

ANNOTATED BIBLIOGRAPHY:

SCALING FRESHWATER AQUACULTURE:

**TRADE-OFFS, RISKS
AND UNEVEN
OUTCOMES**



1. FRAMING AQUACULTURE: FOOD SECURITY AND DEVELOPMENT PATHWAYS

Béné, C., Arthur, R., Norbury, H., Allison, E. H., Beveridge, M., Bush, S., ... & Williams, M. (2016). Contribution of fisheries and aquaculture to food security and poverty reduction: assessing the current evidence. *World development*, 79, 177-196. <https://doi.org/10.1016/j.worlddev.2015.11.007>

This review critically evaluates the evidence linking fisheries and aquaculture to food security and poverty reduction across low- and middle-income countries, drawing on over 100 empirical studies across diverse geographic contexts. It demonstrates that production increases do not inherently translate into improved food access or poverty alleviation, with outcomes mediated by access to resources, market structures, and governance arrangements. Although fish provides approximately 17% of global animal protein intake, the paper shows that the benefits of increased production are unevenly distributed and often realised through income generation rather than direct nutritional gains. The paper is particularly important in interrogating dominant policy narratives that frame aquaculture expansion as a direct food security intervention. Instead, it shows that benefits frequently accrue disproportionately to actors with existing capital and market access. While not specific to freshwater systems or individual country contexts, it provides a strong evidential basis for interpreting aquaculture development outcomes in relation to broader political economy and governance conditions.

Belton, B., & Little, D. C. (2011). Immanent and interventionist inland Asian aquaculture development and its outcomes. *Development Policy Review*, 29(4), 459–484. <https://doi.org/10.1111/j.1467-7679.2011.00542.x>

This paper develops a conceptual distinction between “immanent” aquaculture emerging from existing agrarian systems and “interventionist” aquaculture driven by policy, development programmes, and external capital, drawing on empirical evidence from South and Southeast Asia. It demonstrates that these pathways produce structurally different sectors in terms of participation, integration with local food systems, and distribution of benefits. In particular, the widespread and largely autonomous uptake of small-scale aquaculture in countries such as Bangladesh is used to illustrate how immanent development can scale rapidly when aligned with existing farming systems and livelihood strategies. By contrast, interventionist models—often promoted through state or donor-led initiatives—are shown to be more commercially oriented, less widely adopted, and more socially stratified. The work is focused on Asia, but the framework is analytically robust and transferable. It is particularly valuable for interpreting variation in freshwater aquaculture systems across governance contexts, and for explaining why sector expansion does not produce uniform social or economic outcomes.

2. AQUACULTURE SYSTEMS AND LIVELIHOOD CONTEXTS

FAO. (2023). National aquaculture sector overview: Lao People's Democratic Republic. Food and Agriculture Organization of the United Nations. <https://www.fao.org/fishery/en/facp/lao>

This report provides a detailed sectoral overview of aquaculture in Lao PDR, including production systems, species composition, and institutional arrangements. It highlights the predominance of small-scale pond aquaculture integrated within mixed farming systems, with production largely centred on tilapia and carp species and closely linked to rice-based agriculture. This form of aquaculture contributes to household-level food production and income diversification, reflecting its embedded role within rural livelihood systems rather than a specialised or industrial sector. This embedded production model contrasts with more capital-intensive and export-oriented aquaculture systems observed elsewhere. The overview is primarily descriptive and aligned with institutional reporting, offering limited analysis of environmental externalities or governance constraints. However, it provides a necessary empirical baseline for understanding the structure and functional role of aquaculture within rural production systems.

Britz, P. J., Hara, M., & Weyl, O. L. F. (2015). Scoping study on the development and sustainable utilisation of inland fisheries in South Africa. Volume 1: Research report. WRC Report No. TT 615/1/14. Water Research Commission, Pretoria. <https://www.wrc.org.za/wp-content/uploads/mdocs/TT%20615-1-14.pdf>

This report provides a comprehensive national assessment of inland fisheries in South Africa, based on a Water Research Commission (WRC)-funded scoping study, and is a authoritative syntheses of the sector. Although not a peer-reviewed journal article, WRC reports are widely regarded as high-quality, policy-relevant outputs within the South African research and management context. The report documents the predominantly small-scale, informal, and livelihood-oriented character of inland fisheries, demonstrating that they are widespread and socially significant despite limited formal recognition in policy and management frameworks. It also clearly distinguishes inland fisheries from aquaculture in both institutional governance and functional role, highlighting that the two sectors involve different actor groups, objectives, and regulatory systems. This distinction is critical for understanding the limited substitutability between capture fisheries and aquaculture within inland water systems. While not focused on aquaculture per se, the report provides essential context for situating aquaculture within broader aquatic food systems and for evaluating its role relative to existing livelihood practices.

Rouhani, Q. A., & Britz, P. J. (2004). Contribution of aquaculture to rural livelihoods in South Africa: A baseline study. Water Research Commission Report No. TT235/04. Pretoria: Water Research Commission. <https://static.pmg.org.za/docs/090902catrlinsa.pdf>

This study provides an early baseline assessment of the contribution of aquaculture to rural livelihoods in South Africa, based on a Water Research Commission (WRC) research report. Although not a peer-reviewed journal article, it represents one of the few systematic early evaluations of the sector and is widely cited in subsequent analyses. The study identifies a set of persistent structural constraints limiting aquaculture development, including limited technical capacity, weak input supply chains, and poor market access. It demonstrates that, despite policy support at the time, aquaculture had not developed as a widely accessible or scalable livelihood activity, particularly for small-scale producers. The findings highlight a clear disconnect between development objectives and on-the-ground implementation conditions. Although the study predates more recent policy developments, unfortunately most of the constraints identified have remained consistent in later assessments of the sector. It is therefore useful for illustrating how institutional, economic, and technical barriers have historically constrained the expansion of smallholder aquaculture, and for contextualising the limited contribution of the sector to livelihoods and food systems.

3. ENVIRONMENTAL PROCESSES AND IMPACTS

Boyd, C. E. (2003). Guidelines for aquaculture effluent management at the farm-level. *Aquaculture*, 226(1–4), 101–112. [https://doi.org/10.1016/S0044-8486\(03\)00471-X](https://doi.org/10.1016/S0044-8486(03)00471-X)

This paper provides a detailed and widely cited account of the primary effluent pathways associated with aquaculture systems, including nutrient discharge (nitrogen and phosphorus), organic loading, and suspended solids. It explains how these outputs arise directly from feed inputs, uneaten feed, fish metabolism, and faecal waste across pond, cage, and flow-through systems. These processes are shown to contribute to water quality degradation through mechanisms such as oxygen depletion and eutrophication, particularly in systems with high input intensity and limited water exchange. The paper is widely regarded as a foundational reference for understanding the biophysical mechanisms underlying aquaculture-related water quality impacts at the farm level. While it does not address cumulative impacts, governance, or context-specific outcomes, which tend to be highlighted in later discussion, it provides a useful mechanistic basis required to interpret environmental risks associated with freshwater aquaculture intensification.

Anh, P. T., Kroeze, C., Bush, S. R., & Mol, A. P. J. (2010). Water pollution by pangasius production in the Mekong Delta, Vietnam: Causes and options for control. *Aquaculture Research*, 42(1), 108–128. <https://doi.org/10.1111/j.1365-2109.2010.02578.x>

This study quantifies water pollution associated with intensive pangasius (catfish) aquaculture in the Mekong Delta, providing a regionally relevant case within the broader Mekong system. It documents elevated concentrations of organic matter, nitrogen, phosphorus, and biochemical oxygen demand (BOD) in both production effluents and processing wastewater, arising from high feed inputs and intensive production practices. As pangasius represents one of the dominant aquaculture species in Laos, the study provides a particularly relevant example of the environmental implications of large-scale freshwater catfish production. These findings are also transferable beyond the region, as similar production dynamics and waste pathways are observed in other catfish systems, including *Clarias*—the species of growing interest in South Africa. The study therefore offers a concrete, system-specific illustration of how intensive freshwater aquaculture can generate measurable water quality impacts.

4. FISH WELFARE

Ashley, P. J. (2007). Fish welfare: Current issues in aquaculture. *Applied Animal Behaviour Science*, 104(3–4), 199–235. <https://doi.org/10.1016/j.applanim.2006.09.001>

This review synthesises key welfare considerations in aquaculture, including the effects of stocking density, water quality, handling, transport, and slaughter on fish physiology and behaviour. It demonstrates that welfare outcomes are closely linked to measurable stress responses, with adverse conditions associated with elevated cortisol levels, impaired immune function, and increased susceptibility to disease. The paper shows that intensification—particularly through increased stocking density and declining water quality—can directly compromise fish health and survival. It provides a robust scientific foundation for identifying welfare risks across aquaculture systems, grounded in physiological and behavioural evidence. This is particularly important given that in the two focal countries welfare considerations are underrepresented or absent in aquaculture policy and management frameworks, as is common across the globe.

5. GOVERNANCE, REGULATION, AND IMPLEMENTATION

Cacaud, P., & Latdavong, P. (2009). Fisheries and aquaculture in the Lao PDR: A legislative review. FAO Regional Office for Asia and the Pacific.

<https://openknowledge.fao.org/items/6ae25980-600f-4d1b-b5e4-4c1137dba8a8>

This report provides a systematic legislative review of the legal and institutional framework governing fisheries and aquaculture in Lao PDR, produced by the Food and Agriculture Organization (FAO). It reflects a formal policy-oriented analysis aligned with international development and governance frameworks. It shows that aquaculture is primarily framed within national legislation as a mechanism for resource management, production enhancement, and rural livelihood development, rather than as a sector requiring dedicated environmental or welfare regulation. The review also highlights that governance is distributed across multiple legal instruments and institutions, including fisheries, water, and land management frameworks, reflecting a fragmented regulatory structure. The report is descriptive and does not assess enforcement, compliance, or institutional capacity, nonetheless, it provides a clear account of policy intent and regulatory architecture, and is therefore valuable for understanding how aquaculture is formally positioned within national governance systems.

CSIR. (2019). Appendix B-1: Consultation process for the Falls Fish Farm aquaculture development. Council for Scientific and Industrial Research.

https://aquasea.csir.co.za/wp-content/uploads/2019/12/Appendix-B-1_Consultation-Process.pdf

This document forms Appendix B of the Strategic Environmental Assessment (SEA) for Marine and Freshwater Aquaculture Development in South Africa, a national, government-commissioned assessment conducted by the Council for Scientific and Industrial Research (CSIR). Although not a peer-reviewed source, it represents a formal component of a large-scale, policy-oriented process designed to support aquaculture planning and streamline regulatory approval pathways. The appendix provides a detailed account of the stakeholder consultation process underpinning the SEA, documenting engagement with national and provincial authorities, industry representatives, researchers, NGOs, and the public through workshops, focus groups, and iterative feedback mechanisms. This illustrates the scale and complexity of coordination required across sectors and levels of governance in aquaculture development.

It is particularly valuable in this context because it provides detailed, process-level insight into a specific proposed development, the Falls Fish Farm. The document records the first-person experience of Dee Malcomess (Falls Fish Farm), and captures their experience of navigating the regulatory and consultation process. This case illustrates the iterative, and at times protracted, nature of aquaculture licensing, evidencing the practical challenges associated with coordination across institutions,

stakeholder alignment, and procedural requirements. As such, it provides rare empirical insight into how regulatory systems operate in practice, and how procedural complexity can shape the feasibility and progression of aquaculture development beyond formal policy frameworks.

Tshetlo, P. T. (2015). Implementation of the South Africa–China Agricultural Technology Demonstration Centre at Gariep Dam (Master’s thesis). University of Pretoria. <https://repository.up.ac.za/bitstreams/d3b483c5-80ae-4c84-8bfa-100b5498935c/download>

This Master’s thesis provides a detailed and analytically rigorous case study of the China–South Africa Agricultural Technology Demonstration Centre (ATDC) at Gariep Dam, established as a joint initiative to promote aquaculture development through training, research, and technology transfer. Although not a peer-reviewed publication, it represents a well-structured and empirically grounded analysis of a major state-supported intervention. The study examines the implementation of demonstration systems, including catfish (*Clarias gariepinus*) and carp, alongside training programmes intended to support small-scale sector development. It offers a critical analysis of project outcomes, documenting key limitations including weak integration with local technical expertise, limited and uneven skills transfer, and a mismatch between promoted production models and domestic market conditions. The analysis further shows that the project remained largely externally driven, with limited local ownership and uptake, constraining its long-term viability and impact. As such, the thesis provides a clear example of how aquaculture development initiatives, even when supported by substantial investment and policy backing, may fail to translate into sustained or locally appropriate outcomes. It demonstrates the divergence between development narratives and implementation realities, and for highlighting the institutional and contextual factors that shape aquaculture development in practice in South Africa.

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