

Environmental Monitoring Effectiveness in Hydropower and River-Basin EIAs: A Hybrid Multi-Criteria Assessment

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Abstract:

Hydropower and river-basin development projects pose complex challenges for environmental monitoring. Although Environmental Impact Assessment (EIA) and Initial Environmental Examination (IEE) systems are designed to manage these risks, their effectiveness in translating assessment commitments into sustained monitoring and follow-up outcomes varies widely. This study comparatively analyzes environmental monitoring effectiveness in hydropower- and river-basin-focused EIA/IEE systems in New Zealand, Japan, the Netherlands, Canada, and Sri Lanka, using a novel hybrid multi-criteria evaluation framework. The proposed framework integrates the Woods 0–3 ordinal scoring method with elements drawn from established international assessment frameworks to systematically evaluate monitoring performance. Seven weighted evaluation criteria were applied: water quality and hydrology; biodiversity and ecosystem protection; erosion and sedimentation control; catchment and watershed management; social impacts and community concerns; mitigation hierarchy and environmental planning; and monitoring with adaptive management. Each criterion consisted of operational indicators that address baseline data quality, mitigation planning, monitoring design, institutional responsibility, and adaptive feedback mechanisms. The results reveal clear differentiation in monitoring performance across countries. Systems in New Zealand, the Netherlands, and Canada demonstrate a stronger integration of hydrological and ecological baselines, enforceable environmental management plans, and operational monitoring–feedback linkages. Japan exhibits strong technical assessment capacity but comparatively weaker performance in monitoring transparency and adaptive follow-up. Sri Lanka shows low to moderate performance with limitations in long-term biodiversity monitoring, basin-scale integration, and post-approval compliance despite the presence of formal regulatory provisions. By advancing a transparent and transferable hybrid scoring framework, this study provides a practical tool for diagnosing monitoring gaps and strengthening EIA/IEE systems in support of sustainable hydropower development and river-basin management.

Keywords:

Environmental Monitoring, Hydropower Development, River-Basin Management, Environmental Impact Assessment (EIA), Hybrid Multi-Criteria Assessment, Sustainable Practices.