D35 A Framework for the Cost Evaluation of Deforestation Based on the Habitat Equivalency Analysis (HEA) Principle

David Domingues Pavanelli, PhD, Brazilian Federal Police, São Paulo 05038-090, BRAZIL; Nickolaos Voulvoulis, PhD, Imperial College London, London, UNITED KINGDOM*

Learning Overview: After attending this presentation, attendees will understand the role of financial evaluations in Brazilian environmental forensic reports and the methods used by forensic experts to calculate the total economic value of environmental damages.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by demonstrating the potential of the framework to inform the forensic science community, improving the ability to evaluate interim losses, perpetual damages, and propose better approximations of the total economic value of deforestation.

Under Brazilian law, environmental damages are considered criminal offenses. During the criminal process, environmental forensic experts normally are expected to appraise the damage to set bail, a fine, and the minimum value for its repair. The final financial damage valuation is defined during a civil process and trial, in line with the valuation described in the criminal process.

Deforestation is a typical Brazilian environmental crime. Environmental forensic experts typically evaluate the damage caused by deforestation using the commercial value of the wood extracted plus the cost of reforestation. However, many non-marketable ecosystem services provided by forests are rarely considered in this process. Well-described examples of these include erosion control, water supply, nutrient cycling, pollination, biological control, and many other ecosystem services. Not including these services in valuations of environmental damages is misleading public perception of the true total environmental costs and potentially puts at risk law enforcement and the implementation of environmental policies.

To ensure that ecosystem services are evaluated from the initial damage assessments, a framework for deforestation cost evaluation has been developed, based on Habitat Equivalency Analysis (HEA), as first described by the National Oceanic and Atmospheric Administration (NOAA) and in line with the European Union Liability Directive.[1,2] The framework considers remediation costs as proxies for evaluating ecosystem services, and it enables the calculation of interim losses (i.e., the time elapsed between the loss of ecosystem services caused by deforestation and the return of these ecosystem services after damage recovery).

Four study areas of the Brazilian Atlantic rainforest biome were evaluated using the framework. All four study areas involved a forest structure at the intermediate stage of regeneration prior to the damage: two areas had been converted to pasture; one area had been converted to a *Eucalyptus spp.* Plantation; and one area had had its soil removed by mining activities, causing the damage to be considered perpetual.

The application of the framework resulted in an increase in environmental valuation by 38%–43% in pasture areas, 33% in the *Eucalyptus spp.* area, and 232% in the mined area, without considering land acquisitions. Ratios between adapted forest ecosystem services values described by Costanza et al. and framework values were 1.65–2.23 in pasture areas, 1.75 in *Eucaliptus spp.* areas, and 4.85 in mined areas.[3] The inclusion of land acquisitions in these calculations would push these ratios toward 1.

The results demonstrate the potential of the framework to inform the forensic science community, improving the ability to evaluate interim losses, perpetual damages, and propose better approximations of the total economic value of deforestation. Considering the extent and consequences of deforestation in Brazil, the proposed framework reveals the actual cost of environmental damages and the negative economic impacts of deforestation.

Reference(s):

1. NOAA. 1995. Habitat Equivalency Analysis: An Overview. Damage Assessment and Restoration Program, National Oceanic and Atmospheric Administration, Department of Commerce, 1995. Accessed July 26, 2018. https://casedocuments.darrp.noaa.gov/northwest/cbay/pdf/cbhy-a.pdf.
2. Environmental Liability Directive. 2013. Training Handbook and Accompanying Slides for European Commission DG Environment. Accessed July 26, 2018. http://ec.europa.eu/environment/legal/liability/pdf/eld_handbook/ELD%20Training%20Handbook%20-%202%20days_en.pdf.
3. Costanza, Robert., Ralph d'Arge, Rudolf de Groot, Stephen Farber, Monica Grasso, Bruce Hannon, Karin Limburg, Shahid Naeem, Robert V. O'Neill, Jose Paruelo, Robert G. Raskin, Paul Sutton and Marjan van den Belt. 1997. *The Value of the World's Ecosystem Services and Natural Capital.* Nature 387, 253–260. https://doi.org/10.1038/387253a0.

Environmental Damage Cost, Ecosystem Services, Habitat Equivalency Analysis