risk of insolvency or substantial losses of capital or surplus.'[371]

Innovative alternative risk transfer to insurance mechanisms using a variety of new financial instruments have been developed to transfer and spread these risks onto financial markets and raise more capital from private and institutional investors. Insurance policyholders, insurers, reinsurers and capital markets entertain complex relationships[372] through a highly complex chain of contractual and financial arrangements.

6.13.2 Alternative Risk Transfer to Insurance ('ART')

The limits of traditional reinsurance have stimulated the creation by the finance and risk industry of a series of innovative finance market techniques to deal with environmental problems. These occur on the 'ART market'.[373] These new tools have contributed to blur the traditional distinction between insurance and financial products, thus creating a convergence between the insurance and financial sectors.[374] These techniques contribute

[371] See Monti, above n 126, 68.

[372] For an overview of how these different actors are interrelated in the financial management of catastrophic risks, see David Lalonde, 'Risk Financing' in Patricia Grossi and Howard Kunreuther (eds), *Catastrophe Modeling: A New Approach to Managing Risk*, Huebner International Series on Risk, Insurance and Economic Security (Springer, 2006) 135, 142.

[373] '[t]he ART market is the combined risk management marketplace for innovative insurance and capital market solutions, while ART is a product, channel or solution that transfers risk exposures between the insurance and capital markets to achieve stated risk management goals'. In Banks, above n 220, 49-60. For a classification of ART, see Figure 3.1 'Categories of ART', ibid 50. For a historical background, see ibid 51-52. See also Culp, above n 301.

[374] On the question of transferring risk from the insurance industry to the capital markets, see Sonia Labatt, *Environmental Finance: A Guide to Environmental Risk Assessment and Financial Products* (John Wiley & Sons, 2002) 103, 130-137. For a visual representation of the convergence between insurance/financial techniques, see Figure 3.2 'General insurance/financial convergence' in Banks, ibid 58, where the author also explains that

> 'The ART marketplace and its products and solutions are considered 'alternative' because they pierce the boundaries of conventional risk management concepts and techniques (e.g., pure insurance, reinsurance, derivatives), calling on diverse financial engineering mechanisms from a number of different sectors and drawing in capital from a broad range of sources. This leads to greater customization, flexibility, and cross-sector integration. Indeed, one of the most noticeable aspects of the ART market is the degree to which once – distinct markets have been drawn together […]. Convergence which we have already noted in a cross-sector fusion where insurers and financial institutions participate in each other's markets is well underway. While the insurance, reinsurance and financial markets were once very separate – with individual institutions performing well-defined functions within very strict, and clearly defined, boundaries – this is no

to diversify the new field of environmental finance or eco-finance,[375] defined as 'encompassing all market-based instruments designed to deliver environmental quality and to transfer environmental risks'.[376]

These new financial instruments are embedded in complex institutional arrangements associated with financial engineering techniques, corporate, contract and tax law. These involve a high degree of expertise from a wide range of actors. Although is it is beyond the scope of this thesis to detail them, the goal of this subsection is to provide the context in which they evolve in order to understand the key mechanisms involved to manage environmental risks and achieve environmental protection through the protection of private interests.

Financial markets encompass activities[377] where public and private institutions can issue securities on the primary market to the public to raise more funds as part of a risk transfer and loss financing strategy.[378] A wide range of financial instruments, including securities and derivatives (discussed later) can then be traded between market participants as buyers and sellers on the secondary market. As opposed to transactions occurring on the primary market, secondary market transactions do not contribute to raise capital but they enable buyers and sellers to trade various financial instruments as part of risk transfer and investment strategies. Endorsing a new role in the governance of environmental risks, institutional investors can, in fact, accept new risks by purchasing these instruments and pursue their self-interest by diversifying their portfolio investment and consequently reduce their investment risk. The following section discusses new financial techniques for environmental management occurring in the primary market. The next section concentrates on those occurring in the secondary market. The key idea underpinning these innovative tools is to provide sufficient risk transfer capacity to fund significant

longer true, primarily as a result of the regulatory and competitive forces we have mentioned in the previous chapter.'

[375] See Paul AU Ali and Kanako Yano (eds), *Eco-Finance: The Legal Design and Regulation of Market-based Environmental Instruments*, International Environmental Law and Policy Series (Kluwer Law International, 2004). See also Jerry R Skees, 'Opportunities for Improved Efficiency in Risk Sharing Using Capital Markets' (1999) 81(5) *American Journal of Agricultural Economics* 1228.

[376] Labatt and White, above n 374. The definition of environmental finance can be found at page 1.

[377] For a distinction between the concept of 'markets' and 'marketplaces', see Williams, above n 279, 73-74.

[378] Alternatively, borrowing and issuing debt are alternative strategies to generate funds internally. See Lalonde, above n 372, 135, 142.

losses from catastrophic events. Arguably, these mechanisms could be used to fund environmental restoration costs from catastrophic environmental hazards (including biological invasions from weeds).

6.14 Catastrophic risk securitisation on capital markets

The securitisation of catastrophic risks (catastrophic risk securitisation),[379] such as hurricanes, windstorms and earthquakes through the creation of insurance-linked securities (ILS) in the 1990s is a financial innovation which is directed to manage insurance risks. For example, catastrophe bonds ('Cat bonds') have been issued by insurers and reinsurers to raise capital and transfer their risks onto investors. Since then, this technique has extended to cover insurers' risk exposure from non-catastrophic events, such as weather events (eg temperature), also referred to as 'weather securitisation'. Their conditions of operation can be triggered by different elements/events (indemnity, index, parametric triggers). Figure 6.3, adapted from Banks, represents the different categories of insurance-linked securities relevant to environmental risks.[380] These instruments involve complex payment structures which are beyond the scope of this research to detail. [381]

[379] Technically, securitisation is

> 'the transformation of illiquid financial assets into tradable instruments. Securitization has been one of the most important developments in the period from the early 1970s to the present, and has created new markets, provided new financing opportunities for a number of different entities, provided liquidity for previously illiquid assets, lowered the overall costs of many financial services, and/or provided a mechanism to lower or transfer risk from those who wish to avoid risk to those willing to accept risk in exchange for profits'.

In Williams, above n 279, 154.

[380] Banks, above n 220, 120.

[381] The following references provide further details on the securitisation process: Banks, ibid 115. For a representation of a typical securitisation structure, see Figure 7-4 'Typical securitization structure' in Lalonde, above n 372, 146. See also Howard Kunreuther, Paul Kleindorfer and Patricia Grossi, 'The Impacts of Risk Transfer Instruments: An Analysis of Model Cities' in Patricia Grossi and Howard Kunreuther (eds), *Catastrophe Modeling: A New Approach to Managing Risk*, Huebner International Series on Risk, Insurance and Economic Security (Springer, 2006) 189, 197-205. A catastrophe bond payment structure is represented in Labatt and White, above n 374, 273.

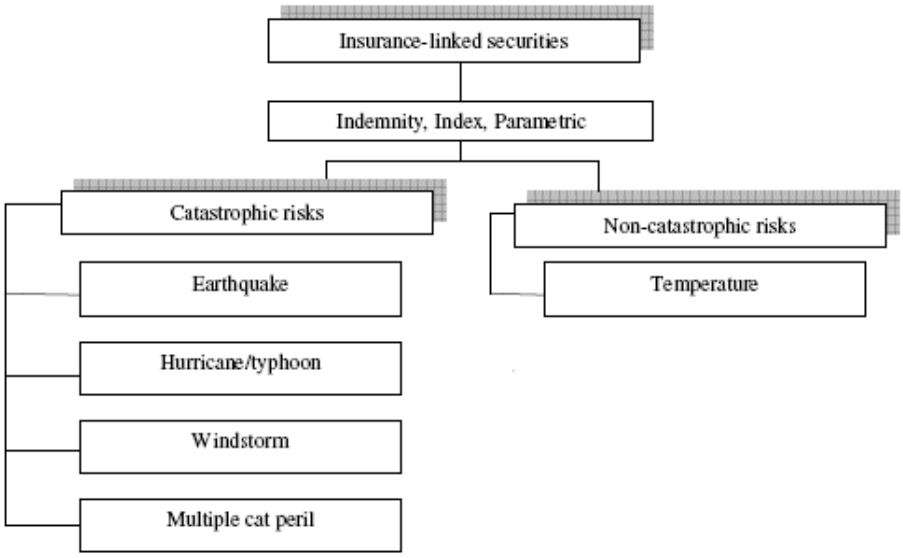

Figure 6.3: Universe of insurance-linked securities[382]

Beyond risk securitisation techniques, other financial techniques have been suggested to cover against catastrophic risk, such as nuclear accident. Tyron and Zweifel suggest that:

> [P]lant operators should be permitted to take risk-participation shares on capital markets. Investors would have the opportunity of buying such a share against deposit of financial assets, creating a warrant in favour of the plant of their choice… The idea behind [their ERICAM system] is that the interest rate of the bonds issued reflects the accident rate.'[383]

As expressed by the OECD, on the financial market 'investors could purchase 'risk bonds' and stock prices would reflect investors' perceptions concerning the riskiness of the activity'.[384] As a result, the pricing of the uncertainty due to the existence of environmental risks would fluctuate accordingly. Under such a system, these instruments would first be created on the primary market and then traded on the secondary market.

[382] Banks, above n 220, 120.
[383] Faure and Hartlief, above n 187, 141, 143.
[384] Ibid 172.

6.15 Hedging environmental risks on derivatives markets

Another risk transfer technique – which occurs on secondary markets – can protect against market price fluctuation due to the occurrence of environmental risk. This was previously illustrated with derivatives contracts whereby private operators can transfer their financial risks by hedging them on agricultural commodities market. These financial contracts derive their existence and value from pre-existing assets (eg commodities, securities, financial instrument). Whilst they can be standardised contracts, in which case they are referred to as 'exchange-traded derivatives,' they can also be non-standardised agreements (over-the-counter derivatives). As represented in Figure 6.4, 'general classes of derivatives',[385] these contracts encompass futures, forwards and options. The diagram has been adapted to include examples of catastrophe and non-catastrophic-linked derivatives associated with environmental risks.

These contracts can internalise risk and uncertain events by organising specific price transfer mechanisms:

> Transfer contracts may be drawn up with immediate effect or may only enter into force after a certain period of time. They may be firm contracts, whose conditions have all been drawn up in advance, or simply **contingent contracts** in which some variables such as the transfer price will depend upon certain events taking place in the future under certain conditions specified beforehand. They may also consist of options. For example, the purchaser may secure an option to carry out the agreed transfer at a given date, in which case the vendor is obliged to comply, but conserves the opposite option not to carry out the transfer, to which the vendor gives his agreement in advance.[386]

[385] From Banks, above n 220, 151.
[386] In Olivier Godard, *Domestic Transferable Permits for Environmental Management - Design and Implementation* (OECD, 2001) 23, 45.

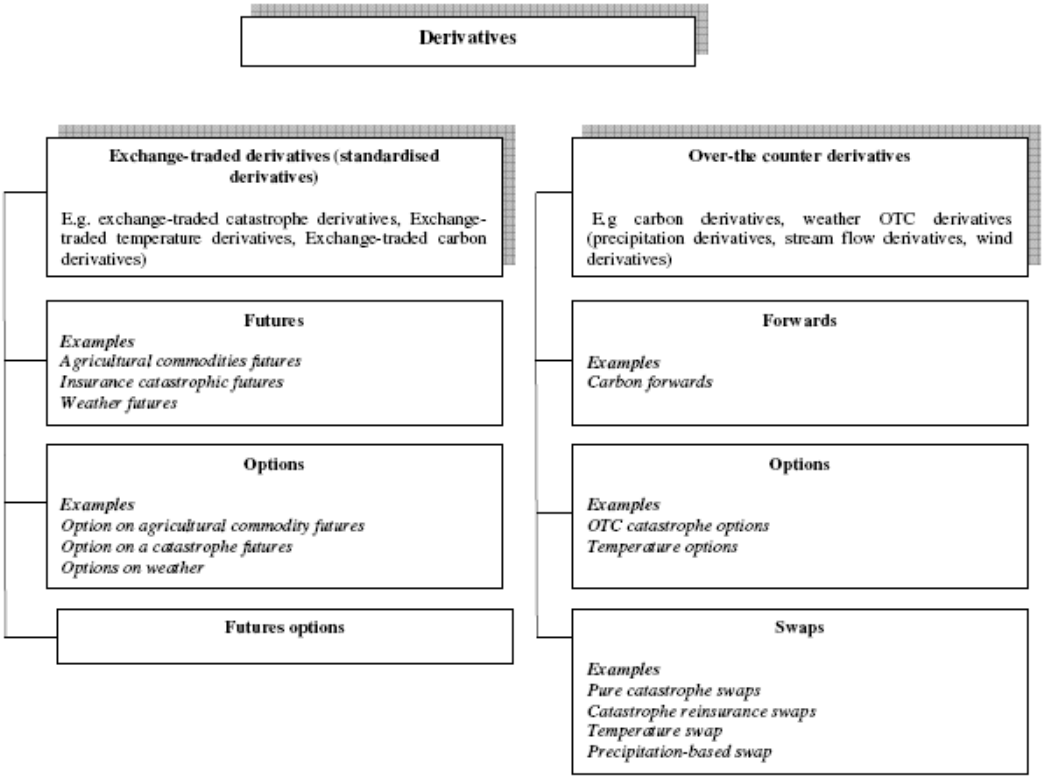

Figure 6.4: General classes of derivatives[387]

The definition of futures, forwards, options and swaps, which are the main forms of derivatives, is given below.

A future is a 'legally binding agreement to buy or sell a security, commodity or financial instrument at a fixed price on a specified date in the future'.[388] By trading futures, companies can hedge their risks by locking in the price of the commodities they produce and/or the assets they own. In turn, investors can speculate by trying to make a profit from market price fluctuations. As for forward contract, it is a 'bilateral legally enforceable contract for the purchase or sale of a defined quantity of a given asset, currency, commodity, deposit, product, or security at a fixed price at a date in the

[387] From Banks, above n 220, 151.
[388] .Australian Securities Exchange, *Futures* <http://www.asx.com.au/glossary/items/futures_futures_contract.htm>.

future.'[389] An option is 'a contract between two parties giving the taker (buyer) the right, but not the obligation, to buy or sell a pre-existing underlying asset at a particular price on or before a particular date'.[390] Finally a swap is defined as 'a financial derivative in which two counter-parties agree to exchange one stream of cash flows for another stream'.[391] These techniques can be combined with environmental rights-based/permits based markets in which legally artificially tradable proprietary defined legal interest are created.[392] This is discussed in the following section where drawing upon the concept of risk and market-based mechanisms for environmental protection, the role of tradable permits/rights-based schemes for environmental management is explored.

6.16 Tradable permits/rights-based mechanisms and risk techniques

Environmental rights market instruments are managerial schemes that implement instruments to control access to natural resources or pollution emissions by using rights, obligations or permits.[393] For example, the goal of rights-based management tools in water trading and fisheries is to control the amount of natural resources abstracted. In pollution control, the purpose is to constrain pollutants. These rights/permits-based schemes offer different flexibility formulas (including time flexibility) and rank from 'measures to ease conventional administrative regulatory regimes to the organisation of a

[389] This definition in given in Peter Moles and Nicholas Terry, *Forward Contract -The Handbook of International Financial Terms (Oxford Reference Online)* Oxford University Press <http://www.oxfordreference.com/views/ENTRY.html?subview=Main&entry=t181.e3262>.

[390] Australian Securities Exchange, *Option* <http://www.asx.com.au/glossary/items/option.htm>.

[391] John Black, Nigar Hashimzade and Gareth Myles, *Swap - A Dictionary of Economics* (Oxford University Press - Oxford Reference Online) <http://www.oxfordreference.com/views/ENTRY.html?subview=Main&entry=t19.e3044>.

[392] For further information about these techniques, see the following references: For detailed information about weather derivatives, see Erik Banks (ed), *Weather Risk Management - Market, Products and Applications* (Palgrave MacMillan, 2001). See also Miriam Joy East, *Potential of Weather Derivatives as a Risk Management Tool for Australian Wheat Farmers* (PhD Thesis, University of New England, 2007) <https://e-publications.une.edu.au/vital/access/manager/Repository/une:2482>; Olivier Roustant, *Produits dérivés climatiques: aspects économétriques et financiers* (PhD Thesis, Université Claude Bernard - Lyon I, 2003) <http://www.emse.fr/~roustant/Documents/these.pdf>.

[393] This definition is inspired from Godard, above n 386, 7. In the introductory chapter of this report, the author traces the historical roots of the mechanism of transfer of permits or quotas applicable to air and water pollution markets (see page 11). The creation of conservation and biodiversity banking markets is reported in Ricardo Bayon et al, 'Introduction' in Ricardo Bayon, Nathaniel Carroll and Jessica Fox (eds), *Conservation and Biodiversity Banking - A Guide to Setting Up and Running Biodiversity Credit Trading Systems* (Eathscan, 2008) 3, 6-7. See also Mead, above n 223, 9-31. For a brief historical overview of the emergence of the carbon credit market in New South Wales, refer to James Shields, 'Australia's Biodiversity Credits' in Nathaniel Carroll and Jessica Fox (eds), *Conservation and Biodiversity Banking - A Guide to Setting Up and Running Biodiversity Credit Trading Systems* (Eathscan, 2008) 205-211.

competitive and open markets for tradeable permits/rights'.[394] Practically, the use of permits/rights can be imposed upon private operators in the following fields (among others):

- Pollution control (transferable emission regimes);
- Resource abstraction matters, including water supply and fisheries; and
- Land use planning (transferable development rights). [395]

They combine two elements:

> [The] setting of quantified physical constraints in the form of obligations, permits or rights [volume of water available, volume of fish that can be caught, threshold of a certain type of pollutants admissible…]… allocated to target-groups… [and]
>
> [T]he authorization of such target-groups, under certain conditions specified by an administrative authority, to transfer these obligations, permits or rights either from one activity to other activities controlled by the same agent, from one time period to another, from one geographical area to another, or from the agent in question to other economic agents; these various options can in turn be combined in different ways.[396]

These schemes are underpinned by statutory licence systems which confer upon licence holders a form of limited property right[397] over the right to take water or fish or emit pollution. To incentivise licence holders to use, in a sustainable way, the natural resources they have access to or to carry out their activities with established pollution thresholds, legislative and regulatory instruments can create a legally defined tradable proprietary interest in order to develop a market through contractual arrangements.[398] A certain amount of permits/rights is allocated to natural resource users/potential polluters. This artificially creates scarcity over entitlements which are priced. These can then be traded by private operators in the marketplace. Economic models argue that these schemes incentivise market participants to use these permits/rights in a cost-effective

[394] Godard, above n 285, 7-9.
[395] For example, the use of market-based instruments is advocated to manage the risk of flood control in the United Kingdom in UK Environment Agency, 'The Potential Role of Market-based Instruments in the Economic Optimisation of Investment in Flood Risk Management (Report Executive Summary)' (2007) <http://www.environment-agency.gov.uk/static/documents/Research/tfpsreportexecsum_1775995.pdf>.
[396] Godard, above n 386, 7-9.
[397] See Bates, above n 2, 176-177.
[398] Environmental rights-based markets are often described as 'artificial markets' as opposed to 'real' markets where commodities are exchanged and traded.

way, use natural resources more efficiently and encourage them to invest in risk-reduction technologies.

More specifically, a theoretical model for the development of a tradable risk-based bio-pollution permit scheme has been proposed to address the invasive risk.[399] Transferable risk-based development rights to be traded between landowners and commercial developers is another possible conceptual strategy[400] to address biological pollutions from invasive species.

Tradable permits/rights systems can also incorporate the concept of risk and uncertainty in various ways, and the method used to define and allocate transferable units within a permits/rights system impacts upon the possibility of creating a risk instrument applicable to the commercial sector.

Theoretical proposals and existing risk-based instruments include the incorporation of risk transfer mechanisms such as insurance and derivatives as discussed earlier. This is illustrated with the two following examples. The Example 1 concerns tradable water entitlements directed to manage the environmental risk associated with water scarcity. The Example 2 relates to carbon pollution.

Example 1: Incorporating risk transfer mechanisms within water trading schemes to manage water scarcity

In water trading schemes, water entitlements can be defined in absolute terms (fixed volume allocations) or in relative terms, as shares (percentage of the water natural resource). The second method takes into consideration the uncertain variations of hydrological realities which depend upon climatic conditions (drought or flooding).

An identified environmental risk associated with water entitlements is drought. A possible risk instrument would internalise the uncertainty of water entitlements directly dependent on weather. This may be done by setting prices for a percentage of flow

[399] Richard D Horan and Frank Lupi, 'Tradeable Risk Permits to Prevent Future Introductions of Invasive Alien Species into the Great Lake' (2005) 52(3) *Ecological Economics* 289.

[400] For an explanation of environmental development rights markets, see Margaret Walls and Virginia McConnell, 'Incentive-Based Land Use Policies and Water Quality in the Chesapeake Bay' (Resources for the Future, 2004) <http://www.rff.org/RFF/Documents/RFF-DP-04-20.pdf>. However, this article, and more generally the literature on tradable development rights, does not explain how these markets can internalise commercial risk-based techniques.

variably with the actual volumes delivered (possibly against a notional "maximum" volume). For example, the buyer price might be x% of an agreed maximum should actual volume fall by y% from a target volume.

For natural resources abstraction, three levels of incorporation of risk are possible:

- The right to use the resource is volumetrically defined with a fixed price per unit. This is how most of the domestic transferable environmental rights market-based instruments traditionally work. This is a limited risk approach. It does not take into consideration possible variations of the available amount of the natural resource.
- The right to use the natural resource is defined as a share: a certain percentage of the available natural resource. The price for this percentage (unit/share price) is fixed. This is an approach that takes into consideration a higher degree of risk and uncertainty than the previous option. The volume to be allocated depends on total variable volume of the natural resource available. This is the basis of Australian agricultural water markets.
- In the third case scenario, a certain percentage of the natural resource is defined over a total variable volume (same as in the previous option), but the price for the unit/share varies with the actual volumes delivered. This incorporates risk to a higher degree than the two previous case scenarios.

As a result, within water trading schemes where entitlements are defined and allocated in relative terms (shares), insurance mechanisms could cover water users against the potential reduced availability of water due to climate-induced environmental risks and thus improve drought planning.[401]

These water entitlements become financial assets to which derivatives techniques, as discussed earlier, could be applied. Natural resource users could decide to hedge the risks of price fluctuations entitlements associated with drought events by entering into contractual arrangements, such as futures, forwards, options and swaps with investors and/ or other natural resource users.

Example one demonstrates, that environmental rights-based and financial markets can have – to a certain extent – common features. The reformulation of environmental rights-based markets in terms of risk and uncertainty reinforce the idea that a variety of financial techniques can also be applied to these artificial markets. As illustrated with the

[401] Martin (Personal communication); See also Alberto Garrido and Gómez-Ramos, 'Risk Management Instruments Supporting Drought Planning and Policy' in A Iglesias et al (eds), *Coping with Drought Risk in Agriculture and Water Supply Systems* (Springer Netherlands, 2009) vol 26, 133.

following example, insurance and derivative techniques can also applied to carbon emissions permits.

Example 2: Environmental permit-based markets and risk transfer mechanisms to manage carbon pollution

Under a cap-and-trade system, regulatory authorities predetermine a certain amount of pollution that potential polluters can emit or discharge. A certain number of carbon permits are then issued on the primary market by the relevant authorities and are allocated for free or auctioned to potential polluters. These materialise a certain amount of 'rights to pollute'. These permits are then traded between polluters on the secondary market. These 'rights to pollute', which in fact become a financial asset, are subject, as any other commodity, to market price fluctuations due to uncertain events. These can be hedged by locking the permit prices through contractual-based financial techniques such as forward contract, futures and options in order to organise their transfer with immediate or delayed effects.[402]

These financial contracts can be considered as a way to internalise, through the pricing mechanism, uncertainty factors associated with environmental risks. In these mechanisms, a risk-based instrument, such as a derivative, is here created upon a pre-existing environmental permits-based market. Other complex proposals using swaps have

[402] This is explained in detail by the OECD

> 'Transfer contracts may be drawn up with immediate effect or may only enter into force after a certain period of time. They may be firm contracts, whose conditions have all been drawn up in advance, or simply **contingent contracts** in which some variables such as the transfer price will depend upon certain events taking place in the future under certain conditions specified beforehand. They may also consist of options. For example, the purchaser may secure an option to carry out the agreed transfer at a given date, in which case the vendor is obliged to comply, but conserves the opposite option not to carry out the transfer, to which the vendor gives his agreement in advance.'

In Godard, above n 386, 45.

> As with all other shares and assets, TPs [transferable permits] can *a priori* be traded in transactions with immediate or delayed effect. By determining prices and volumes *ex ante*, forward transactions have the major advantage of offering different securities to agents who wish to preserve good operating conditions for their plant or meet in advance the conditions for new projects. This allows these agents to protect themselves against the possible use of market power in the future. Naturally, by authorizing speculative transfers, forward transactions and options markets also generate a systemic risk which may have a feedback effect on the operation of the market, as in other markets of this type.'

In Godard, ibid, 46.

been suggested for energy companies to hedge their carbon emission risks within a carbon pollution cap-and-trade scheme.[403]

In the EU Emissions Trading Scheme (EU-ETS), the trading of derivatives on the secondary market is estimated to represent 95 per cent of the total volume traded.[404] Within the Australian context, the Australian Securities Exchange (ASX) has mentioned the role of a futures market for carbon emission permits trading.[405]

Likewise insurance products can be combined with environmental pollution-based schemes as mentioned earlier.

Insurance products are advocated to cover against the financial risk associated with the trading of carbon permits on domestic and international markets (*Kyoto Protocol*).[406] They also have the potential to cover corporations against possible liabilities that might arise from a wide range of carbon-related issues, such as the uncertainty derived from carbon capture and storage technologies (a technological performance risk), or contract performance in the carbon offset market (in case the carbon credits are not delivered). For instance, the AIG Risk Finance insurance company has created a specific carbon credit delivery risks insurance product.[407]

However, as previously mentioned, regulations are needed to regulate these speculative instruments against excessive risk taking and potential resulting risks of subprime carbon crisis,[408] and to provide the secure institutional bases for markets to operate efficiently.

[403] See J Weinstein, *Carbon-denominated Weather Swaps* (2009) <http://scholar.googleusercontent.com/scholar?q=cache:-N7KwQf81-EJ:scholar.google.com/+Carbon-denominated+Weather+Swaps&hl=fr&as_sdt=0,5>.
[404] In David Hodgkinson and Renee Garner, 'Emissions Trading and Carbon Markets' in *Global Climate Change - Australian Law and Policy* (LexisNexis Butterworths Australia, 2008) 239, 337 with references in footnotes 391 and 392.
[405] Anthony Collins, *The Changing Climate in Financial Markets: The Role of Financial Markets in Emissions Trading* (2009) Australian Securities Exchange <http://www.asx.com.au/products/pdf/20080416_role_of_financial_markets_in_emissions_trading.pdf>.
[406] Mills, above n 331, 20.
[407] AIG Risk Finance, above n 348.
[408] Michelle Chan, 'Subprime Carbon? Re-thinking the World's Largest New Derivatives Market' (Friends of the Earth, 2009) <http://libcloud.s3.amazonaws.com/93/77/4/452/SubprimeCarbonReport.pdf>.

6.17 The potential of green investment indexes

The importance of corporate socially responsible (CSR) investment in financial markets, also referred to as SRI, is illustrated by the following figures.[409] In Europe, Core SRI represented €1.2 trillion and Broad SRI €3.8 trillion at the end of 2009.[410] In the US, total assets under SRI-related management strategies represented $3.07 trillion at the beginning of 2010.[411]

For Australia and New Zealand

> Core responsible investment (including managed responsible investment portfolios, community finance, responsible investment portfolios of charities and client portfolios of financial advisers) rose 8% in 2010-11 from $18.12 billion (re-stated) to $19.55 billion.
>
> Managed responsible investment portfolios alone rose by 7% from $15.41 billion to $16.52 billion – an increase of $1.1 billion. The increase in responsible investment portfolios fared better than the broader market with total assets under management of all types of managed portfolios rising 1.8% in that same period.[412]

SRI investment organisations provide public good performance information to institutional and individual investors, in the form of investment evaluations, or by having public good threshold or selection criteria for investees.

Sustainable bio-fuels have been a priority target for 'green investment' funds. These investors are often concerned about the social and environmental risk associated with the sector. Improving their capacity to select least risk-investment can create private market incentives to reduce those risks. The potential for bio-fuel sustainability risk to be relevant to investors is illustrated by the Bache Commodity Green Index^{SM} (BCGI^{SM}) developed by the Bache Commodities Group, which is a global commodities and

[409] Note that accounting standards, definitions and methodologies vary widely between jurisdictions, so comparability is a potential problem.
[410] Eurosif, 'European SRI Study' (2010) <http://www.eurosif.org/images/stories/pdf/Research/Eurosif_2010_SRI_Study.pdf>, 11.
[411] Social Investment Forum Foundation, '2010 Report on Socially Responsible Investing Trends in the United States - Executive Summary' (2010) <http://ussif.org/resources /pubs/trends/documents/2010TrendsES.pdf>, 8.
[412] CAER, 'Responsible Investment Annual 2011: A Benchmark Report on Responsible Investment in Australia and New Zealand by the Responsible Investment Association Australasia' <http://www.responsibleinvestment.org/wp-content/uploads/2011/12/RI-Annual-2011-Report.pdf> 5.

financial derivatives broker. This index[413] is composed of 11 commodities including sustainable renewable agricultural products (corn, sugar, soybeans, cotton, palm oil, rapeseed, canola oil) used for the production of bio-fuels[414] on the one hand, and commodities that reduce greenhouse gas emissions on the other hand.[415] Its assessment methodology is 'a systematic quantitative risk reduction technique based on the commodity price momentum'. It includes agricultural commodities used for the production of 1st generation bio-fuels.

This index takes a risk-based approach, reflecting risk-reduction measures undertaken by specific businesses. The mechanism creates pressure upon indexed companies/sectors to demonstrate high standards of environmental stewardship as a means to preferred status with investors. It also creates an incentive for non-indexed corporations to comply with the required index-related standards in order to attract investors.

Another possible approach is for government (alone or jointly with the industry) to require full risks disclosure. The potential invasiveness of bio-fuels crops might generate commercial and legal liabilities that can impact on the financial performance of shares/securities. By providing objective information to support investor assessment of the ecological riskiness of bio-fuels investees it may be possible to create effective pressure across the industry to adopt superior environmental risk-control.

Under proposed changes to its *Corporate Governance Principles and Recommendations with 2010 Amendments*, the Australian Stock Exchange (ASX) considers expanding risk management reporting to 'material business risks' that include environmental risks.[416] If this proposal were to be adopted, disclosure of bio-fuels weed risk information would potentially translate into commercial pressure for the management of these risks.

[413] It is described in PFDS Holdings LLC, 'Guide to: The Bache Commodity Green Index[sm] - The Bache Biofuels Composite - The Bache Clean Air Composite' (2009) <http://ebookbrowse.com/index-handbook-pdf-d24085907>.
[414] Also referred to as the Bache Biofuels composite (BBC).
[415] Also referred to as the Bache Clean Air Composite (BCAC).
[416] Australian Securities Exchange Corporate Governance Council, 'Corporate Governance Principles and Recommendations with 2010 Amendments' (ASX, 2007) 33 <http://www.asxgroup.com.au/media/PDFscg_principles_recommendations_with_2010_amendments.pdf>.

6.18 The potential of mandatory reporting

Corporate environmental reporting is increasingly used in the business sector as part as a marketing and transparency strategy.[417] These can be strengthened by an obligation of disclosure. This is illustrated with the Australian *National Greenhouse and Energy Reporting Act 2007* (Cth), which imposes an obligation upon specific targeted polluters[418] to report their GHG emissions. Bio-fuel weed risks are substantially about species and location. A plant may be benign under one combination of site characteristics and management regimes, and likely to become a weed in another. As has been discussed in relation to Factory Mutual insurance arrangements, site specific risk management are an important way to understand the specific conditions and the management arrangements in response to those conditions. Without site and management system specific information it is difficult to reliably price and supervise site-specific risk.

It has previously been suggested that independent weeds inspection on the transfer of real estate would create a pricing mechanism for weed risk and thereby promote weed management actions. No further intervention in the operation of the market may be necessary to achieve significant gains in weed management. Once information is available about the potential additional costs to a purchaser of contamination of the asset they are buying, it can be expected that this will become part of the negotiation of prices and terms of purchase. In order to protect the value of the asset and to avoid the uncertainty of such a negotiation, it can be expected that some, if not most, potential vendors will pay more attention to weed risk avoidance and weed removal than they would in the absence of such information.[419]

Whilst these inspection issues are raised in the context of bio-fuel weeds risk management strategy, inspection is likely to be increasingly part of environmental due

[417] For a discussion of corporate environmental reports and case studies within the Australian context, see Jean Baptiste Lesourd and Steven G.M Schilizzi, 'Corporate Environmental Reporting' in *The Environment in Corporate Management - New Directions and Economic Insights* (Edward Elgar, 2002) 150.

[418] This legislation was originally adopted to enhance the rejected carbon pollution reduction scheme. For a discussion, refer to Geoffrey R Frost, 'The Introduction of Mandatory Environmental Reporting Guidelines: Australian Evidence' (2007) 43(2) *Abacus* 190. Other corporate public social and environmental reporting obligations include, for example, *Corporations Act 2001* s 299(1)f (Cth) and *Corporations Act 2001* ss1013(A to (F) (Cth) (information disclosure on financial products).

[419] Martin, above n 119, 6, 11.

diligence.[420] It reflects other moves to integrate land administration with environmental restrictions and responsibilities.[421]

6.19 Reducing transaction costs with risk-based information instruments

The first chapter of this thesis noted that there are two fundamental flows which can be managed in order to adjust the operation of a social system that drives resource consumption. One is the flow of resources, a strategy for including the use of markets or contracts to reallocate resources. The other is the flow of information, which changes the intelligence available to make decisions. Improved information about risk issues is a fundamental means to improve the quality of environmental risk management.

Environmental product labeling is widely used to encourage consumers to select products with lower impact, and thereby to provide a stimulus to producers to reduce these impacts and to provide objective evidence of their superior performance.[422]

Certification and labeling of the environmental risk characteristics of production approaches and products requires that the affected industry engage with risk-identification and quantification. This dynamic is well demonstrated with corporations which have adopted ISO lifecycle accreditation (14040 – LCA Standards), as well as by the many consumer environmental standards. Thus it could be expected that extending environmental standards and certification down the supply chain of biofuels (to the point of crop production) and expanding its focus to embrace environmental risks of crop production would lead to better risk intelligence (and therefore to better risk control decisions).

[420] Within the British context, the due diligence process is discussed in Gary Soloman and Georgie Messent, 'Environmental Due Diligence' in *Property Transactions: Planning and Environment* (Sweet and Maxwell, 2007) 15.

[421] Rohan Bennett, Jude Wallace and Ian Williamson (eds), *Achieving Sustainable Development Objectives through Better Management of Property Rights, Restrictions and Responsibilities*, Sustainability and Land Administration Systems : Proceedings of the Expert Group Meeting (University of Melbourne, 2005).

[422] Tavis Potts and Marcus Haward, 'International Trade, Eco-labelling, and Sustainable Fisheries - Recent Issues, Concepts and Practices' (2007) 9(1) *Environment, Development and Sustainability* 91; Paul Martin et al, 'The Costs and Benefits of a Proposed Mandatory Invasive Species Labelling Scheme' (Discussion Paper, WWF-Australia and Australian Centre for Agriculture and Law , University of New England, 2005); Frieder Rubik and Paolo Frankl (eds), *The Future of Eco-Labelling: Making Environmental Product Information Systems Effective* (Greenleaf Publishing 2005).

Given competition between suppliers, this should stimulate industry engagement and debate over analysis and quantification of these risks; and consumer and supply chain engagement with the issues. Although labeling and certification schemes are characterised by many different institutional arrangements, they share common features.[423]

Because competitors are required to signal and justify their environmental performance, labeling schemes can stimulate research in improving scientific risk assessments of the industrial process and the commodities produced. Certification and eco-labeling closely interact because certification programs are then the basis for the design of labeling schemes. The effectiveness of voluntary industry schemes is variable.[424] However, where there is effective legal control against consumer deception, misleading labeling of environmental credentials or characteristics may be supported under general law.[425]

Under the present *New South Wales Invasive Species Plan 2008-2015,* the nursery and garden industry, labeling producers and Industry and Investment NSW are developing environmental standards for plant labeling. The nursery industry, partly in response to increasing awareness of their potential liability for unintended deception[426] has adopted, within their voluntary code, soft measures to encourage members to avoid deceptive labeling of potentially weedy plants.[427] The industry and government are collaborating to determine the basis to accredit non-invasive species, which would be labeled accordingly.[428]

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[423] This is developed in Pooja Seth Parikh, 'Harnessing Consumer Power: Using Certification Systems to Promote Good Governance' (Environmental Law Institute, 2003) <http://www.elistore.org/reports_detail.asp?ID=10841>. More specifically, certification schemes require the establishment of standards, a certification assessment for compliance with the standards, a certification seal or label, an accreditation of the certifier by the certification body and a compliance monitoring process.

[424] In the German context, eco-labelling schemes are considered as efficient, as they are supported by strong environmental regulations. See Renate Gertz, 'Eco-labelling - a Case for Deregulation?' (2005) 4(3) *Law, Probability and Risk* 127.

[425] See for example Martin et al, above n 422.

[426] Ibid.

[427] See Nursery and Garden Industry Australia, 'National Plant Labelling Guidelines' (NGIA, 2007) <http://www.ngia.com.au/Category?Action=View&Category_id=501&Highlight1=national%20plant%20labelling%20guidelines&Highlight2=national%20plant%20labelling%20guidelines&Highlight3=national%20plant%20labelling%20guidelines&Highlight4=national%20plant%20labelling%20guidelines>.

[428] Statement by Scott Charlton, Weeds Strategy & Planning Officer, Industry and Industry Investment (Personal Email Correspondence to Paul Martin and Elodie Le Gal, 24 June 2009). This strategy corresponds to goal 1- objective 1.1 of the New South Wales Invasive Species Plan which focuses on the

6.20 Summary

The ability to use market instruments to price (and thereby manage) environmental values is well-established and increasingly applied. In other aspects of natural resource science and management risk instruments are well accepted. Examples include the use of resilience (a risk concept) in targeting natural resource management actions, and risk evaluation in biosecurity management. One innovation proposed in this thesis is to marry two elements of 'market' and 'risk' to create new instruments and strategies for otherwise potentially intractable problems. The innovation is not, in terms of risk management traditions in commerce, a radical leap. However, despite some tentative moves in this general direction, thus far, the potential of such innovations has been unrealised. This step is not unheralded. The coupling of different risk market instruments, such as insurance mechanisms, other incentives and regulatory mechanisms designed to tackle natural catastrophic risks, is recommended by the OECD.[429]

The weeds challenge can be reframed around commercial risk concepts. Risk management could help protect private economic interests and also contribute to increase the value of business assets. New legal arrangements will be pivotal to such developments.

The role of contract law and property rights, supported by institutional arrangements, is essential in creating methods to internalise the multiple uncertainties associated with environmental risks as a basis for innovative environmental risk management instruments. Legislative and regulatory instruments can create a legally defined tradable interest in order to allow a market through contractual arrangements. Contract law has, therefore, the potential to assist in better organising risk transfer and thereby creating a restorative and/or preventative tool directed to protecting the environment. Effective risks instruments incorporate a price or penalty – directly or indirectly – for undertaking a specific risk. Thus insurance, bonds, risk-variable development rights and the like,

identification and management of high risk species and pathways. See NSW Department of Primary Industries, State of New South Wales, *New South Wales Invasive Species Plan 2008-2015* (2008) <http://www.dpi.nsw.gov.au/agriculture/pests-weeds/nsw-invasive-species-plan>. In the USA, to create biofuels incentives, the *Food, Conservation, and Energy Act* of 2008 provides a labeling program for producers of bio-based products. See also *Food, Conservation, and Energy Act of 2008*, tit IX Energy, § 9002, which provides a labelling program related to biofuels.

[429] Monti, above n 126, 82-83.

although they focus on different behaviours and motivations, and require specific institutional arrangements, all seek a behavioural response of risk-identification and risk-reduction, and impose a contingent cost on the failure to avoid the targeted risk.

Arguably, the creativity in the use of the concept of risk on commercial and financial markets can be limitless. However, theoretical potential does not necessarily reflect the reality of markets or of policy-making. The next part of this thesis explores some of the practical impediments to the greater use of more sophisticated risk instruments (as well as other forms of regulatory innovation) to broaden the available suite of instruments and strategies to address biofuels weed risk.

PART III: IMPLEMENTATION AND FEASABILITY ISSUES OF RISK GOVERNANCE INNOVATIONS

CHAPTER 7 EXPERTS RESPONSES TO PROPOSALS FOR BIOFUEL WEED RISK GOVERNANCE INNOVATIONS

This chapter is the basis for the journal article which has been submitted as 'The Effects of Institutional Path Dependence, Political Dynamics and Transaction Costs on the Potential for "Smart" Regulatory Innovation: An Illustration with the Biofuel Weed Risk Case Study'. *This has been submitted to the Australasian Journal of Natural Resources Law and Policy and accepted for publication. The article is provided as Appendix 1.*

The chapter itself is slightly modified, in part to provide a little more detail for the examiner.

7.1 Introduction

Climate change and increasing production costs due to high oil prices require alternative energy sources to fossil fuels to achieve a low-carbon economy and national goals such as energy security and environmental protection. Worldwide and in Australia, these concerns attract the attention of the public and private sectors, resulting in supportive bio-fuels policies which intend to harness new energy markets and incentivise investment in new clean energy technologies.[430] As reported by the recent Australian Energy Resource Assessment, the use of bio-fuels including biodiesel and ethanol is projected to increase by 60% from 2007-2008 to 2029-30.[431] The construction and operation of bio-fuels plants and biomass plantations on marginal agricultural lands could strengthen regional economic resilience. They may result in new commercial opportunities with valuable intellectual rights including for the management of risk (eg such as quality assurance schemes, legal and regulatory compliance audits and environmental certification schemes). The production of biofuels could also generate a set of positive social outcomes including the creation of new jobs opportunities.[432]

[430] Sorda, above n 34.
[431] Organisation for Economic Co-operation and Development and Food and Agricultural Organization, above n 53 (database).
[432] O'Connell et al, above n 37, 26-27.

CHAPTER 8 THE CHALLENGES OF IMPLEMENTING LEGAL AND REGULATORY INNOVATIONS FOR PROTECTING ENVIRONMENTAL VALUES

This chapter is the basis for the journal article which has been submitted as, 'The Challenges of Implementing Legal and Regulatory Innovations for Protecting Environmental Values' *to the Environmental and Planning Law Journal. This publication was accepted by the first reviewer but rejected by the second reviewer. It is currently being redrafted for submission to another journal.*

CHAPTER 9 MOVING TOWARDS NEXT-GENERATION NRM GOVERNANCE MODELS

The purpose of this research was to explore more effective designs in natural resource governance models to control effectively complex risks to the environment. The introductory chapter highlighted the sorts of implementation issues jeopardising the effectiveness of NRM established models to achieve sustainable environmental outcomes. This provided the rationale for governance innovation in NRM laws and policies including regulatory and market innovations. This was discussed within the biofuel weed risk context which epitomises some of the long-established key weeds governance challenges that policy-makers have to consider when proposing NRM law reform proposals. Whilst each of the publications which form part of this thesis has provided its own set of detailed conclusions, it is the aim of this chapter to restate the key findings of this research project. This concluding chapter also discusses research implications and provides further research directions.

9.1 Summary of key research findings

Regulatory and institutional theory, including a 'smart ' 'responsive' design approach as well as transacting systemic thinking, co-regulation between industry and government and commercial risk based instruments were explored as some of the research directions that could inform next-generation NRM governance models to better protect environmental values. These design concepts were specifically discussed in Chapters 3, 4, 5 and 6 and integrated into a single sophisticated conceptual architecture which was underpinned by key principles and assumptions. The strategy adopted for biofuel weed risk control was driven by a corporate risk accountability approach whereby the biofuel industry should be held responsible for introducing the risk of biological infestations from second-generation biofuel crops into the natural environment. An institutional perspective, that was explained in Chapters 3 and 4, helped to identify potential corporate responsible parties. This approach underpinned the methods employed in this thesis and was integrated into the pragmatic approach which provided the theoretical research framework of this overall research project (Chapter 3). The resulting sophisticated co-regulatory bio-fuels risk management model that formed part of a new strategy for

addressing the biofuel weed risk – and possibly on a broader level complex environmental risks – was exposed in Chapter 5. By adopting non-legal perspectives (eg theory of path dependence, public choice theory and transaction costs theory) Chapter 7 pointed out some of the key institutional and political challenges that governance innovations are likely to face in practice. Chapter 8 identified additional cultural, jurisprudential and methodological barriers to the adoption of a smart NRM regulatory approach for managing the biofuel weed risk. All of these challenges are rooted in the complex dynamics that occur in natural and socio-economic systems. The complexity of the institutional environment surrounding the biofuel context was specifically discussed in greater detail in Chapter 2.

On balance, the main key research findings of this set of publications is that:

1. Whilst is possible to design sophisticated NRM governance models based upon regulatory and market innovations that are in theory superior to NRM established models, NRM governance innovations also carry in practice their own risk of failures due to institutional, political, cultural, jurisprudential and methodological challenges which arise in a complex, uncertain and dynamic environment.
2. To achieve successful innovation in natural resource governance, it is essential to explore the broader institutional environment surrounding the specific environmental issue that legal innovations attempt to resolve. This is because beyond the instrumental and technicalities associated with NRM legal and regulatory innovations, there are broader institutional and political issues to consider when implementing new governance approaches.
3. Non-legal perspectives from other disciplines (eg institutional analysis, political science) can help to identify and mitigate the implementation risks that are likely to arise from governance innovations. These can contribute to improve NRM law reform proposals.

9.2 Research implications and future research directions

9.2.1 Improving biofuel governance

The biofuel weed risk case study has illustrated the many uncertainties (eg scientific, economic, legal) and the complex institutional and political dynamics that surrounded the proposed conceptual co-regulatory biofuel weed risk management model in the biofuel context. Chapter 2 particularly discussed the real-world feasibility of implementing innovative governance in the biofuel context where powerful conflicting vested interests are likely to emerge on the energy front scene. This suggests that traditional NRM

regulatory tools are likely to be unable to manage successfully the emerging (environmental) risks associated with biofuels production. The public choice theory highlighted the risk of political opposition from various interest groups to develop a partnered approach between government and the private sector to manage the biofuel weed risk. This suggests further research opportunities to identify the type of institutional arrangements needed to enhance a co-regulatory approach for improving biofuel governance.

9.2.2 Enhancing corporate risk accountability mechanisms for invasive species/weeds management

This thesis argued that current institutional arrangements for weeds control did not (or insufficiently) transfer the costs of habitat protection or rehabilitation onto the risk beneficiary when (for example) new species are revealed as invasive, or new practices are identified as risky. It also argued that the integration of economic incentives into weeds institutional arrangements should improve the management of biological infestations from weeds. In this thesis was discussed a corporate risk accountability approach whereby those who undertake risky activities should bear the risks associated with their actions. This suggests that further research is needed to effectively close the weeds accountability circle. This requires investigating how those who are made responsible for the weeds risk have sufficient financial resources to cover the costs associated with weeds.[587]

9.2.3 Integrating market-risk based instruments into institutional arrangements

This thesis explored innovative market-based risk instruments underpinned by commercial risk management concepts to improve the performance of environmental management in the biofuel weeds context. Chapter 6 particularly pointed out their diversity and demonstrated that these mechanisms could contribute to manage environmental risks in many different ways. However, these developments mostly emphasised the objective (probabilistic) aspect of the concept of risk without considering its subjective facet. Market risk based instruments rely on probabilistic methods to

[587] Paul Martin et al, 'Innovations in Institutions to Improve Weed Funding, Strategy and Outcomes' (RIRDC Publication No 12/091 RIRDC Project No. PRJ-006906, Rural Industries Research and Development Corporation 2012) <https://rirdc.infoservices.com.au/items/12-091>.

predict future events including environmental hazards. As discussed in section 6.2 of this thesis, the subjective foundation of the concept of risk means that it can also refer to the level of acceptability of an opinion. This subjective foundation suggests further research opportunities to identify better ways of developing people's risk acceptability criteria for managing environmental risks and then integrating these into environmental regulatory and contractual mechanisms supporting market-based instruments. This includes consideration of the management of risk perception issues into NRM institutional arrangements. This research also suggests that the integration of probabilistic methods into environmental market mechanisms is likely to be technically insufficient to manage the many uncertainties (eg scientific, political, economic) that were identified in the biofuel weed risk context. This provides further research opportunities for exploring how the institutional and legal frameworks can better manage institutional uncertainties surrounding NRM issues.

9.2.4 Improving environmental/NRM legal scholarship

The second part of this research particularly stressed the potential significance of non-legal perspectives to better theorise and understand the adoption and implementation processes of governance innovations in the NRM context. The theory of path dependence, the theory of transaction costs and public choice theory provided insights into the types and extent of the barriers for the adoption of any 'smart' regulatory design approach for managing a complex environmental risk. This suggests exploring other conceptual tools/frameworks available to better understand the nexus between institutional innovation and implementation risks. This can help to support institutional arrangements for enhancing successful NRM law reform proposals and improve NRM legal scholarship.

9.3 Overview of critical issues

Overall, the adoption of new risk management strategies to control the biofuel weeds risk as a complementary approach to more traditional regulations and policies suffers from a lack of institutional support on three different levels. The first one relates to the nature and the quality of the information necessary to implement sophisticated NRM legal innovations. One of the key challenges faced during this research was accessing risk

experts to collect their views on smart regulatory approaches for environmental management. In the interview process, the many complexities embedded in the commercial risk-based instruments proposed for biofuel weed risk control raised communication challenges. These aspects are often disregarded in the environmental policy decision-making process for proposing effective NRM law reform proposals. Compounding this, as shown in the survey analysis, is the fragmented nature of risk perception and the multi-dimension nature of the concept of risk. This research has also portrayed the cumbersome normative environment which surrounds biofuel energy regulations. Such a normative environment jeopardises the ability for policy-makers to understand the institutional environment in which they regulate. The complexity of the institutional environment also highlights the limitations of the legal discipline to grasp the complex multi-faceted aspects associated with environmental policy-making. Environmental law scholarship faces key methodological challenges due to its immaturity.[588]

The second aspect of the lack of institutional support for implementing innovative NRM governance models relates to the high transaction costs associated with 'smart' untested regulatory models. Transaction costs are aggravated by the informational and communication challenges that have just been discussed. To overcome these communication challenges, the integration of a comprehensive knowledge management system into the decision-making process and the creation of a capacity-building mechanism to enhance stakeholders' participation are likely to be key elements for any 'smart' regulatory design approach.

Finally, from a more philosophical standpoint, the beliefs and values of the socio-economic system are key institutional supportive elements to consider when proposing new NRM institutional arrangements. As opposed to formal institutions, there are likely to be more prone to resistance. The choice between a state or market approach to regulate unsustainable behaviours depends upon the societal values promoted (eg entrepreneurship, protection of the public interest). The implementation of more

[588] Fisher et al, above n 244.

sophisticated environmental risk regulatory models involve much broader jurisprudential cultural issues than those which narrowly focus on instrumental regulatory design.

This research has also substantiated the argument that the effectiveness of environmental policies and regulations are highly context-dependent. Institutional capacity and values vary from one context to another. These variables impact upon the nature and the type of implementation risks that may arise from new market-orientated governance models. Innovative approaches for environmental management, as illustrated with the co-regulatory biofuel weed risk management model, are underpinned by complex institutional arrangements and require sophisticated and costly technological devices. This suggests that the chance of success of these approaches is likely to be higher in countries where a sufficient level of economic development has been reached. Mirroring traditional NRM models, environmental regulatory and market-oriented innovations also generate economic, social and environmental spillovers. Some policy risks associated with the proposed model for biofuel weed risk control have been identified in this research. These second-order risks suggest that institutional frameworks should also explore innovative institutional arrangements to develop risk mitigation strategies associated with legal and regulatory innovations.

9.4 Limitations of the study

Some of the limitations of this study were discussed in Chapter 8. It was mentioned that this thesis, which framed the sustainability challenge as a resource consumption issue, did not address social spillover risks. Chapter 8 also discussed the limitations of risk science to address the multiple uncertainties, including scientific, political, economic and legal uncertainties which surround NRM governance innovations. The effective implementation of pragmatism as an overarching conceptual research framework is also noted as a limitation because it requires complementary research methods from different disciplines.

In addition, the institutional systems-based approach used in this thesis has limitation. That is, adopting an institutional systems-based approach is appealing in theory but faces key challenges. In the empirical component of this study, the experts raised multiple intertwined issues that are hard to describe methodologically. The complexities of

environmental and socio-economic systems generate 'wicked problems' for public policy.[589] A systemic approach to NRM issues emphasises the interconnectedness – through formal and informal rules – between the different elements which compose these various open dynamic systems. Whilst systems thinking offer an interesting analytical tool to describe holistically and simplify the complexities of the multiple interactions occurring in the real world, it faces a series of conceptual and practical challenges. These may challenge the methodological approach of using systems analysis of NRM issues. For example, in relation to the weeds risk, some authors have criticised the current regulatory approach for relying extensively on list-based species laws which are underpinned by probability-based scientific proofs of the environmental hazard. They argue that it does not take sufficiently into consideration the complex and multiple interactions occurring in ecosystems.[590] From a practical point of view, these interactions – materialised by flows of resources and information – are difficult to identify because there are many existing informational gaps within environmental systems (eg weeds pollution levels, uncertain causal risk vectors). Jurisdictional boundaries and sectoral legal approaches[591] are other practical challenges which undermine, in practice, the effectiveness of systems-based approaches as is illustrated with the *Convention of Biological Diversity* ('*Biodiversity Convention*').[592]

The evolving nature of both systems and the intangible beliefs and values embedded in socio-economic systems [593] are also hard to 'materialise'. From a conceptual standpoint, systems thinking challenges traditional, linear and hierarchical ways of thinking about legal and regulatory frameworks to achieve integrated policy and adaptive governance/management within an iterative process. Functions/purposes[594] – other key

[589] These are characterised as 'difficult to clearly define', 'have many interdependencies and are often multi-causal', 'are often not stable', 'usually have no clear solution', 'are socially complex' 'hardly ever sit conveniently within the responsibility of any one organisation', 'involve changing behaviour', 'are characterised by chronic policy failure'. 'Attempts to address wicked problems often lead to unforeseen consequences'. Australian Public Service Commission, above n 552.
[590] Mark Burgman et al, 'Designing Regulation for Conservation and Biosecurity' (2009) 13 *Australasian Journal of Natural Resources Law and Policy* 92.
[591] Shine et al, above n 25, 31.
[592] See *Convention on Biological Diversity*, opened for signature 5 June 1992, 1760 UNTS (entered into force 29 December 1993). 79.
[593] Meadows, above n 149, 12-14.
[594] For Meadows, functions are associated with non-human systems while purposes relate to human systems. See ibid 15.

constitutive components of systems with elements and interconnectedness[595] – are also hard to identify. As noted by Meadows

> If a government proclaims its interest in protecting the environment but allocates little money or effort toward that goal, environmental protection is not, in fact, the government's purpose. Purposes are deduced from behaviour, not from rhetoric or stated goals.[596]

Inspired from natural sciences, the transposition of the systems theory to the realm of social sciences raises specific issues due to the distinctiveness of social systems as opposed to natural/environmental systems.[597]

In her book *Thinking in Systems*, Meadows identifies a wide range of 'systems traps'[598] which are beyond the scope of this research to discuss. However, the relatively new discipline of systems analysis could inform an improved systemic methodological approach to NRM policy-making.

A systems-based approach also raises the key challenge of delimitating system boundaries, including social systems boundaries.[599] Other challenges include delays in informational feedback loops, lack of harmonised goals and the nonlinearity of systems.[600]

Using the socio-economic system as a conceptual basis for a risk accountability approach presupposes that organisations and actors are clearly identified and categorised. With the use of the bio-fuel weeds pathway, the researcher acknowledges that, although it is a useful conceptual tool, it does not rely on clear-cut categorisations.[601] The literature identifies additional challenges with systems-thinking which include both the selection of

[595] Ibid 11.
[596] Ibid 14.
[597] The origins of systems theory is often associated with the work of Ludwig Von Bertalanffy.
[598] Meadows, above n 149, 111-141.
[599] John Mingers, Realising Systems Thinking - Knowledge and Action in Management Science (Springer, 2006) 65.
[600] To illustrate the nonlinearity of systems as a challenge from a policy perspective, Meadows reports that wide pesticide spraying policy responses have aggravated weeds spread patterns within the Canadian context. Meadows, above n 149, 92-94.
[601] This contrasts with for example the Australian and New Zealand Standard Industrial Classification (ANZSIC) 1996 (revision 1.0) which enables the identification of industries in the economic system. See <http://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/1292.0Contents12006%20%28Revision%201.0%29?opendocument&tabname=Summary&prodno=1292.0&issue=2006%20%28Revision%201.0%29&num=&view= >.

measurement endpoints in systems[602] and the creation of single points of entry system for NRM service deliveries.[603]

As with any model, representations of systems and their components do not reflect the complexities of the real world, including the rules of the game and the interactions between the various players involved in the biofuel debate.

Finally, the adoption by policy-makers of a systems-based approach combined with complex risk-based instruments may result in high design transaction costs which may have public and private impacts. The complexity of new environmental technologies/practices and conflicting information, among other factors, have for example been identified as a key barrier to the adoption of agricultural innovation.[604]

To move from theory to the application of systems-based thinking, a multi-methodology and multi-method research approach is suggested.[605] As noted by Mingers, this raises a certain number of key issues:

> Four levels of problems can be identified: i) *philosophical* [feasibility] – particularly the issue of paradigm incommensurability; ii) *cultural* [feasibility] – the extent to which organisational and academic cultures militate against multi-method work; iii) *psychological* [cognitive barriers] – the problems of individual researchers who are often more comfortable with a particular type of method; and iv) *practical* [barriers].[606]

Challenges for adopting systemic thinking is particularly relevant for implementing an 'optimal' policy mix, as suggested with the concept of 'smart' regulation. The systems-

[602] Within the context of environmental systems, see Burgman, above n 231, 6, 50-51.
[603] For example, Western Australia has created a single water licence system which enables a single-point entry system for water rights. For a broader discussion in the NRM context, see M D Young and J C McColl, 'Robust Separation – A Search for a Generic Framework to Simplify Registration and Trading of Interests in Natural Resources' (CSIRO Land and Water, 2002) <http://www.clw.csiro.au/publications/consultancy/2002/Robust_Separation.pdf>.
[604] F Vanclay, 'Social Principles for Agricultural Extension to Assist in the Promotion of Natural Resource Management', *Australian Journal of Experimental Agriculture* (2004), 44(3), 213-222, 217, 218.
[605] Mingers, above n 598, 217.
[606] Ibid, 204-208.

based approach adopted by Sandall in her PhD thesis for improving native vegetation policy can provide useful insights as future research directions.[607]

However, even given such conceptual and practical challenges, it remains clear that for governance issues of the potential magnitude and complexity of biofuels, society is likely to require significantly more powerful and comprehensive approaches that those upon which we currently rely. Within this context, exploring new approaches even with their limitations known is an important contribution to the development of more effective legal rules and institutions.

9.5 Final conclusion

To conclude, this research has shown that the law could be a highly creative tool to regulate unsustainable behaviours, protect environmental values and respond to new societal needs and values. While the use of economic risk instruments for environmental management suggests that policy-makers should be more adventurous in the way environmental problems are addressed, it also raises the key challenge of finding a right balance between entrepreneurship and distributive justice issues. Achieving this balance can contribute to better understanding the nexus between institutional innovation and implementation risks associated with innovative NRM governance models.

[607] Jean Sandall, Navigating Pathways through Complex Systems of Interacting Problems: Strategic Management of Native Vegetation Policy (Doctor of Philosophy Thesis, University of New England, 2006).

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INTERVIEWS

Interview with participant 1 (Armidale, 4th March 2010)
Interview with participant 2 (Armidale, 2nd April 2010)
Interview with participant 3 (Armidale, 4th April 2010)
Interview with participant 4 (Armidale, 14th May 2010)
Interview with participant 5 (Armidale, 17th May 2010)
Interview with participant 6 (Armidale, 27th May 2010)
Interview with participant 7 (Armidale, 28th May 2010)
Interview with participant 8 (Armidale, 31st May 2010)
Interview with participant 9 (Armidale, 31st May 2010)
Interview with participant 10 (Armidale, 22nd June 2010)
Interview with participant 11 (Armidale, 18th June 2010)
Professor Paul Martin, Interview with participant 12 (United States of America, 15th June 2010)
Interview with participant 13 (Armidale, 2nd July 2010)

Response to questionaire from participant 14 by email to Elodie Le Gal, 14th June 2010)
Interview with participant 15 (Brisbane, 26th May 2011)
Interview with participant 16 (Armidale, 24th February 2011)
Interview with participant 17 (Armidale, 10th March 2011)

APPENDIX 1

APPENDIX 2

Decoding process

Summary of the response	#	Embedded themes or concepts in the response	Political interests	Lower risk appetite	Values, beliefs	Risk perception	Policy uncertainty	Resource allocation	Policy uncertainty - CBA	Feedback	Capability and trust	Risk attitude	Rules of the game	Blame avoidance	Complexity	Liability	Accountability	Risk issue characterisation	Institutional capacity	Information	Decision-making	Resources	Institutions
Scientific uncertainty about the true environmental attributes of biofuel crops	1	Impact evaluation - Net public benefit - Scientific uncertainty - - Risk perception		X	X	X						X								Information			
The feasibility of biofuel from marginal lands vs competing for high value inputs	2	Impact evaluation - Net public benefit - Scientific uncertainty - Economic uncertainty - Risk perception		X	X	X						X								Information			
Unresolved scientific uncertainties about climate change, biofuel crop biology and production, potential weed control technologies	3	Impact evaluation - Scientific uncertainty - Risk perception			X		X					X								Information			
The onus or proof and credibility of industry claims about public risk/ benefits of biofuel crops	4	Net public benefit - Credibility and trust in private market operators				X				X										Information			
Complex interacting factors contribute to influence risk perception (e.g., cognitive biases, political interests..)	5	Risk perception - Complexity									X		X							Decision-making			
Lack of economic intelligence eg true cost of weeds, limiting economic pricing decisions	5	Economics - Risk pricing					X							X						Information			
Concerns for the economic capacity of an emerging industry to implement accountabilities and embrace strong governance frameworks, and the lack of clear policy goals for public support	7	Policy uncertainty - Economics - Accountability - Industry capacity and development						X	X							X	X				Resources		
Potential competitive neutrality problems between biofuels and other fuels, given a different regulatory/accountability treatment.	8	Regulatory architecture - Distributional and anti-competitive issues - Industry capacity and development													X			X	X		Resources		
Uncertainties about which government agency/policy frameworks will be used (e.g agriculture vs energy vs rural development)	10	Policy uncertainty - Regulatory structure - Industry capacity and development -						X							X				X		Decision-making		
Varied characterisation of the risk issues may result in radically different strategy selection (e.g manage vs avoid, and instrument choices	11	Risk issue characterisation - Industry capacity and development															X	X			Decision-making		
Effects of different environmental philosophical stances on the choice to avoid or to accept some risk	12	Risk perception - Risk attitude - Rules of the game										X	X	X							Decision-making		
The potential for conflicts with existing laws to be an impediment to regulatory innovations	13	Rules of the game - Complexity - Regulatory Architecture												X	X						Institutions		
Attitudes to risk and innovation are framed by current institutional roles and institutional boundaries/ responsibilities	14	Risk attitude - Rules of the game											X	X							Decision-making		
Different nations frame and evaluate ecological risk differently (e.g science vs social factors) and are predisposed to different strategies	15	Risk perception - Rules of the game - Risk issue characterisation										X		X		X					Decision-making		
The subjectivity of what is valued (viz ecological and economic) reflects personal and role values, and shapes acceptability of tradeoffs	16	Values and beliefs - Rules of the game				X								X							Decision-making		
The "precautionary principle" embedded in laws predisposes to avoidance rather than risk management innovation, but is not applied uniformly	17	Rules of the game - Regulatory structure												X	X						Institutions		
The issues involved in regulatory innovations in the biofuel sector are very political, depending on roles, values and interests. These are likely to involve power issues.	18	Political interests - Power relationships - Values and beliefs - Rules of the game	X	X	X									X							Decision-making		
There is not a unified view on issues, even within the notional 'biofuel industry'	19	Power relationships - Rules of the game - Organisational structure	X											X							Decision-making		
Political factors are a risk in themselves to any regulatory innovation proposals; with political acceptability being a key institutional concern	20	Political interests - Power relationships - Rules of the game	X	X										X							Decision-making		
A smart systemic approach requires very sophisticated analysis of both the specific proposed instruments for biofuel weed risk control and the complex interactions within the natural and socio-economic systems	21	Complexity - Communication - Institutional capacity											X	X					X		Decision-making		
The use of a civil instrument such as negligence will be technically complex, and even strict liability raises difficult avoidance concerns	22	Complexity -Regulatory structure - Liability -Accountability - Instrument design and risks												X		X	X	X			Decision-making		

The interactions between instruments are going to be difficult for governments to understand and manage, and could lead to failure	23	Complexity - Communication - Regulatory structure - Instrument design and risks														X	X		X					X							Decision-making
A collective insurance product required by statute may fail if no commercial insurance product emerges in the marketplace	24	Risk pricing - Instrument design and risks - Industry capacity and development - Organisational structure																X						X		X		X			Resources
Characterisation of issues institutionally as being about fuels, or agriculture, or natural resources will alter their treatment	25	Policy uncertainty - Risk issue characterisation - Industry capacity and development								X													X			X					Decision-making
The creation of an innovative regulatory approach for one sector may create significant problems of integration (e.g. weeds vs biofuel weeds)	26	Complexity - Regulatory structure - Distributional and anti-competitive issues														X			X						X						Decision-making
Because the issues are at an intersection of many others, should implementation be via sui generis law or pervasive law reform?	27	Regulatory structure - Organisational structure																	X								X				Decision-making
With any such innovation in the legal regime, there will be new jurisprudential methods required for implementation	28	Complexity - Regulatory structure - Liability - Institutional capacity														X			X	X								X			Decision-making
The complexity of such a systemic approach and the instruments is challenging to communicate and to the available expertise	29	Complexity - Communication - Institutional Capacity														X	X											X			Decision- making
It will be important to be more precise about the exact nature and conditions of the proposed insurance product	30	Liability -Instrument design and risks - Institutional capacity																		X			X					X			Decision-making
Business groups are likely to respond negatively to any proposal that is complex and hard for them to understand readily	31	Complexity - Communication - Institutional capacity														X	X											X			Decision-making
There are risks to the implementation of the civil liability proposals from issues of causation, which could lead to over-legalism	32	Liability - Instrument design and risks																		X			X								Decision-making
Financial liability mechanisms could be prejudiced by the use of bankruptcy to avoid responsibility	33	Liability - Instrument design and risks																		X			X								Resources
The effectiveness of an insurance scheme may be undermined by the lack of an established insurer, and possible uninsurability	34	Risk pricing - Instrument design and risks - Institutional capacity																X					X					X			Resources
Bond pricing could be a difficult issue, as it involves difficult issues of risk-weighting and pricing	35	Risk pricing - Instrument design and risks - Institutional capacity																X					X					X			Decision-making
Risk pooling funds could become unduly bureaucratic, and involve high supervision costs	36	Instrument design and risks - Organisational structure																					X			X					Resources
Certification schemes require good traceability, and given the pooling of fuel sources this may be difficult	37	Complexity - Instrument design and risks														X							X								Information
As the proposed independent site report occurs only on property transfer, it may be inhibited by administrative and timing issues	38	Instrument design and risks																					X								Decision-making
A number of risk pricing complexities require high level qualitative and quantitative evaluation. Insurance availability and pricing are challenging	39	Complexity - Risk pricing - Institutional capacity														X		X										X			Information
It will require strong motivations for an industry to accept such a complex and costly system	40	Political interests - Risk perception - Complexity - Distributional and anti-competitive issues	X										X			X								X							Decision-making
To make the consumer certification aspect of the programme work will depend on consumer sensitivity to environmental performance	41	Values and beliefs			X																										Decision-making
Effective management of weeds requires coordinated action across a large number of private and public titles.	42	Complexity - Regulatory structure - Institutional capacity														X			X									X			Institutions
There is a variety of motivational and integrity concerns associated with any scheme of collective self-regulation by an industry.	43	Credibility and trust in private market operators - Instrument design and risks - Industry capacity and development										X											X		X						Decision-making
There is skepticism of industry voluntary and information-based codes and standards, and the need for strong regulatory governance	44	Credibility and trust in private market operators - Regulatory structure - Instrument design and risks										X							X				X								Decision- making
An effective co-regulatory approach will require strong institutions with cost-effective oversight systems	45	Credibility and trust in private market operators - Regulatory structure - Institutional capacity										X							X									X			Institutions
To design an effective public risk-management programme, you need to have clear policy goals (which are lacking).	46	Net Public benefit, Policy uncertainties and ambiguity					X			X																					Decision- making
For an effective system the roles and accountabilities need to be very clear and specific, particularly in determining govt vs. industry roles	47	Regulatory structure - Accountability - Organisational structure																	X		X					X					Institutions

APPENDIX 3

(Provided on UNE letterhead)

INFORMATION STATEMENT FOR PARTICIPANTS (In-Depths Interviews)
Research Project: Co-Regulatory Risk Management Model to Manage the Risks Associated with the Used of Second-Generation Bio-Fuels Crops for the Production of Bio-Ethanol

I wish to invite you to participate in my research and I hope you will consider being involved. I am conducting this research project for my PhD at the University of New England. My supervisors are Professor Paul Martin, Director of the Australian Centre for Agriculture and Law (AgLaw Centre), Dr. Amanda Kennedy, Deputy Director of the Aglaw Centre, and Dr. Jacqueline Williams, Post-Doctoral Research Fellow. They can be respectively contacted by email at paul.martin@une.edu.au, amanda.kennedy@une.edu.au, and jacqueline.williams@une.edu.au.

Aim of the study
Second-generation bio-fuels crops, which are to a large extent commercial non-native species, are used for the production of bio-ethanol present strong invasive features. Rather than opting for a risk avoidance approach in the form of bans on importation, our view is that the bio-fuels weeds risks may be minimised by risk management strategies inspired by the commercial sector. However, to be a trustworthy alternative to standard regulatory methods this will require credible co-regulatory approaches engaging the public and private sectors. For this purpose, we have developed a conceptual architecture for a risk management model. The purpose of this study is to discuss with you and explore your views and practices in relation to commercial risk-based strategies/concepts and the model proposed as well as possible institutional arrangements (including legal, contractual and financial) to improve environmental management performance.

Time requirements:
Face-to-face interviews, phone interviews (and possibly focus group session) will last approximatively between 60 and 90 minutes (at my expense) and will be audiotaped/electronically captured.

Methodology

The study will be qualitative in nature. There will be a series of open-ended (in-depths interviews). Following the interview (face-to-face or by phone)/focus group, a transcript will be provided to you if you wish to see one. You will be free to withdraw at any time throughout the process.

Participation is completely voluntary. You may withdraw from the project at any time and there will be no disadvantage if you decide not to participate or withdraw at any time.
The audiotapes will be kept in a locked filing cabinet at the researcher's office for the purpose of being transcribed. They will be kept for five years after completion of the PhD. They will then be destroyed. The transcriptions will be kept in the same manner for five years following thesis submission and then destroyed.

Research process

It is anticipated that this research will be completed by the end of September 2011. The results may be presented at conferences and written up in journals without any identifying information.

This project has been approved by the Human Research Ethics Committee of the University of New England (Approval No HE09/109,Valid to 30/09/2011)

Should you have any complaints concerning the manner in which this research is conducted, please contact the Research Ethics Officer at the following address:

Research Services
University of New England
Armidale, NSW 2351.
Telephone: (02) 6773 3449 Facsimile (02) 6773 3543
Email: ethics@une.edu.au

Thank you for considering this request and I look forward to further contact with you.

Regards,

Elodie Le Gal
PhD Candidate
School of Law
Australian Centre for Agriculture and Law
University of New England
2351 Armidale, NSW
Email: elegal@une.edu.au

APPENDIX 4

In-Depth Interview Framework:

Dear _____,

I am seeking help from experts like yourself to evaluate novel proposals for the management of the risk of weeds from biofuels crops. There have been suggestions that weed risk is a serious hazard from biofuels, and that tighter regulation is needed to minimise this risk.

We have proposed with Professor Paul Martin (Australian Centre for Agriculture and Law, University of New England) an approach that focuses on risk-management rather than risk-avoidance. These concepts have been exposed in the concepts paper 'Concepts for Industry Co-Regulation of Bio-Fuel Weeds' (short and long versions) I have attached hereto.

Summary of the proposed approach being researched

The elements in the proposed approach are underpinned by the following principles:

- A risk-proportionate intervention with a precautionary balance using science methods while ensuring sufficient private funds for effective weed control should an emergency arise. This implies that the costs of failures must fall upon specific people or organizations.

- A combination of mechanisms at different points of intervention for ensuring that the costs of and responsibilities of risk are borne by the risk beneficiary and that the risk management strategy is reliable. This implies to preliminary deconstruct the transactions to identify potential responsible parties.

- A collective industry risk management program monitored by governmental authorities to ensure that the risk governance framework is reliable and that the public interest is effectively protected (co-regulatory framework/strategy).

This interview is structured as follows:

The **first section** asks for your contact details. This will allow us to assess responses in terms of your area of expertise.

The **second section** is to assess your responses in terms of the overall program detailed in our concepts paper.

The **last section** is to obtain your feedback on the specific risk-based instruments which underpin this risk management program.

Section 1: Your details

Your name:

Your organisation

Email address:

Phone number:

Category of specialisation (multiple responses permitted)

- ☐ Biofuels (industry or technology)
- ☐ Risk (industry or methods)
- ☐ Natural resources (policy or management)
- ☐ Legal
- ☐ Government
- ☐ Other

Section 2: Response to the overall program

Question 1: What (if anything) would ensure that such a program would achieve effective control over biofuels weed risk?

Question 2: What (if anything) would make such a program less costly (in terms of direct cost and lost biofuels opportunities) than traditional bans or regulation?

Question 3: What (if anything) would make such a program acceptable as an alternative to other regulatory methods to the biofuels industry, or to key stakeholders?

Question 4: If you were charged with designing and implementing a risk-management approach for biofuels weeds, what three main strategies would you propose (and why)?

Question 5: Do you have any additional comments to make?

Section 3: Response to particular instruments

The instruments that are proposed are

1. Civil liability

2. Financial responsibility mechanisms
    a. Individual performance bonds/bank guarantees
    b. Industry pooled risk sinking funds
    c. Environmental risk insurance (third-party liability insurance)

3. Invasiveness risk inspection in property transactions
4. Bio-fuel 'green investment standards
5. Eco-certification and eco-labelling

Question 6: What is your view of the possibility of collective industry legal responsibility for control of biofuels weed invasions?

Question 7: What is your view of the possibility of individual civil liability for failure to control biofuels weed risk?

Question 8: What is your view of requiring that biofuels growers demonstrate sufficient financial resources to remediate and compensate for the biological invasions that may arise from bio-fuels crops in the future?

Question 9: What is your view of requiring from bio-fuels crops producers and/or bio-ethanol producers posting a bond or obtain a bank financial guarantee against biofuels weed invasion?

Question 10: What is your view of requiring that biofuels crop growers subscribe to a third-party liability insurance as a condition of their licence to operate?

Question 11: What is your view of a levy across the bio-fuels supply chain to provide funding for an invasiveness response?

Question 12: What is your view of requiring an independent environmental report to establish the potential costs of control and eradication of invasive plants at the time of the property transfer?

Question 13: What is your view of using green investment indexes (or other weeds risk information instruments or standards) to inform investors of biofuels weeds risk ?

Question 14: What is your view of using eco-certification and eco-labelling schemes to inform consumers of bio-fuels weeds risk?

Question 15: What combination of these (or other) risk-management instruments do you consider would be most effective and efficient in managing biofuels weed risk?

Question 16: Do you have any additional comment(s)?

Thank you again for your participation!

Kind regards,

Elodie Le Gal
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Australian Centre for Agriculture and Law (AgLaw Centre)
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Armidale
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international access code + 61 2 6773 3602
Mobile phone: 04 0854 5481

This project has been approved by the Human Research Ethics Committee of the University of New England (Approval No. HE 09/109 Valid to 31 May 2011).

Should you have any complaints concerning the manner in which this research is conducted, please contact the Research Ethics Officer at the following address:
Research Services, University of New England, Armidale, NSW, 2351
Telephone: (02) 6773 3449
Facsimile: (02) 6773 3543 Email: Ethics@pobox.une.edu.au

APPENDIX 5

(Provided on UNE letterhead)

Consent Form for Participants

Title of the Project: Co-Regulatory Risk Management Model for the Management of the Risk Associated with the Use of Second-Generation Bio-fuels Crops for the Production of Bio-Ethanol

I, _____, have read the information contained in the Information Sheet for Participants and any questions I have asked have been answered to my satisfaction.
YES/NO

I agree to participate in this activity, realising that I may withdraw at any time.
YES/NO

I agree that research data gathered for the study may be published using a pseudonym.
YES/NO

I agree to the interview being audiotaped recorded and transcribed.

I would like to receive a copy of the transcript.
YES/NO

_____	_____
Participant	Date
_____	_____
Elodie Le Gal UNE PhD Candidate Researcher	Date