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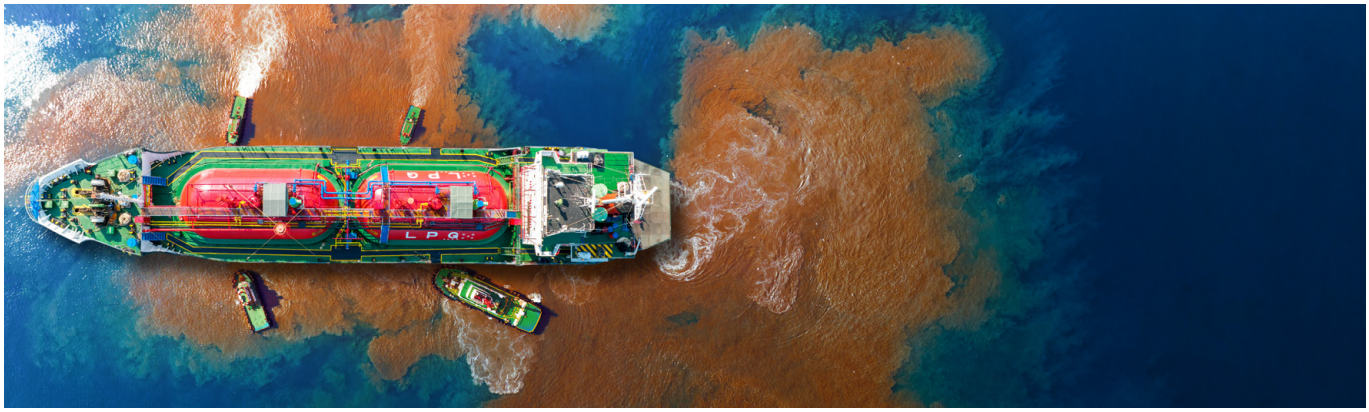

CLIMATE CHANGE LAW. CURRENT PERSPECTIVES.

Quantification of environmental damages in large-scale environmental disasters

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Quantification of environmental damages in large-scale environmental disasters

Large-scale environmental disasters typically cause several kinds of immediate and consequential loss. Where such losses are financial, they can be quantified in the usual way. The quantification of environmental damage in and of itself, however, presents particular challenges for courts and experts alike. While the usual measure of recoverable loss remains the claimant's position but-for the harmful event which caused the environmental damage, individual claimants affected by environmental harm suffer disbenefits which may be difficult to ascribe a pecuniary value, even though they are real. As such, traditional economic concepts do not straightforwardly apply.

As a result of these difficulties, a variety of quantification methods have been utilised by those bringing environmental damage claims in international and domestic courts. These methods generally derive from the field of environmental economics. Through these methods, a hypothetical ecosystem (absent the damage) is first reimagined as providing various tangible and intangible "goods and services". These are then valued by reference to fundamental economic theory of consumer preferences, using established statistical techniques to estimate from market and survey data how much consumers are willing to pay in monetary terms to enjoy an environmental good or service, or to avoid degradation or destruction of those natural resources.[1]

In this article, we explore the challenges involved in valuing environmental damage in two parts. Part One considers what can be gleaned from the limited jurisprudence on the approach that courts may take to valuing environmental damage. In Part Two, expert economists Ravi Kanabar and Dr Meloria Meschi from FTI Consulting introduce the fundamental concepts, frameworks and techniques used by economists to place a monetary value on environmental assets and explain their merits and limitations.

1 Separately to the economic methods discussed here, ecologists have developed a method known as "emergy accounting", which relies on the principle that it is the *energy embodied* in an environmental system that determines its value, regardless of how much consumers might be willing to pay for the goods and services that the system might provide. Emergy accounting involves calculating the total energy that has been used historically to develop and maintain an ecosystem service. This might include solar energy, geological processes, and human-induced transformations. For example, the emergy of a forest ecosystem would include the solar energy used for photosynthesis, the geological energy in soil formation, and any human energy inputs in managing or preserving the forest. When environmental damage occurs to the forest, emergy accounting can be used to estimate the energy cost to restore the ecosystem to its original state, or, if restoration is impossible, the emergy equivalent of the lost services. We are not aware of emergy accounting techniques ever having been relied upon by courts in determining environmental damages. For more information, see the seminal paper by Odum (1969).

Part One: Valuation methods in the case law

There is no dominant valuation method in the case law. Part of the reason for this appears to be that many environmental damage cases (such as Bhopal, Exxon Valdez, Deepwater Horizon) settle before the Court is called upon to determine the question of quantum. As a result, Courts and Tribunals have not had substantial opportunities to consider and pronounce on the merits of different quantification methods.

However, some helpful guidance is to be found in *Costa Rica v Nicaragua*, the first Judgment of the International Court of Justice ("ICJ") on compensation for environmental damage. The decision concerned the sum due to Costa Rica for material environmental damage caused by the unlawful activities of Nicaragua, which included the excavation of certain *caños* and damage to wetland (at [23]). The Parties produced significantly different calculations of the quantum of Costa Rica's damages. The US$6,711,685.26in damages claimed by Costa Rica was reached by assigning a monetary value to the damaged environmental goods and services by reference to values drawn from data and/or or studies about the direct and indirect use value of the same environmental goods and services in analogous ecosystems ("the ecosystem services approach") (at [47]). The US$188,504.00 in damages which Nicaragua claimed that Costa Rica was entitled to was reached by calculating the price that would have to be paid to preserve an equivalent area until the services provided by the impacted area had recovered (at [49]).

Rather than prefer one of the Party's valuations over the other, the ICJ instead decided that it would take into account whatever elements of either method *"offer a reasonable basis for valuation"* (at [52]). In so doing, it valued Costa Rica's claim for environmental damage at USD$122,708.39; a fraction of the US$6,711,685.26 damages claimed.

The ICJ's approach was not grounded in any scientific opinion: experts do not appear to have been examined or consulted under the ICJ's powers in Article 50 of the ICJ Statute. Rather, the Judgment *"reads somewhat like an itemized list of what the Court deemed to be reasonably appropriate"*. The ICJ also did not give any guidance as to how the question of 'reasonableness' should be approached. The approach of the ICJ and the prevailing uncertainty only underscores, in the authors' view, the need for a better understanding of the different quantification methods and their relationship to each other.

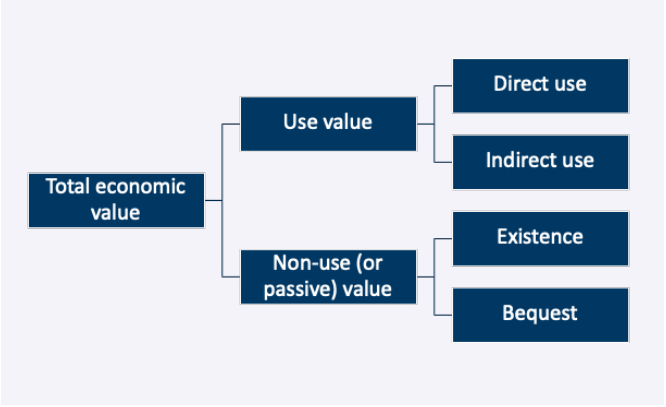
Though the guidance from case law is limited, what is clear is that this requires a multidisciplinary approach – with input from legal experts, quantum and economics experts, and environmental experts.

Part Two: The economists' perspective
Frameworks

Environmental economists have developed various conceptual frameworks that are used to distil, organise and address these the issues. Two of these are especially important to understand, because they pervade the academic literature and are frequently cited in the (albeit limited) case law. These are the "Total Economic Value" ("TEV") framework and the "Ecosystem Services" framework.

The TEV framework breaks down the value of the environment into several components, reflecting both the direct and indirect benefits derived by humans generally from the use of the environment, as well as its intrinsic value. It highlights the broad range of benefits that the environment provides and encourages valuers and courts to produce a more comprehensive valuation.[2] The TEV framework is illustrated in Figure [1]:

Figure 1: Total Economic Value framework



It recognises that:

- There is a certain value to individuals in their use of natural resources. Use can be direct, or indirect. Direct use relates to consumption of the resources themselves – for example, the value of the timber in a forest, which is relatively easy to quantify by reference to the market price for that timber. However, the TEV framework recognises that the environment provides further – sometimes non-commercial – benefits that are also valuable to people. This indirect use value derives from indirect benefits received from resources *without* their being consumed – for example, purification of the air due to photosynthesis. This is not paid for, but it is still valuable: consider how costly it would be to replace this function with artificial carbon capture and storage technologies.
- Non-use (passive) value arises when individuals derive satisfaction from a natural resource without ever using it. They may value the existence of a certain environment– for example, they may value the Amazon rainforest, even if they never go to South America. They may also value saving the environment for future generations (bequest value). This component is trickier to value, but we discuss available approaches below.

The "Ecosystem Services" framework is a way of looking at the environment through the lens of the benefits it provides to humans. These benefits are grouped into four main types of services: (1) provisioning services (e.g. timber provided by a forest), (2) regulating services (e.g. the role of photosynthesis in regulating carbon dioxide levels in the atmosphere and therefore the climate), (3) cultural services (e.g. the recreational, aesthetic, or spiritual benefits that a forest might provide to local residents), and (4) supporting services (e.g. forests provide a habitat for other species to thrive).

The Ecosystem Services framework facilitates a more

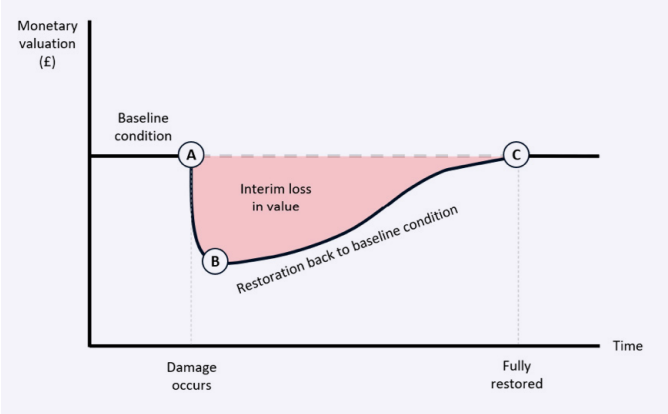
2 The TEV framework is referred to by relevant government agencies across the world. For example, Italy's environmental protection agency, APAT, refers to this framework in section 2.4 of its technical guidelines on calculating compensation of environmental damage. In the USA, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 and the Clean Water Act (CWA) of provide that natural resource trustees may assess damages to natural resources resulting from oil spills or a release of a hazardous substances. Damages assessment procedures set out in the corresponding Code of Federal Regulations refer to the TEV framework: *"Compensable value is the amount of money required to compensate the public for the loss in services provided by the injured resources between the time of the discharge or release and the time the resources are fully returned to their baseline conditions, or until the resources are replaced and/or equivalent natural resources are acquired. The compensable value can include the economic value of lost services provided by the injured resources, including both public use and nonuse values such as existence and bequest values."* In England, there is no case law or statute which refers to the TEV framework in the context of environmental damage. A claim for compensation under Environmental Damage (Prevention and Remediation) (England) Regulations 2015 (which implemented the EU's Environmental Liability Directive 2004/35) for damage to an interest in land is quantified by reference to s. 5 of the Land Compensation Act 1961, which quantifies land based on market value. However, this UK Government guidance paper by DEFRA states at p.6: *"A range of methodologies are available to value changes in ecosystem services. These values are considered in a Total Economic Value framework that takes into account both the use and non-use values individuals and society gain or lose from marginal changes in ecosystem services."*

detailed exploration of the "use value" component of the TEV. For example, in *Costa Rica v Nicaragua*, the Claimant sought compensation for environmental damage caused by excavation of channels and damage to wetlands by first identifying 22 goods and services that it claimed had been impaired or lost, and then seeking compensation in respect of six of them, including standing timber, gas regulation and air, and biodiversity (at [55]).

Calculation of environmental damages

With these frameworks in mind, one also needs to take into account how the environment will evolve over time, with or without human intervention. An illustration of this is found in Figure [2] below. The vertical axis represents monetary value, the horizontal axis represents the passage of time, and the black line represents the evolution of the Total Economic Value of an ecosystem over time.

Figure 2: Simplified calculation for environmental damages



Suppose that an event, perhaps a forest fire, occurs at point A, resulting in immediate damage to the environment, whose value falls quickly to point B. The environment is slowly restored (either naturally, or with human assistance) to reach its pre-damage condition at point C. Compensatory damages are the sum of (1) the cost of restoring the environment to its pre-damage condition,[3] and (2) the interim loss in the value of the environment while this restoration occurs (represented by the shared area between points A, B and C).[4]

How does a court put a number on these two parts?

Quantifying the restoration cost

For the first part, the specific restoration work required (if any) is first determined, and then the cost of conducting that work is assessed. Conceptually, this is a straightforward exercise. In practice, it can be complicated and contentious. For example, in *Puerto Rico v SS Zoe Colocotronni* 628 F.2d 652 (1st Cir. 1980), in support of their claim for damages caused to its coastal environment by the dumping of over 5,000 tonnes of crude oil, the claimants adduced detailed expert evidence and cost estimates relating to the work required to remove contaminated sediment and mangrove, and replant and maintain mangroves for a period of five years (at 659-661). The defendant's experts' evidence was that the spilled oil no longer had a toxic effect, that the mangroves were damaged for unrelated reasons and would in any event regenerate naturally within ten to fifteen years, meaning that less extensive and costly restoration work was truly needed (at 661). The District Court awarded damages based on the cost of purchasing replacement invertebrate organisms from biological supply houses (at 676). However, the decision was overturned on appeal because it could not reasonablybe expected that the claimants would actually replace the organisms only for them to perish when returned to the oil-soaked sands (at 677).

3 The Appeal Court in *Puerto Rico v SS Zoe Colocotronni* describes this as follows: *"...the cost reasonably to be incurred by the sovereign or its designated agency to restore or rehabilitate the environment in the affected area to is pre-existing condition, or as close thereto as is feasible without grossly disproportionate expenditures"* at 675.

4 As the International Court of Justice explained in *Costa Rica v Nicaragua* at [41]-[42]: *"...it is consistent with the principles of international law governing the consequences of internationally wrongful acts, including the principle of full reparation, to hold that compensation is due for damage caused to the environment, in and of itself, in addition to expenses incurred by an injured State as a consequence of such damage...damage to the environment, and the consequent impairment or loss of the ability of the environment to provide goods and services, is compensable under international law. Such compensation may include indemnification for the impairment or loss of environmental goods and services in the period prior to recovery and payment for the restoration of the damaged environment."* This is also consistent with US law. The relevant section of the Oil Pollution Act 1990 is Section 1006(d)(1) which states: *"(1) IN GENERAL.—The measure of natural resource damages under section 1002(bX2XA) is— (A) the cost of restoring, rehabilitating, replacing, or acquiring the equivalent of, the damaged natural resources; (B) the diminution in value of those natural resources pending restoration; plus (C) the reasonable cost of assessing those damages".*

Quantifying the interim loss in value (area A-B-C)

Quantifying the interim loss in value can be a more challenging proposition. One straightforward 'shortcut' is to approximate it by the cost of providing equivalent resources and services elsewhere. This so-called "replacement costs approach"[5] was used in *Puerto Rico v SS Zoe Colocotronni*, where the District Court awarded damages based on the cost of purchasing replacement invertebrate organisms from biological supply houses (at 660). (The decision was overturned on appeal because it could not reasonably be expected that the claimants would actually replace the organisms only for them to perish when returned to the oil-soaked sands (at 667).) The approach was also used by the defendant in Costa Rica v Nicaragua, which estimated the cost of preserving an equivalent area until the damaged area recovered by reference to payments made by Costa Rica to landowners as an incentive to protect the habitat under its domestic environmental conservation scheme (at [49] and [77]). However, the court rejected this approach again, considering that these payments did not reflect the true value of the goods and services provided by the ecosystem. Clearly, it is not easy to quantify this element.

Analytical approaches to quantifying the interim loss in value

Fortunately, economists have developed two broad analytical approaches that have had more success in helping to address this question: (i) revealed preference techniques; and (ii) stated preference techniques.[6] Both are grounded in fundamental economic theory which posits that the value of any good or service (which extends to environmental goods and services) is not inherent but is determined by individuals' preferences and the satisfaction or utility that consumers derive from those goods and services. Consumers make choices based on their preferences, and these choices reveal the value they place on those goods and services. Finally, (iii), the value transfer 'technique' has often been used to apply valuations made in a different context by way of analogy.

(i) Revealed preference techniques

Revealed preference techniques infer value indirectly from the choices made by individuals in analogous real-world market transactions. For example, by examining how the prices of otherwise identical properties vary between areas with different levels of air pollution, economists can estimate in monetary terms how much people value clean air. Since property prices depend on many factors apart from the environment, and otherwise identical properties are very difficult to identify in practice, statistical methods are used to isolate and measure the value ascribed to the environmental goods in question. These are called "hedonic price models".

Another revealed preference technique involves analysing how much people are willing to spend on travel and other costs to visit a site as a means of quantifying, by reference to their willingness to incur these costs, what that site is worth to them. This can be used, for example, where an oil spill closes access to a beach. The underlying assumption here is that local residents and visitors value the site at *least* as much as these costs (or else they would not incur them). This "travel costs approach" featured in the expert methodology in a claim by federal and state trustees against BP and other defendants arising out of the Deepwater Horizon oil spill in 2010 (English et al, (2018)). Revealed preference techniques have the advantage of being based on tangible consumer behaviour, objective data and real-world transactions that reflect the choices and trade-offs consumers actually make. However, they have a limited scope because one needs to identify a related market, and they cannot be used to assess non-use values, such as the existence value of a forest that people value merely by knowing it exists but may never visit or directly use themselves.

(ii) Stated preference techniques

Stated preference techniques are based on *hypothetical* choices made in carefully designed surveys. In "contingent valuation" surveys, respondents are presented with hypothetical scenarios and asked to state how much they would be willing to pay to avoid (or to accept) certain environmental changes. This method was used in proceedings arising out of the Exxon Valdez oil spill in 1989. The case settled out of court, and it has

5 *Replacement* costs are distinct from *restoration* costs, even though the restoration work may involve replacing environmental resources.
6 We focus on the economic approaches, although other non-economic approaches are also possible (see fn 1 above).

been suggested that a contingent valuation study, which valued the damage at US$3 billion, was an impetus for settlement (Carson, 2012, p.29). Similar techniques were also deployed in calculating natural resource damages arising from the Deepwater Horizon oil spill in 2010 (Bishop et al, 2017). In "choice modelling" surveys, respondents are presented with sets of hypothetical scenarios containing different attributes and asked to choose their preferred scenario. Their choices are then analysed using statistical models to understand the trade-offs they make between environmental attributes and monetary values, and to infer from these trade-offs the monetary value they place on those attributes. The primary advantage of stated preference techniques is that they can be used to value a wider range of non-market environmental goods, including non-use values. However, they have been criticised because respondents are not engaged in real transactions, which can lead to unreliable, inconsistent and sometimes inflated valuations. This was especially true of early applications, although the techniques have since evolved and become more widely accepted.

(iii) Value transfer technique

A third and final technique is that of "value transfer". This refers to the practice of obtaining existing valuation estimates from one context (the "study site") and applying them to another, similar context where direct valuation is not conducted. Even though this is not strictly speaking a distinct technique (the study site valuations were likely produced using revealed or stated preference analysis), it deserves special mention here because it is often used and referred to. For example, by the Claimant in *Costa Rica v Nicaragua* assigned a monetary value (at [47], [62], [64]-[65]). It may well be a pragmatic approach in small value claims, where it may be impractical or disproportionately costly to conduct a bespoke valuation study, although the relevance and applicability of the study site needs to be demonstrated.

Conclusion

- Given that case law in environmental damages cases is at an early stage, there is no established valuation method for assessing environmental damage. What is clear, however, is that many of the traditional market valuation concepts will not translate to the valuation of environmental damage when the benefits derived from the environment are not traded as such. This will often require creative and hypothetical market-driven approaches to identify the appropriate measure of the impact of the environmental damage.
- The starting point is to identify an appropriate economic framework; either the TEV framework or the "Ecosystem Services" frameworks are commonly adopted, and may serve as alternative or complementary frameworks.
- Once the economic frameworks have been identified, the financial impact of the environmental damage needs to be calculated. There are likely to be two components of this: (i) the cost of restoring the environment; and (ii) the interim loss in value of the environment pending restoration (in so far as it can be restored). This assessment of the interim loss is likely to require some evaluation of (real and/or hypothetical) consumer choices with respect to the use of the environment.
- Given the novelty of the issues arising, it is likely that the quantification of such damages claims will require the application of multiple valuation approaches in order to cross-check and provide balance to the assumptions of any one given approach.
- In order to address the complex issues which arise, a multidisciplinary approach is necessary. Lawyers and experts in environmental damages and economics will have to work together to identify and translate the specifics of each environmental damage case to identify the relevant valuation components in order to arrive at a holistic and defensible valuation of the loss caused.

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