

Value and Natural Capital: Examining the Economist's Perspective

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This paper considers what economics brings to a conversation about environmental value, and what the limits of its contribution might be. Two parties with expertise in dissimilar fields might view the same problem or issue through differing conceptual lenses. A failure to make each party's underlying assumptions and goals explicit may diminish the effectiveness of the communication between them. With this in mind, this paper seeks to highlight and examine the assumptions and implicit goals that underpin the way in which economists think about value in general, and environmental value in particular. It also draws attention to the useful concepts – such as non-use value, opportunity cost, and the distinction between marginal and average valuations – that economics brings to a discussion of environmental value that other disciplines may overlook. Pulling these assumptions and concepts to the foreground is a necessary precursor to understanding the ways in which approaches taken in other fields differ. It may help economists be clearer themselves about what they are assuming, and also improve the communication between economists and thinkers from disciplines such as law, philosophy, and the natural and social sciences.

Arthur River, Mitre Peak and Milford Sound. Moore, Robert Percy, 1881-1948 :Panoramic photographs of New Zealand. Ref: Pan-1036-F. Alexander Turnbull Library, Wellington, New Zealand. <http://natlib.govt.nz/records/22453491>

I. Introduction

Two parties with expertise in different fields will often view the same issue through different conceptual lenses. If the assumptions and implicit goals that form the basis for each party's view are hidden from sight, the parties may talk past one another without fully understanding the other's perspective. This paper is motivated by the idea that communication between economists and thinkers from other disciplines will be enhanced if economics' implicit assumptions about value in general, and environmental value in particular, are brought to the foreground. Economics focuses on subjective value in exchange, and sees value as an individual's preference for one good relative to another. Thinkers from other disciplines may argue that this understanding of value is a normative and challengeable assumption. They may point out, for instance, that preferences do not necessarily reflect moral concepts or the needs of future generations, and by definition cannot reflect intrinsic value. They may

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argue that the very idea of preferences assumes commensurability between goods, which is contestable in itself, and furthermore emphasise that the way in which monetary valuations aggregate preferences is specific to the way wealth is distributed across the group in question. They may also reject treating the environment as an asset. Raising these sorts of issues gives us a clearer sense of the conceptual bounds within which the economics approach exists. It also reveals the strengths of the economics approach, especially its emphasis on concepts of scarcity and opportunity cost, and the distinction between average and marginal value. With an increased awareness of what economists are and are not doing, this paper aims to show what economics contributes to conversations about environmental value, and what the limits of its contribution might be. Some of the limitations raised could theoretically be resolved, but in real world applications they rarely are. The paper does not attempt to define a decision rule that is preferable to cost–benefit analysis but is instead an argument for greater dialogue among disciplines and humility when making decisions using any existing approach.

2. The Relevance of Perspective

A proposal to draw water from a river for private usage is likely to be assessed differently by parties with different background assumptions.¹ A scientist's priority might be to understand the effects of such an action on the local ecosystem. An economist might be most concerned with efficiency, working out which use of the water would maximise benefits to society. A lawyer may emphasise the importance of decisions being made in accordance with the laws governing resource use, emphasising the legitimacy of parliament as a democratically elected rule maker, making rules to govern society. Māori might conceive of the river as not just a resource but as something they have a spiritual and cultural connection to. A sociologist or social psychologist will take a different perspective again. Each way of looking at the issue contains different implicit assumptions about the nature of the river and our goals in using it, or in refraining from doing so. None of these perspectives is obviously “better” than the other. And they are all relevant to New Zealand's multi-faceted legislative regime governing resource management (which includes the Resource Management Act 1991, iwi management plans, regional policy statements and various Treaty of Waitangi settlement acts). At times, these different viewpoints may not be mutually exclusive, but at other times, they may conflict. For instance, in 2012 Te Kaunihera Māori o Aotearoa/New Zealand Māori Council acknowledged the role of the law in dealing with water allocation rights but distinguished “narrow legal” concerns from “moral” issues around water allocation, emphasising the importance of the latter and insisting that their proper place was the public sphere, rather than the court room (Small and Watkins, 2012). If each party's own goals and assumptions are made clear, they are more likely to be able to understand each others' perspective, have a clearer idea about why they see things differently, and contribute to a broad, multi-faceted understanding of the issue in question.

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¹ To avoid offence and stereotyping, we stress that an individual from any one discipline or background, within their own thinking may draw on other disciplines. For economists, we emphasise thinking that is common among economists, and similarly for other perspectives.



3. Valuing the Environment: The Economist's Perspective

3.1. Why do Economists Seek to Value the Environment?

In general, economists evaluate possible courses of action or future states of the world in order to achieve efficient outcomes that maximise net present benefits (the value now of all benefits arising in the future). If the net present benefits of a proposed course of action exceed its net present costs (the value now of all costs arising in the future), then the action is a desirable one (Tietenberg and Lewis, 2009). Economic estimates of environmental values are used in cost–benefit analyses and to determine legal liability for environmental damage, to set eco-tax rates, in natural asset management and for green accounting.

For the cost–benefit framework to be used properly, all relevant costs and benefits – including those that are environmental – must be included. Assume that under a simple one-period model, the water that can be drawn from our river has a market value of \$100, and the cost of delivering water to consumers (for instance, through constructing pipelines and monitoring usage) is \$90. Simply comparing these two numbers to show that the benefits outweigh the cost is insufficient if there are also environmental effects to consider. Removing the water may also reduce the resilience of fish stocks in the river, and the ability of bathers downstream to use the river for recreation. If these costs together amount to more than \$10 then the total cost of the project would exceed \$100 and it would be inefficient for it to go ahead.

3.2. What do economists mean by “value”?

The meaning of “value” has not remained static throughout the history of economic thought. Adam Smith (1776) drew a distinction between “value in use” and “value in exchange”. He described the former as “the utility of some particular object”

and the latter as “the power of purchasing other goods which the possession of that object conveys”. Smith also saw a connection between the labour time expended in producing a good and its value: “If ... it usually costs twice the labour to kill a beaver which it does to kill a deer, one beaver should naturally exchange for or be worth two deer. It is natural that what is usually the produce of two days’ or two hours’ labour, should be worth double what is usually the produce of one day’s or one hour’s labour”. However it is unclear whether Smith believed labour created value in some fundamental sense or merely served as a predictor of value in exchange (Robinson, 1962).

David Ricardo (1821) thought that the latter was true, arguing that “the value of a commodity, or the quantity of any other commodity for which it will exchange, depends on the relative quantity of labour which is necessary for its production”. For Karl Marx (1867), the quantity of labour used up in the manufacturing of a product was more than merely a predictor of value in exchange: labour time determined the value of a good in a more fundamental and immutable sense, independently of how the goods were exchanged in a market. Indeed Marx refers to labour as “the value-creating substance”.

In more recent economic thought, there is less interest in value as an abstract concept. The subjective theory of value that Hicks builds in *Value and Capital* (1939) is a model of consumer demand based on preferences. Debreu’s *Theory of Value* (1959) constructs an axiomatic model of consumer and producer behaviour and ultimately, economic equilibrium. What Hicks and Debreu fail to say is important: there is no discussion of “value” in a metaphysical sense; it is assumed that value is to be understood subjectively. This means that how highly an individual values a good is not necessarily connected to the labour used to produce it or its “usefulness”. Instead, it is simply based on the individual’s preference for that particular good relative to others. If Adam has a belt but would be willing to swap it for a hat, then he values hats more highly than belts. The move from barter to monetary purchasing does not introduce an absolute measure of value for either of the goods – money is merely a medium of exchange between them. If Adam will pay up to \$5 for a belt and up to \$10 for a hat, this simply indicates his relative preferences for these two and any number of other goods, subject to his budget constraint.

Importantly, the value of these goods in exchange will not necessarily reflect Adam’s subjective valuations. Value in exchange will depend on the point at which supply and demand are in equilibrium, which is determined by all other consumers’ subjective valuations, as well as the cost of supply. It may be the case that, due to these factors, belts are exchanged for \$4 and hats for \$12 in the market. In this case Adam will purchase a belt but not a hat.

The implications of a subjective theory of value based on preference ordering are illustrated by the history of value of Stevengraphs – small, decorative, Victorian-era, woven-silk pictures. The “Dick Turpin” Stevengraph, depicting a romanticised outlaw figure, retailed for 5p in 1879 (£2.1 today), and between 1881 and roughly 1960 were more or less unsellable (in other words, had a value of basically zero). However, due to the revival of interest in Victorian-era collectables, by 1970 one would fetch around £100 (£1,310 today) at auction (Thomson, 1979). These fluctuations in value are drastic. They demonstrate that the value of a good is not related to its physical

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properties, nor its usefulness or the labour expended in producing it – as these were all constant as the value of the Stevingraph fluctuated. Thomson argues that value is conferred upon the object by society itself. We might add that this conferral of value is simply a reflection of changing social preferences.

3.3. How do economists value the environment?

We have seen that valuation is necessary in order to quantify the costs and benefits of a given course of action. But how are the costs and benefits of a decision about an environmental good conceptualised? People's willingness to pay to preserve an environmental good represents the benefit of preservation. Cost is understood in terms of the opportunity cost of preservation, namely, the benefits of the most valuable alternative course of action foregone. For instance, the benefits of preserving a river will be the sum of individual willingness to pay to keep it as it is, while the cost will be the foregone benefits that drawing water from the river (or whatever the best alternative is) would bring.

The "total economic value" of an environmental resource has three components: use value, option value, and non-use value (Tietenberg and Lewis, 2009). Use value reflects the value of the direct use of a resource. This might include the value (on the market) of the water drawn from our river, as well as the value of non-market uses such as recreational kayaking, or a resilient river ecosystem. Option value reflects the value placed on a future ability to use a resource. We might be willing to preserve an option to use the river in the future, even if we are not using it now, and this future use might even be one which we have not yet anticipated. Non-use value reflects the idea that people are willing to pay for a resource they will never use. Adam may never intend to visit the river, but he may place a value on its continued existence (existence value). Likewise, he may place a value on simply being able to pass the river on in its present state to future generations (bequest value).

Some uses of a given environmental good are rival, meaning that one person's use of the good will be detrimental to others' ability to use it. Drawing water from the river is an example – if Adam takes enough water from the river, Belinda's ability to do the same will be impeded. However, environmental goods also have non-rival elements. Non-uses are non-rival: for instance, Adam's ability to derive satisfaction from knowing the river exists or that he will be able to pass it on to his heirs does not conflict with Belinda's ability to do the same. Some uses of an environmental resource are also *largely* non-rival: unless space is already very limited or the water is very crowded, Adam swimming in the river will not prevent Belinda from doing the same. Graphically, the aggregate demand for non-rival aspects will equal the vertical sum of individual demand curves. In other words, the aggregate value of the good will be equal to the sum of each individual's valuation. If our society consists of 10 people and they each value non-rival uses of the river at \$10 each, then the total value of these aspects of the river to society is \$100.

Different techniques can be used to elicit these values, and they can be grouped into revealed and stated preference techniques. Revealed preference techniques use observable behaviour to elicit the value of environmental assets. Market prices, such as the price at which water from the river can be sold, directly reveal exchange values.

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Valuations can also be revealed in indirect ways. The travel–cost method is used to infer the value of the river to people by looking at how much people spend visiting it (for instance, the opportunity cost of their time, fuel costs, and any admission cost). Hedonic property valuations look at behaviour outside river visits or river water but in a related market – property. Using regression analysis, we might tease out the value of the river by looking at how much more people are willing to pay to live nearby, all else being equal.

Stated preference techniques are used when there is no observable behaviour available to reveal preferences. Individuals are questioned about hypothetical changes to the environment. Under a contingent valuation survey, a respondent might be asked what they would be willing to pay to keep the river in its current state, as opposed to it being dammed or drained. Conjoint analysis is another, less direct method of ascertaining stated preferences. A respondent’s choices between alternate states of the world reveal preferences for different attributes which vary across the bundles – one of which might be the condition of the river.

Valuing the environment in these ways is not uncontroversial. For instance, economists disagree about how good a job stated preference techniques can do of revealing preferences. During the controversy sparked by the Exxon Valdez spill, Diamond and Hausman (1994) argued that stated preference techniques were fundamentally flawed and incapable of revealing preferences, while a panel of other eminent economists argued that if used correctly they could in fact have value (Arrow et al., 1993). While the techniques used have developed and become more robust since, the accuracy of stated preference techniques continues to be debated, and the field continues to develop accordingly (Kling et al., 2012).

However, the point of this paper is to examine the economic approach to environmental valuation and the assumptions it rests upon, rather than the problems that arise within it. We have seen that generally speaking, statements about the economic value of an environmental good reflect subjective preferences for that good relative to other goods, within an individual's budget constraint. We have also seen that these valuations are aggregated in order to ascertain the total costs and benefits of possible courses of action, so that we might allocate resources most efficiently to achieve socially optimal outcomes – this methodology has a certain attraction to it. We might feel intuitively that something is wrong if a decision about drawing water from a river depends on the decision-maker's personal views or is based on an incomplete consideration of relevant factors – such a decision would be arbitrary. By contrast, a cost–benefit analysis requires us to translate dissimilar units – such as litres of water and kilograms of food – to one common monetary unit. This might seem to give an objective way of making policy decisions, whereby the right course of action might be revealed by a mechanical process. This idea will be returned to at the end of this paper. By that point, hopefully, it will have been shown that any claims of neutrality are too simplistic. Economic analysis of environmental value is a useful tool, but it cannot be seen as being neutral or objective in any meaningful way, as it is premised on normative, contestable assumptions which assert a distinctive moral position.

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4. Assumptions in the use of preferences

4.1. Do we necessarily have defined preferences?

The theory of value we have described assumes that all goods are comparable, and that we have preferences between them in some meaningful sense. If there are two goods to choose between – say an apple and an orange – there are three possible preference orderings: we either prefer the apple to the orange, the orange to the apple, or we view them equally.

However, the notion of incommensurability challenges the idea that things are necessarily comparable and that we have preferences between them. If it is true that neither of two options are better, and also true that they are not of equal value, then the two options are said to be incommensurable (Raz, 1998). If two options are incommensurable, then they cannot be compared in a meaningful way.

Say that Adam is asked to choose which he values more highly – his daughter Belinda's ability to swim in the river that he swam in as a boy, or his chance of a better-paid job that could result from further dairy conversions around his rural town. He might claim that he cannot choose – not because the two options are of equal value, but because he feels that he cannot meaningfully compare them. An economist might respond that Adam merely feels uncomfortable placing a value on Belinda's connection with nature, and surely the decisions he makes will reveal his preferences. For instance, say Adam is offered a similar, better-paid job in a far-off city. Accepting it will mean that that he will earn more money, but that Belinda will not be able to swim in the river. If he accepts, it might seem that we can conclude that the job opportunity is more valuable to him, and therefore, that we can put a maximum dollar value on his concern about the river. We can also imagine a



Aerial view of the Manawatu River and surrounding plains. Raine, William Hall, 1892-1955: Negatives of New Zealand towns and scenery, and Fiji. Ref: 1/4-019720-F. Alexander Turnbull Library, Wellington, New Zealand. <http://natlib.govt.nz/records/22817120>

scenario where, put at gunpoint, Adam is forced to choose to either give up the clean swimming hole or give up the chance of a better-paid job. The economist might argue that Adam's preferences could (at least in theory) be revealed in these ways.

This argument depends on an assumption about the nature of preferences. It assumes that preferences are like a landscape obscured by fog. We cannot directly observe the landscape, but we know that it is out there, has a defined shape at a given moment in time, and is waiting to be discovered through a mediated observation – in the case of preferences, through conclusions we can draw from choice.

Joseph Raz (1998) argues that the fact that a choice was made is not enough to prove that the chooser valued the chosen option over its alternative. He argues that one might even choose the less valued of two options, in a case of “weakness of the will”. This is like saying that the methodology that we use to cut through the fog and look at the landscape might be misleading us. Psychologist and behavioural economist Dan Ariely (2008) gives an example of Raz's point when arguing that we are often irrational in our decision making. If we allow for the possibility of irrational decisions, it seems reasonable to think that our decisions do not necessarily reveal preferences in any meaningful way.

More fundamentally, though, Raz argues that the response an economist would make to Adam's assertion that he cannot choose would be putting the cart before the horse. Such a response assumes that Adam has defined preferences between the two options, despite his insistence that he does not. It asserts that there is a landscape with a defined shape under the fog, and then works backwards through observation (of choice) to describe the shape of that landscape. Raz, however, insists that we take Adam seriously when he claims that there is no landscape, or no clearly defined preferences – at least not in the way that the economist commonly conceives of them.

The economist's theory of preference simply assumes that what we choose is what we prefer. There are philosophical and psychological arguments, taken seriously in those disciplines, that choices might not reveal preferences in a meaningful way, and that

we might genuinely not rank preferences between different options. If one thinks that these views have some merit, then the whole idea of valuing environmental goods by inferring preferences on them from people's behaviour starts to seem shaky.

4.2. Issues with preference aggregation

4.2.1. Preference aggregation depends not only on what people want but on how wealth is distributed

Putting aside fundamental issues around whether we have meaningful preferences, issues with the aggregation of preferences remain. One such issue is that of weighting: how are we to compare preferences between individuals. Say that Adam quite likes both dogs and cats, but when pushed, he prefers cats. Belinda, on the other hand, loves dogs but cannot stand cats. If we try to aggregate their preferences, should we rank their favourites equally – in which case, the two-person group equally prefers both cats and dogs? Or should we try to take into account the intensity of their preferences? In a case like this, this might seem easy to do – dogs intuitively seem to be the overall group favourite. But where we have more than two people or where preferences are not as convenient as those in the example, making interpersonal comparisons becomes more difficult (see, for example, Harsanyi [1955]). Cost–benefit analysis uses the principle of ‘potential pareto improvement’ proposed by Kaldor (1939) and Hicks (1939), where an outcome is considered to be efficiency improving if it is possible to arrange sufficient compensation from those that are made better off to those that are made worse off so that all parties end up no worse off than before. Cost–benefit analyses can be used to assess the distributional implications of decisions, and sophisticated weighting systems can take account of distributional considerations (Hanley and Barbier, 2009, Chapter 2) but in many simple applications they are not.

In liberal democratic politics we put to one side the question of making interpersonal comparisons, and simply revert to egalitarian principles. Each eligible voter in New Zealand's general elections can cast one party and one electorate vote under the Mixed Member Proportional voting system. Say Belinda has informed herself about the key election issues, strongly believes that the Cricket Party would best govern New Zealand, and votes accordingly. Adam, on the other hand, has no interest in politics, turns up on the day undecided, and votes for the Rugby Party and their candidate because he likes their logo. The difference in the strength of their preference and, it might seem, the validity or justification of those preferences, is not reflected in the method of aggregation – instead, every person's vote carries the same weight.

However, when we aggregate preferences in order to value environmental goods, it is apparent that not everyone's preferences carry equal weight. If we use either revealed preference or estimates of ‘willingness to pay’ (a stated preference technique), the value we assign to an environmental asset depends not only on what people want, but on how wealth is distributed. Say that Adam and Belinda make up a two-person society with a total wealth of \$100. Belinda proposes to build a lodge on a headland by a currently untouched beach and has lodged an application for a resource consent. It has been calculated that opportunity cost of keeping the beach untouched (the net benefits associated with building the lodge that would be foregone if the beach is



preserved) amount to \$10. With this in mind, a willingness to pay study is conducted to ascertain the value Adam and Belinda place on preserving the beach in its current state. Adam, who identifies as an environmentalist, is willing to commit 20% of his wealth (at any level of wealth) to preserve the beach in its current state, rather than allowing the lodge to be built. Belinda wants most of all to build the lodge, but she does care somewhat about the beach. She would be willing to commit 1% of her wealth (also at any level of wealth) to preserve it against any threat other than her lodge. Consider two wealth allocation scenarios. In the first Adam, the environmentalist, has \$90, and Belinda has \$10. Adam's willingness to pay to preserve the beach – in other words, his valuation of the beach in its current state – is 20% of \$90, or \$18. Belinda's is 1% of \$10, or \$0.10. The total value of the untouched beach to society under this allocation is therefore \$18.10. In the second allocation, Adam has \$10 and Belinda has \$90. The value of the untouched beach to Adam is 20% of his \$10, namely \$2. Belinda's valuation is 1% of \$90, or \$0.90, meaning that the total value of the untouched beach to society is \$2.90.

In the first scenario, the benefits of preserving the beach outweigh the opportunity cost of doing so, and the beach should remain as it is. The 'rich environmentalist' holds sway, constraining the poor person's land use. In the second scenario, the opportunity cost of preservation outweighs the benefits, and the lodge should be built. The 'rich developer' holds sway over the poor environmentalist. Importantly, the total wealth of the society has not changed between the two scenarios. And if we accept that expressing willingness to pay as a fixed portion of income roughly represents a consistent level of "desire" to preserve the beach, then what each person "wants" appears not to have changed across the two scenarios either. The social decision is, however, reversed.

If Belinda were required to directly compensate Adam for the loss of untouched beach, Adam's level of wealth would be less decisive – his willingness to accept

(the amount of compensation at which he will accept the lodge) may be much higher than his willingness to pay when he is poor. Decisions in situations where private transfers are easily negotiated, and actual pareto improvements must be achieved to reach agreement, will tend to mimic the outcome of a cost–benefit analysis. Cost–benefit analyses are however used because private agreements cannot easily be reached, and the parties who lose from the decisions made are not often compensated. If compensation is not going to be offered, can the validity of a principle that depends on it still hold?

This is true not just for willingness to pay but also for all revealed preference methods. For instance, under the travel cost method, a relatively poor individual is less likely to be able to afford to travel to the river or pay an entry fee (and if they were, the opportunity cost of their time is probably less). If preferences are expressed in monetary terms, then those with less wealth will have less ability to make their preferences count towards the aggregated whole. That your ability to pay influences the extent to which you have a say in decision making (assuming we are eliciting values in order to make decisions about resource allocation) is in direct contrast with the egalitarian, non-wealth focused approach made clear in New Zealand’s Electoral Act 1993 (s 216) – which explicitly makes it illegal to buy or sell votes in a general election.

4.2.2. Comparisons of value between two societies with differing levels of wealth

Say that Richland and Poorville are two societies that have the same number of citizens and identical natural environments. The citizens of each are all willing to contribute 10% of their wealth, at any level of wealth, to avoid having one tonne of toxic waste dumped in the main river that runs through their respective countries. If Richland has a wealth of \$200 and Poorville a wealth of \$20, then the value or benefit of avoiding the waste will be \$20 in Richland and \$2 in Poorville. It may seem counterintuitive to some that the natural environment in Poorville has less “value”, given that it has the same characteristics – and, moreover, given that the number of people are the same and they appear to feel the same way about preserving the river (again, taking a willingness to pay as a fixed proportion of income as roughly meaning that the desire to avoid pollution and preserve the river is the same). The upshot of this difference in value is that if Richland was to produce one tonne of that waste, it would make sense in economic terms for them to pay Poorville between \$2 and \$20 to take it on (assuming no alternative disposal methods other than river dumping). However, while this could in theory be a fully informed and voluntary transaction which benefits both parties, it may also run contrary to human instincts of equality and fairness. We can see a real-life example in the controversy surrounding a 1991 internal memorandum by the then-Chief Economist of the World Bank, Larry Summers. The memorandum stated that “a given amount of health-impairing pollution should be done in the country with the lowest cost, which will be the country with the lowest wages ... the economic logic behind dumping a toxic load of waste in the lowest-wage country is impeccable”. While *The Economist* conceded that “on the economics, [Summers’] points are hard to answer” the memorandum, unsurprisingly, proved hugely controversial. Brazil’s Secretary of the Environment, José Lutzenberger, said that “[Summers’] reasoning is perfectly logical

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but totally insane ... [it provides] a concrete example of the unbelievable alienation, reductionist thinking, social ruthlessness and the arrogant ignorance of many 'economists' concerning the nature of the world we live in". Lutzenberger's statement appeared to resonate with a wider public sentiment that human lives and the environment should not be worth more or less depending on people's level of wealth. It is worth noting that, contrary to the economic logic behind selling waste, the international community has widely adopted the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal in order to regulate, reduce and restrict the international transfer of hazardous substances, especially from developed to less developed nations.

Otaki Forks, Waiotauru River, Tararua Forest Park. 2010. Wikimedia Commons. http://commons.wikimedia.org/wiki/File:Otaki_Forks_Waiotauru_River.jpg

4.2.3. Preference aggregations are specific to a given moment in time

Thinking of value as aggregated preferences is an anthropocentric stance and means that the value of an environmental good will vary depending on how many people are alive when the valuation occurs. This may seem obvious, but the results can be surprising. If 10 percent of the population of New Zealand suddenly succumbed to a deadly virus, then the Tararua Forest Park, for instance, would immediately be worth less. This may seem counterintuitive to some, and ties in with a discussion of the intrinsic value perspective.

The economic concept of value might be criticised for the way it includes the needs of the future generations who will receive natural and other forms of capital from us only to the extent that concern about their wellbeing affects our preferences. Those who are not yet born cannot retaliate against actions we take, nor offer us anything in exchange for preserving assets on their behalf. As a result, we may not have enough incentive to refrain from making decisions that, while more beneficial than costly to us within our lifetimes, impose costs on others in the future – in other words, we may not fully internalise a sort of inter-temporal externality into our decision

making. This is obviously an issue in the case of a depletable resource, whereby our decision to maximise our own gain now may mean costs for others in the future. For instance, if the benefits of extracting coal from an open cast mine and burning it now are not invested, then future generations will bear the environmental cost of worsened environmental amenities without receiving the benefits that mining the coal brought. In such a case, the cost (from the lost use, option and non-use value) may continue to be borne by additional generations to come, while the benefits (again, assuming no or incomplete investment) may not stretch into the future.

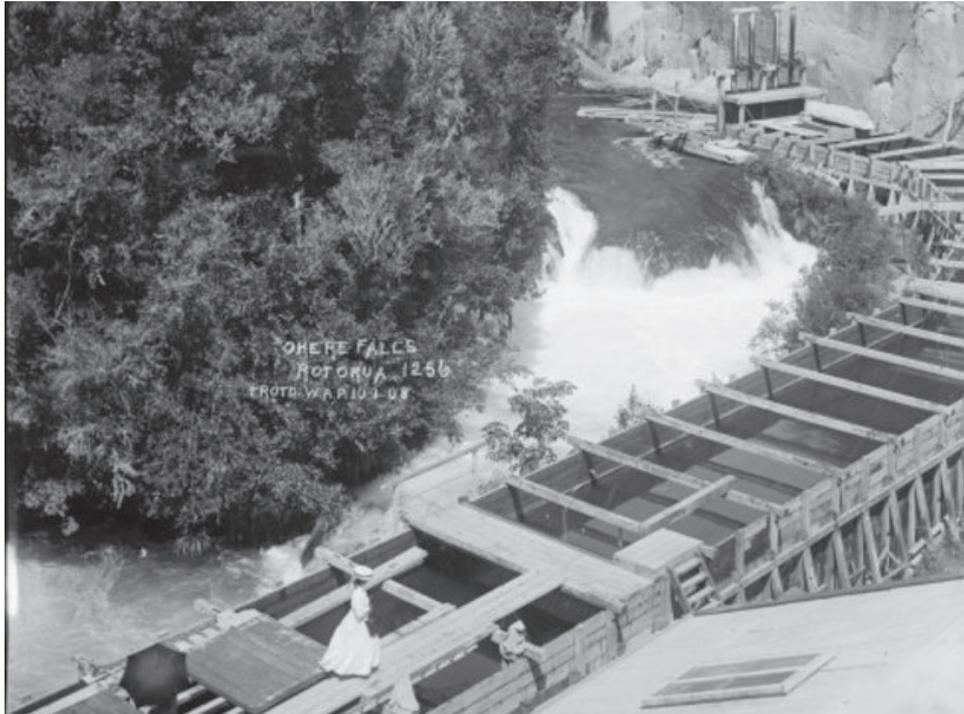
Even if we did fully consider the interests of future generations, the idea that future generations should be taken into account is still problematic. Caplin and Leahy (2004) point out that we have no reason to believe that preferences in the future will coincide with preferences as they exist now. This may well be true of our individual preferences (which of course do evolve – we can all recall decisions made 10 years ago that we are unlikely to repeat today) and seems particularly likely if we try to imagine the preferences of people who do not yet exist. If we think back to any period of history, social norms and preferences change continually and at a rapid rate, and there seems no reason to believe that this will not continue to be the case.

Caplin and Leahy show that the way we think about trade-offs in the future misses the idea that preferences may change. For instance, standard two-period investment–consumption decisions that are modelled on a Fisher diagram representing trade-offs between current and future investment explicitly consider only our current preferences when deciding the optimal consumption level. While this might make sense from a private decision making perspective – for our welfare maximising individual, for instance – Caplin and Leahy argue that social policy making is a different matter. Say that a decision is made now that depletes the natural environment in a lasting way but offers ongoing benefits that *we* perceive to outweigh the costs. For instance, we might all agree that the benefits of diverting our hypothetical river at its source to a reservoir to generate electricity outweigh the costs that we have ascertained through observed and stated preference techniques. However, the preferences of those who are not yet born but who will one day inherit a world with either one more river or with more plentiful electricity may well be different to ours, just as social preferences for Dick Turpin Stevengraphs have varied so much over the years. Unlike decisions to purchase a woven-silk picture or not, a decision to divert a river is likely to have serious elements of irreversibility. These issues are not ignored in discussions of appropriate ways to discount future costs and benefits; nor however are they completely resolved.

Earlier, we showed that valuations based on aggregated preferences are specific to a given wealth distribution. Here we have shown that they are also specific to the moment in time at which they occur. Finally, the fact that preference aggregation does not attempt to take into account future preferences – which we in any case cannot know – is further complicated by the idea that who actually exists in the future and what their preferences are will be influenced by the choices we make in the present.²

If the benefits of extracting coal from an open cast mine and burning it now are not invested, then future generations will bear the environmental cost of worsened environmental amenities without receiving the benefits that mining the coal brought. In such a case, the cost may continue to be borne by additional generations to come, while the benefits may not stretch into the future.

² Preference aggregation is also beset by a far more fundamental problem. Arrow's impossibility theorem (1951) demonstrates that no possible system of aggregating rank-ordered preferences can meet a set of basic conditions, which we might consider pre-requisites to fairness, without being prone to intransitivity.



Power station at Okere Falls, Rotorua District. Price, William Archer, 1866-1948 :Collection of post card negatives. Ref: 1/2-001464-G. Alexander Turnbull Library, Wellington, New Zealand. <http://natlib.govt.nz/records/22604008>

5. Other ways of thinking about value and the environment

Thinkers from other disciplines may argue not just that a cost–benefit analysis of the environment depends upon a contestable assumption about how we weight preferences, but also that both value and the environment can be conceptualised in fundamentally different ways. These views are worth briefly surveying – even if the economist chooses to reject them, an awareness of other ways of thinking will give a clearer idea of what an economic valuation of the environment is and is not doing.

5.1. Moral philosophy

We have seen that economic statements of value are budget-constrained statements of preference, and that we try to understand these preferences in order to best allocate resources. It is important to recognise that this approach is making a normative claim about what we should be doing: that is, satisfying individual preferences.

Moral philosophers would point out that such a claim is contestable. Of the major schools of thought in moral philosophy, the idea of preference maximisation most naturally aligns with utilitarianism. A simple statement of utilitarianism first proposed by Bentham (1776) and adopted by Mill (1879) is “it is the greatest happiness of the greatest number that is the measure of right and wrong”. Assuming that people prefer what makes them happy (which Mill effectively does), then making decisions based on valuations – which reflect preferences – seems aligned with utilitarianism. The most fundamental criticism of this is the positing of general happiness as the sole moral good (Flynn, 2000). In much the same way, we might disagree that preference satisfaction is the sole moral good that individuals ought

to aim for. It is not difficult to think of examples of our preferences not correlating with what we consider to be *right*; the following example is adapted from Flynn's critique of utilitarianism. Imagine that psychology discovers that sadists' preferences for sadistic behaviour are the most strongly felt preferences that exist. Furthermore, psychology also discovers a way of conditioning everyone to be a sadist and a machine is invented that can give the illusion of torturing innocent people. These people are imaginary, but they are believed to be real by those using the machine. Conditioning and the use of the machine would enable us to maximise preference satisfaction. But as Flynn points out, many of us would feel uneasy with this. We might be willing to accept a lower level of preference satisfaction in exchange for a gain in human dignity and decency.

In some cases at least, it is easy to see how preference satisfaction may seem like an impoverished goal for human action. Simply put, this is because we may feel that individual preferences do not always coincide with what is morally "right" or "wrong".

We might even think of examples where we have made social decisions to forbid transactions which both parties would prefer to occur. The Basel Convention, for instance, prevents possible voluntary and preference-satisfying transactions from taking place on moral grounds. Prostitution, until relatively recently in New Zealand, was another, whilst underage prostitution remains forbidden.

None of these examples, of course, relate to decision making about environmental goods. The point is to demonstrate that if making decisions in accordance with subjective valuations has the implicit goal of satisfying preferences, then decisions made this way might be contested. In some cases at least, it is easy to see how preference satisfaction may seem like an impoverished goal for human action. Simply put, this is because we may feel that individual preferences do not always coincide with what is morally "right" or "wrong".

5.2. Intrinsic value

Intrinsic value can be defined as the value that something has "in itself" or "for its own sake" (Zimmerman, 2010). The idea of an aspect of the natural environment having value in and of itself is at odds with the economics perspective, which conceives of value in an anthropocentric sense. Deep ecologists such as Arne Næss (2010) have argued that human and non-human lives have intrinsic or inherent value, which is independent of the usefulness of the non-human world for human purposes. Proponents of the deep ecology view argue that allowing humans to place a value on other species has no more of a moral basis than allowing other species to place a value on human lives. This perspective is fundamentally different to that of the economist. Under this view, the natural environment would not be more or less valuable depending on how wealth is distributed and indeed, the natural world would retain an intrinsic value even if no humans were alive. For the economist, at a moment in time where no human beings were living, the natural environment would have a total economic value of zero.

From the deep ecology perspective, humans also have no right to reduce the richness and diversity of life-forms other than to satisfy vital needs. This is in direct contrast to the economic view of the environment as an asset which produces raw materials that the economy converts into consumer products, energy and services to consumers (Tietenberg and Lewis, 2009). For the economist, there is nothing fundamentally



different about the natural environment compared to any other asset, and as such, the environment and other assets are substitutable to the extent that they can replicate each other's usefulness to humans. Accordingly, protection of the environment is just like any other commodity that can be bought and sold (Ackerman and Heinzerling, 2002). These two competing perspectives come from such different starting points that it is difficult to know how to evaluate them. What is important is to recognise that they cannot be reconciled by appeal to fact. An element of the deep ecology sentiment potentially permeates the consciousness of the wider public: while it is unlikely these views are completely accepted to any significant degree, there may be some affinity to the idea that nature has an importance that goes beyond humans. For instance, it may be the case that people think that planet Earth, devoid of human beings, would be better if it were a thriving ecosystem than a barren wasteland. Yet the economics perspective is incapable of capturing this sentiment – under either scenario, the value of the planet – with no humans to construct use, option or non-use values – would be zero. This difference between the perspectives of deep ecologists and economists is a fundamental philosophical disagreement about the importance of different classes of living organisms. It is also not clear how intrinsic values could systematically affect human decision making since, by definition, humans probably cannot conceptualise values that do not come from a human perspective. If we are, however, to reject Næss and other deep ecologists' views and value the environment from an anthropocentric perspective, we should at least be aware of – and comfortable with – our reasons for doing so.

5.3. Other perspectives may offer more diverse approaches to thinking about these issues

Other disciplines or points of view might lead us to think about the environment and value in different ways. For instance, religion can play a meaningful role in shaping adherents' understanding of and interaction with nature (Jenkins and Chapple,

Dead trees, Catlins district. Williams, Edgar Richard, 1891-1983 :Negatives, lantern slides, stereographs, colour transparencies, monochrome prints, photographic ephemera. Ref: 1/2-140731-G. Alexander Turnbull Library, Wellington, New Zealand. <http://natlib.govt.nz/records/22623508>

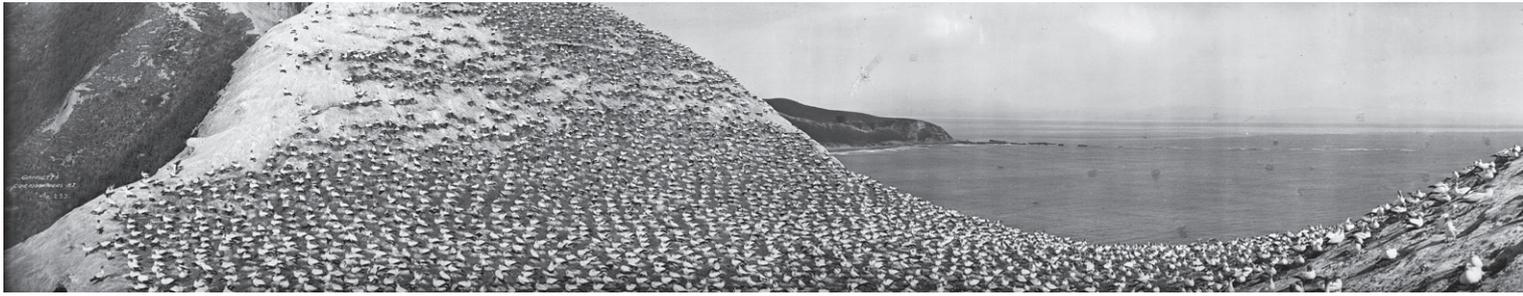
2011). Those whose understanding of the environment is influenced by a spiritual perspective may also take issue with the approach of treating the environment as an asset that is substitutable for other goods. Under a traditional Māori worldview, an aspect of the natural environment such as our hypothetical river might be understood as having mauri (life force), taniwha (spirit guardians), and a central place in tribal identity (The Waitangi Tribunal, 2012). More generally, under this view the environment is not conceived of as being a passive resource awaiting exploitation. Instead, it is inextricably linked to humans through a concept of mutual dependency. It has vast spiritual significance, and is important in creating human and cultural identity (Roberts et al., 1995).

This worldview is so radically different that it would be inaccurate to simply say that Māori place a higher value on the environment and meaningless to try and express this – or any – relationship of people and the natural environment as numbers in a cost–benefit analysis. This view is not the same as the deep ecology view but is similar in that it lacks the clear dichotomy of mankind and nature required by the anthropocentric system that values the environment in terms of its usefulness to man. A Kantian view may argue that humans need to protect other species, not because they are useful to us but in order to maintain our humanity (Kant, 1785, p. 240).

The concept of “value” is not explicitly employed in law in a sense equivalent to the economics usage. However, one comparison between the two disciplines may illustrate the way in which thinking differs. The principle of the rule of law, one of New Zealand’s central constitutional principles, is of relevance here. Under Dicey’s (1885) formulation of the principle, no one ought to be punished except for a breach of law proved in court, and everyone is equal before the law regardless of status. Bingham (2007) formulates the core of the principle as being that all persons within the state should be bound by and entitled to the benefit of laws publicly and prospectively promulgated and publicly administered in the courts. Bingham emphasises that the law should be knowable in advance, and exercised properly and not in a discretionary fashion.

So in the law, it is not just the outcome of a legal decision that matters, but the process. If we focus too singularly on achieving the most efficient allocation of resources, we may lose sight of the importance of the route which we take to get there. Putting all possible concerns about how we value the environment to one side, assume that it is agreed that the most efficient use of our hypothetical river is to use a certain portion of the water that flows through it to irrigate nearby fields. It may be the case that because of other factors that the legislative regime requires to be considered, this outcome is not achieved. Instead, no water is permitted to be taken, to the detriment of society. From a legal point of view, it may be more important that the law was correctly applied than that the best outcome was reached. A decision that ignored those factors that the legislation mandated would be seen as arbitrary, unfair and contrary to the rule of law, no matter if it brought about the desired outcome. It would render the state of the law uncertain, and blur the rights of others seeking to rely on the same piece of legislation. The law will not, of course, always shape inefficient outcomes – there is no necessary tension between the rule of law and principles of economic efficiency. However, this comparison reminds us that in other disciplines processes are as important as outcomes.

Under this view the environment is not conceived of as being a passive resource awaiting exploitation. Instead, it is inextricably linked to humans through a concept of mutual dependency.



6. What strengths does the economics approach offer?

How might economists respond to claims such as that the natural environment has an intrinsic value, and that people might not always have meaningful preferences between different options? Economics does provide us with a number of concepts that help clarify our thinking. Chief among these are scarcity and opportunity cost. A resource is scarce when not enough of it exists to satisfy demand at a price of zero. Scarcity introduces the necessity of choice, which implies rejected as well as selected alternatives. The value of the most highly valued of the rejected alternatives or opportunities is the opportunity cost of the choice made.

Essentially, these concepts remind us that decision making necessarily involves trade-offs. Regardless of whether Adam is willing or even can make a comparison between his friendship with Belinda and his holiday home, a decision maker deciding how resources are to be allocated does so under conditions of scarcity, and foregoes alternative courses of action. Rivers and water are scarce resources. If we are motivated by the idea of intrinsic value to leave our hypothetical river untouched, this action brings with it the cost of foregone electricity generation or improved crop yields. The trade-off being made may come most into focus where the choice is between two similar options, such as two environmental protection programmes. Say a decision maker has \$100 left in her environmental budget, and that this will be just enough to *either* run a programme to prevent a native bird from going extinct *or* to buy a large tract of privately owned native forest that is about to be logged and convert it to a national park. It may be the case that both projects are highly desirable. However, regardless of the conviction with which views about intrinsic value, spiritual connection to the environment, and moral rights and wrongs of certain courses of action are held, a trade-off has to be made. Arrow et al (1996) argue that “because society has limited resources to spend on regulation, benefit–cost analysis can help illuminate the trade-offs involved in making different kinds of social investments ... it seems almost irresponsible to not conduct such analyses, because they can inform decisions about how scarce resources can be put to the greatest social good”.

A non-economist might accept that trade-offs have to be made and that every action has an opportunity cost. This does not mean, however, that they have to accept that the only way we can think about trade-offs is in terms of values which represent budget-constrained subjective preferences. It may be the case that the benefits of damming our river to generate power come to \$300, and the costs (as ascertained through the revealed and stated preferences of the entire society) come to \$100. A deep ecologist might accept that trade-offs are being made and recognise what will

Gannets, Cape Kidnappers, New Zealand. Moore, Robert Percy, 1881-1948: Panoramic photographs of New Zealand. Ref: Pan-2381-F. Alexander Turnbull Library, Wellington, New Zealand. <http://natlib.govt.nz/records/22744736>

be foregone if the dam is not built, while still believing that the dam ought not to be constructed on the basis of the principle of doing as little harm to nature as possible. Furthermore, a non-economist might point out that economists tend to assume competent, benevolent dictators and tend to assess situations in isolation from their broader context. Poorly done, cost–benefit analyses could systematically benefit strong lobby groups. Simple models of decision making – such as the example given above, whereby either a bird species will be saved or a national park created – create direct trade-offs which may not represent how decisions are made in real life. While it is true that resources are scarce and, for instance, decision makers do have limited money to spend, it is not necessarily the case that trade-offs are as obvious or clear as those posed in this example. In real life, a decision not to spend the last \$100 on saving the bird species might not mean that a national park is created. The cost–benefit study might instead lead to a change in the agency’s budget.

While it is true that resources are scarce and, for instance, decision makers do have limited money to spend, it is not necessarily the case that trade-offs are obvious.

Economics also draws a distinction between marginal and average valuations, which enriches what it is that economists do when they place a value on a good. Say that one is opposed to placing a value on water, on the basis that it is wrong or immoral to try to put a dollar figure on something which is necessary for all life on Earth. This may reflect an instinctive feeling that surely placing a dollar value on a unit of water means that the total supply of water – and all life forms on Earth – could be thought of as having a finite (and quite low) value. Economics corrects this mistaken intuition by distinguishing between average and marginal valuations. When water is exchanged in a market, for instance when Adam buys a one-litre bottle for \$1, one dollar per litre is the value in exchange of water *at the margin*. It is not, however, the value of every unit of water. This value at the margin, under conditions of abundance, is lower than water’s average value. As water becomes more scarce, its importance to life means that we will value each unit more and more highly. Likewise, as water becomes more plentiful, supply costs and the price which consumers will pay for an extra litre will diminish, and the marginal value in exchange will fall. This distinction was overlooked by Costanza et al (1997) who calculated the economic value of 17 ecosystem services for 16 biomes, to estimate the total value of the world’s ecosystem services and natural capital. Their figure (\$16–54 trillion per year, with an average of \$33 trillion per year) was arrived at by multiplying the marginal value per hectare of each biome by the total number of hectares of that biome. As Masood and Garwin (1998) point out, each of the biomes would become more valuable as they become more scarce, meaning that the last hectare to vanish would be much more valuable than the first.

Economists might also respond that preferences can in fact reflect some of the things that non-economists think that the economic concept of value fails to include. Recall that the total economic value of an environmental asset was conceived of as including use, non-use and option value. Non-use values, in particular, leave room for our preferences to reflect what is “right” morally. If we think that it is right that our hypothetical river should continue to exist in its current state, this may be reflected through the notion of existence value. Similarly, concerns for future generations may be reflected through bequest values. And if process is valuable, as lawyers may insist, our preferences about a decision could include a preference that it is made in a procedurally correct manner, rather than just reaching a certain outcome. However, while it is possible that subjective preferences can reflect some of these ideas, in practice they do not necessarily do so.



7. Conclusion

If a cost–benefit analysis appeals as a neutral and objective way of making decisions about environmental goods, it may be difficult to understand why non-economists might argue for outcomes that seem inefficient and sub-optimal. An examination of the assumptions underpinning the cost–benefit framework suggests that this is too simplistic a view of what economists do when they value the environment.

The subjective model of value which feeds into a cost–benefit analysis contains no *necessary* overlap with moral concerns as to what is “right” or “wrong”. Furthermore, the cost–benefit framework generally gives more weight to the preferences of the wealthy than the poor, and does not necessarily give any weight to the preferences of those who have not yet been born. Ideas of intrinsic value and incommensurability which others may argue for are, by definition, irreconcilable with a model of value that depends on human preferences. Economics does, of course, bring a number of valuable concepts to a conversation about environmental value. It reminds us that trade-offs are inevitable and that every decision has costs in terms of courses of action foregone. The distinction between marginal and average values adds a sophistication to the process of valuing scarce goods that may be missed by those who feel that pricing environmental goods is in some way immoral. Limitations to the economics approach are real but recognising these does not imply rejecting it entirely; no other approach is flawless.

All of this demonstrates that whilst the economics approach to making decisions about environmental goods may seem neutral, in reality it occupies a distinct moral position. An awareness of this position ought to help economists better understand what they are and are not doing when they place a value on the environment, and thereby improve their ability to communicate with non-economists about these issues and ultimately enhance the decision-making processes.

8. References

- Ackerman, Frank and Lisa Heinzerling. 2002. “Pricing the Priceless: Cost–Benefit Analysis of Environmental Protection”, *University of Pennsylvania Law Revue*, 150:5, pp. 1553–84.
- Ariely, Dan. 2008. *Predictably Irrational: The Hidden Forces That Shape Our Destinies*, London: HarperCollins.
- Arrow, Kenneth J. 1951. *Social Choice and Individual Values*, New York City: John Wiley & Sons.

The Gardens, Masterton. Moore, Robert Percy, 1881-1948: Panoramic photographs of New Zealand. Ref: Pan-0836-F. Alexander Turnbull Library, Wellington, New Zealand. <http://natlib.govt.nz/records/22788254>

- Arrow, K.; Robert M. Solow; Edward E. Leamer; Paul R. Portney; Ray Radner and Howard Schuman. 1993. "Report of the NOAA Panel on Contingent Valuation", *Federal Register*, 58:10, pp. 4601–14.
- Arrow, Kenneth J.; Maureen Cropper; G. C. Eads; Robert W. Hahn; L. B. Lave; Roger G. Noll; Paul R. Portney; M Russell; R. Schmalensee; K. S. Smith and R. N. Stavins. 1996. "Is There a Role for Benefit–Cost Analysis in Environmental, Health and Safety Regulation?", *Science*, 272:5259, pp. 221–2.
- Bentham, Jeremy. 1776. *A Fragment on Government*, Reprinted 1891 ed. Oxford: Clarendon Press.
- Bingham, Lord T. 2007. "The Rule of Law", *The Cambridge Law Journal*, 66:1, pp. 67–85.
- Caplin, Andrew and John Leahy. 2004. "The Social Discount Rate", *Journal of Political Economy*, 112:6. Available online at <http://www.jstor.org/stable/10.1086/424740>.
- Costanza, Robert; Ralph D'Arge; Rudolph De Groot; Stephen Farber and Monica Grasso. 1997. "The Value of the World's Ecosystem Services and Natural Capital", *Nature*, 387:6630.
- Debreu, Gerard. 1959. *Theory of Value*, New Haven and London: Yale University Press.
- Dicey, A. V. 1885. *An Introduction to the Study of the Law of the Constitution*.
- Flynn, J. R. 2000. *How to Defend Humane Ideals: Substitutes for Objectivity*, Lincoln: University of Nebraska Press.
- Diamond, Peter A. and Jerry A. Hausman 1994. "Contingent Valuation: Is Some Number Better Than No Number?", *Journal of Economic Perspectives*, 8:4, pp. 45–64.
- Hanley, Nick and Edward B. Barbier, 2009 *Pricing Nature: Cost–Benefit Analysis and Environmental Policy*, Cheltenham: Edward Elgar.
- Hicks, John. 1939. *Value and Capital: An Inquiry into Some Fundamental Principles of Economic Theory*, Oxford: Oxford University Press.
- Hicks, John. 1939. "The Foundations of Welfare Economics", *The Economic Journal*, 49:196, pp. 696–712.
- Jenkins, Willis and C. K. Chapple. 2011. "Religion and Environment", *Annual Review of Environment and Resources*, pp. 441–66.
- John C. Harsanyi. 1955. "Cardinal Welfare, Individualistic Ethics, and Interpersonal Comparisons of Utility," *Journal of Political Economy* 63:4, pp. 309–21.
- Kaldor, Nicholas. 1939. "Welfare Propositions in Economics and Interpersonal Comparisons of Utility", *The Economic Journal*, 49:195, pp. 549–52.

- Kant, Immanuel (1785) *Lectures on Ethics*, translated and edited by P. Heath and J.B. Schneewind, Cambridge: Cambridge University Press, 1997. Part of the Cambridge Edition of the Works of Immanuel Kant
- Kling, Catherine L.; Daniel J. Phaneuf and Jinhua Zhao. 2012. "From Exxon to BP: Has Some Number Become Better Than No Number?", *Journal of Economic Perspectives*, 26:4, pp. 3–26.
- Marx, Karl. 1867. *Capital: A Critique of Political Economy Vol I, Book One: The Process of Production of Capital*. First English edition 1887, trans. Moore and Aveling. Moscow: Progress Publishers. Available online from Marx/Engels Internet Archive, <http://www.marxists.org/archive/marx/works/1867-c1/>.
- Masood, Ehsan and Laura Garwin. 1998. "Audacious Bid to Value the Planet Whips Up a Storm", *Nature*, 395:6701, p. 430.
- Mill, J. S. 1879. *Utilitarianism*. Seventh edition. London: Longmans, Green & Co. Available online from the Gutenberg Project, <http://www.gutenberg.org/files/11224/11224-h/11224-h.htm>.
- Næss, Arne. 2010. "The Basics of the Deep Ecology Movement" in *The Ecology of Wisdom: Writings by Arne Næss*, Alan Drengson and Bill Devall Eds. Emeryville, CA: Counterpoint Press, pp. 105–20.
- Raz, Joseph. 1998. *The Morality of Freedom*, Oxford Scholarship Online. Available online at <http://www.oxfordscholarship.com.wmezproxy.wnmeds.ac.nz/view/10.1093/0198248075.001.0001/acprof-9780198248071>.
- Ricardo, David. 1821. *On the Principles of Political Economy and Taxation (3rd Edition)*, available online at <http://www.gutenberg.org/ebooks/33310> Last accessed 25/11/2013
- Roberts, Mere; Waerete Norman; Nganeko Minhinnick; Del Wihongi and Carmen Kirkwood. 1995. "Kaitiakitanga: Māori Perspectives on Conservation", *Pacific Conservation Biology*, 2:1, pp. 7–21.
- Smith, Adam. 1776. *An Inquiry into the Nature and Causes of the Wealth of Nations*, London: A. Strahan and T. Cadell. Available online at <http://etext.library.adelaide.edu.au/s/s64w/>. Last accessed 4 November 2005.
- Tietenberg, Tom and Lynne Lewis. 2009. *Environmental and Natural Resource Economics*, 8th ed., Boston, MA: Pearson Education, Inc.
- Zimmerman, Michael J. 2010. "Intrinsic Vs. Extrinsic Value" in *Stanford Encyclopaedia of Philosophy*, Edward N. Zalta (ed). California: Stanford University. Available online at <http://plato.stanford.edu/entries/value-intrinsic-extrinsic/>.