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ARTICLE

Achieving Groundwater Governance: Ostrom's Design Principles and Payments for Ecosystem Services Approaches

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Abstract

Groundwater is a largely unseen common pool resource. Yet, driven by strong economic incentives, whether or not encouraged by existing policies, and the difficulty to exclude others, groundwater users are competing with each other to extract as much as possible, with devastating consequences for its sustainability. The challenges faced for sustainably managing such common pool resources, on which people have established de facto individual rights, are manifold. However, creating a market for trades of some kind in ecosystem services associated with groundwater could actually enhance the protection of this critical resource on the basis that protection can benefit individual groundwater users economically as well as provide a broader public good. This article uses Elinor Ostrom's design principles as an analytical tool to examine how market-based approaches such as payments for ecosystem services (PES) fit with some of the governance models that could be used to protect and enhance groundwater as a common pool resource. It argues that while there are specific design challenges to be overcome, PES as an institutional tool can align with Ostrom's ideas for the governance of groundwater.

Keywords: Groundwater, Governance, Common pool resources, Ostrom's design principles, Payments for ecosystem services

1. INTRODUCTION

The importance of groundwater – water stored underground in soil, sand and porous rock, called aquifers – in meeting global water security challenges cannot be overstated.

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Globally, groundwater accounts for about 33% of total water extractions, and over two billion people rely on groundwater as their primary source of water.[1] It is also important for agricultural uses, with over half of the global water used to grow crops derived from underground sources.[2] Groundwater can also act as a strategic reserve during heatwaves and droughts, which are becoming more common in many parts of the world.[3]

Despite the importance of groundwater for global water security, it has attracted less governance attention compared with surface water. In 2011, the launch of the Groundwater Governance Project signalled a shift in focus to groundwater scarcity,[4] and since then the role of groundwater management has been identified as central to the, individual and combined,[5] achievement of many of the targets of the Sustainable Development Goals (SDGs).[6]

This historical lack of governance attention is partly because, compared with the more visible surface water supplies such as rivers and reservoirs, groundwater is an elusive and largely unseen common pool resource (CPR),[7] with little visible signs of depletion. In most countries, groundwater is a publicly owned resource managed by national, state or local specific laws and institutions. Strong economic incentives, combined with governmental policies[8] and the difficulty in excluding others, have led groundwater users to compete with each other to extract as much as possible. This issue is compounded, from a regulatory perspective, by the fact that the rise in groundwater abstraction and use has mainly been carried out without governments being aware.[9] As a consequence, groundwater is being pumped at a far greater rate than

1 S. Siebert et al., 'Groundwater Use for Irrigation: A Global Inventory' (2010) 14(10) *Hydrology and Earth System Sciences*, pp. 1863–80.

2 Ibid.

3 J.S. Famiglietti, 'The Global Groundwater Crisis' (2014) 4 *Nature Climate Change*, pp. 945–8; R. Langridge & A. Fencl, 'Implications of Climate Change to Groundwater', in L.H. Suring (ed.), *Encyclopedia of the World's Biomes* (Elsevier, 2020), pp. 438–53.

4 See Food and Agriculture Organization of the United Nations (FAO) et al., 'Groundwater Governance: A Global Framework for Action (2011–2016)', factsheet, available at: https://www.fao.org/3/bs184e/bs184e.pdf.

5 L. Guppy et al., 'Groundwater and Sustainable Development Goals: Analysis of Interlinkages', United Nations University – Institute for Water, Environment and Health Report Series, Issue 4, 2018, available at: https://inweh.unu.edu/groundwater-and-sustainable-development-goals-analysis-of-interlinkages; K.I. Conti et al., 'Groundwater in the Context of the Sustainable Development Goals: Fundamental Policy Considerations', Brief for GSDR, International Groundwater Resources Assessment Centre, 2016, available at: https://www.un-igrac.org/resource/groundwater-context-sustainable-development-goals-fundamental-policy-considerations.

6 United Nations (UN), Department of Economic and Social Affairs, 'The 17 Goals', available at: https://sustainabledevelopment.un.org/sdgs. See specifically, SDG 3.3, 3.9, 11.5, 12.4, 15.1 and 15.8.

7 Elinor Ostrom defines a common pool resource as 'a natural or man-made resource from which it is difficult to exclude or limit users once the resource is provided by nature or humans … One person's consumption of resource units, such as water, removes those units from the resource system': E. Ostrom, 'The Value-Added of Laboratory Experiments for the Study of Institutions and Common-Pool Resources' (2006) 61(2) *Journal of Economic Behavior & Organization*, pp. 149–63, at 151.

8 E.g., India even subsidizes electricity costs for pumping to encourage greater agricultural productivity at the expense of falling aquifer levels; see T. Shah et al., 'Groundwater Governance through Electricity Supply Management: Assessing an Innovative Intervention in Gujarat, Western India' (2008) 95(11) *Agricultural Water Management*, pp. 1233–42.

9 A. Mumma et al., 'Kenya Groundwater Governance: Case Study', Water Papers, World Bank, June 2011, p. 1, available at: https://openknowledge.worldbank.org/handle/10986/17227; M.R. Llamas &

can be replenished naturally, with many of the major aquifers in arid and semi-arid parts of the world that rely most heavily on groundwater experiencing rapid rates of groundwater depletion.[10]

The devastating mid- and long-term impacts of this behaviour on the environment and local populations, together with the unpredictable patterns of intensification on the global water cycle as a result of climate change, combine into an urgent need for effective governance. Much has been written about the reasons behind the depletion of global groundwater supplies,[11] and understanding these reasons is a necessary first step towards an effective governance system. Central to this is the lack of appreciation of the interconnections between surface water and groundwater in existing water law and policy.[12] These and other problems provide at least a prima facie case for questioning and rethinking our existing governance approaches to groundwater management. Like many CPRs, the effective governance of groundwater requires a set of rules, norms and values that underpin exploitation consistently with the ecosystem approach, while building on possible synergies.

The challenges faced in sustainably managing such common resources, over which people have established de facto individual rights, are manifold. Traditionally, the regulation of groundwater has been based mostly on setting limits on how much water can be abstracted by prohibiting over-exploitative behaviour.[13] This article focuses on market-based approaches, such as creating a market for trades of some kind in the ecosystem goods and services associated with groundwater. Even if we consider it preferable that groundwater should be under public stewardship and that the role of the private sector should be supplementary,[14] marketization promises to enhance the protection of such a critical resource on the basis that protection can benefit individual groundwater users economically as well as provide a broader public good (such as flood protection, or recreational or aesthetic value). This perspective can lead to the re-evaluation of wetlands and groundwater aquifers, as well as improved understanding of the linkages between groundwater and various ecosystems and ecosystem services, and the vulnerability and resilience of groundwater-dependent systems.[15]

P. Martinez-Santos, 'Intensive Groundwater Use: Silent Revolution and Potential Source of Social Conflicts' (2005) 131(5) *Journal of Water Resources Planning and Management*, pp. 337–41.

[10] L.F. Konikow & E. Kendy, 'Groundwater Depletion: A Global Problem' (2005) 13(1) *Hydrogeology Journal*, pp. 317–20; Y. Wada et al., 'Global Depletion of Groundwater Resources' (2010) 37(20) *Geophysical Research Letters*, article L20402, doi:10.1029/2010GL044571; T. Gleeson et al., 'Water Balance of Global Aquifers Revealed by Groundwater Footprint' (2012) 488 *Nature*, pp. 197–200; Famiglietti, n. 3 above, p. 946.

[11] Famiglietti, n. 3 above, p. 946.

[12] R.B. Jackson et al., 'Water in a Changing World' (2001) 11(4) *Ecological Applications*, pp. 1027–45, at 1030; Famiglietti, n. 3 above, p. 947.

[13] R. Nelson & P. Quevauviller, 'Groundwater Law', in A.J. Jakeman et al. (eds), *Integrated Groundwater Management* (Springer, 2016), pp. 173–96; see also K.E. Kemper, 'Instruments and Institutions for Groundwater Management', in M. Giordano & K.G. Villholth (eds), *The Agricultural Groundwater Revolution: Opportunities and Threats to Development* (CABI, 2007), pp. 153–72.

[14] FAO, *Global Framework for Action to Achieve the Vision on Groundwater Governance* (FAO, 2016), available at: https://www.fao.org/publications/card/en/c/a3a0357f-e93b-43c7-8be1-971ba4330171.

[15] CGIAR Research Program on Water, Land and Ecosystems (WLE), *Groundwater and Ecosystem Services: A Framework for Managing Smallholder Groundwater-Dependent Agrarian Socio-Ecologies – Applying*

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The question that this article investigates is: How do market-based approaches such as payments for ecosystem services (PES) fit with the governance models that could be used to protect and enhance groundwater as a CPR? To answer this question, the article draws on Elinor Ostrom's seminal work *Governing the Commons*,[16] which led to the development of eight design principles that summarize factors which have played a role in long-enduring CPR governance mechanisms. The article argues that PES can function in line with Ostrom's ideas for the governance of CPRs and fit the eight design principles. Section 2 sets out why we need a better governance structure for groundwater, and highlights some of the core areas of tension. Section 3 analyzes governance models for CPRs, including an assessment of Ostrom's work. Section 4 discusses the main features of PES approaches and the extent to which Ostrom's design principles inform the application of PES. Section 5 concludes.

2. THE NEED FOR GOVERNANCE

Groundwater makes up 97% of global freshwater and is the most intensively exploited natural material in the world.[17] Its importance in meeting global water demands for humans and the environment and for spurring socio-economic growth across the world cannot be overstated. For example, estimates from 2010 show that three of the largest economies in the world (the United States (US), China, and India) account for over 50% of global groundwater abstraction.[18] This significance has led to increasing interaction between individuals and groundwater systems, with the cumulative effects of individual action and behaviour usually not resulting in socially optimal situations.[19] This practice has devastating consequences for the long-term sustainability of groundwater resources and the wider environment, consequences of which individuals may be unaware or may not seek to mitigate. Besides the individual actions, challenges such as population growth and climate change add to the problem by generating changes in patterns of water flow into aquifers that may not be known or understood by users. Given the wider community benefits of groundwater resources and the range of problems that beset the resources, there is a need for both individual and collective action to respond to these problems.

Historically, groundwater and surface water have been treated separately in water law and policy. Most significant is the possibility of private ownership of surface reservoirs, with private owners being allowed to sell water to other parties for uses such as

an Ecosystem Services and Resilience Approach (CGIAR & International Water Management Institute, 2015), available at: http://www.iwmi.cgiar.org/Publications/wle/corporate/groundwater_and_ecosystem_-services_framework.pdf.

[16] E. Ostrom, *Governing the Commons: The Evolution of Institutions for Collective Action* (Cambridge University Press, 1990).

[17] Mumma et al., n. 9 above, p. 1.

[18] US National Ground Water Association, 'Facts about Global Groundwater Usage', 2020, available at: https://www.ngwa.org/what-is-groundwater/About-groundwater/facts-about-global-groundwater-usage; see also J. Margat & J. van der Gun, *Groundwater Around the World* (CRC Press/Balkema, 2013), Ch. 5; World Bank, 'Deep Wells and Prudence: Towards Pragmatic Action for Addressing Groundwater Overexploitation in India', 2010, available at: http://hdl.handle.net/10986/2835.

[19] FAO, n. 14 above, p. 25.

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irrigation works. In contrast, in some jurisdictions groundwater is *perceived* as a similarly 'private resource' (landowners consider that they have an absolute right to the water beneath their land, often irrespective of what the law may say).[20] It is legally considered a CPR in many other jurisdictions, especially in the global south, with little regulatory attention to its management by landowners.[21] This characterization encourages the unsustainable use of groundwater, with widespread consequences for the wider community.

Groundwater and surface water interlink in significant ways. For example, the abstraction of groundwater reduces surface water supplies, while the diversion of surface water may lead to the depletion of groundwater resources.[22] This interconnectedness historically has not informed water law and policy in many jurisdictions, although this is starting to change.[23] We see this, for example, in the European Union (EU) Water Framework Directive,[24] which provides a framework for water management, including groundwater, and in Australia's federal Water Act 2007.[25] Both instruments refer to the 'conjuctive use' of groundwater and surface water: a situation where 'both groundwater and surface water are developed (or co-exist and can be developed) to supply a given urban area … although not necessarily using both sources continuously over time nor providing each individual water user from both sources'.[26] The aim of conjunctive use and management is to 'maximise the benefits arising from the innate characteristics of surface and groundwater water use'.[27] This requires coordination of the operation and governance of groundwater and surface water resources in order to increase total water supplies and enhance water quality. While, scientifically, the concept has potential, legally and from a governance perspective it neither fully addresses the problem of separation between the notions of groundwater and surface water, nor does it

[20] S.S.D. Foster et al., 'Groundwater Governance: Conceptual Framework for Assessment of Provisions and Needs', The World Bank GW-MATE, *Strategic Overview Series*, No. 1, Oct. 2009, available at: https://drstephenfoster.files.wordpress.com/2015/03/d-3-foster-et-al-2009b.pdf. Even in jurisdictions where individual rights to use groundwater exist, groundwater is still considered to be owned by the state and entitlement to use it is given by public authorities through licences and permits. In some jurisdictions (e.g., Australia and some US states) these entitlements are generally considered private property rights, unlike in others (e.g., some EU Member States): Nelson & Quevauviller, n. 13 above, pp. 176–77.

[21] P. Cullet, *Water Law, Poverty, and Development: Water Sector Reforms in India* (Oxford University Press, 2009), pp. 35–6.

[22] P.K. Smith, 'Coercion and Groundwater Management: Three Case Studies and a "Market" Approach' (1986) 16(4) *Environmental Law*, pp. 797–882, at 805.

[23] C.N. Dahm et al., 'Nutrient Dynamics at the Interface between Surface Waters and Groundwaters' (1998) 40(3) *Freshwater Biology*, pp. 427–51; T.C. Winter et al., *Ground Water and Surface Water: A Single Resource*, US Geological Survey Circular 1139 (US Government Printing Office, 1998).

[24] Directive 2000/60/EC Establishing a Framework for Community Action in the Field of Water Policy [2000] OJ L 327/1.

[25] Water Act 2007 (No. 137, 2007) (Australia), s. 4(1).

[26] S. Foster et al., 'Conjunctive Use of Groundwater and Surface Water: From Spontaneous Coping Strategy to Adaptive Resource Management', The World Bank GW-MATE *Strategic Overview Series*, No. 2, 2010, p. 3, available at: http://documents.worldbank.org/curated/pt/874731468315319173/pdf/575560replacem1onjunctive1Use120100.pdf.

[27] W.R. Evans et al., 'Conjunctive Use and Management of Groundwater and Surface Water within Existing Irrigation Commands: The Need for a New Focus on an Old Paradigm', Groundwater Governance, Thematic Paper 2, 2016, p. 6, available at: http://www.fao.org/fileadmin/user_upload/groundwatergovernance/docs/Thematic_papers/GWG_Thematic_Paper_2.pdf.

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assist in clarifying the nature of rights over groundwater and surface water resources.[28]

The interconnectedness between groundwater and surface water and the problematic nature of developing adequate policies that cover both is further compounded by the transboundary nature of water resources. There are approximately 276 transboundary river basins covering almost half of the earth's surface and 60% of freshwater supplies; 145 countries have territory in this area and there are also approximately 300 transboundary aquifers, which serve the almost 3 billion people who depend on groundwater resources.[29] This means that they may transcend national, state, and local boundaries, thereby requiring collaboration between stakeholders across different jurisdictions to manage them. The EU Water Framework Directive is one of still relatively few examples of such cross-border collaboration, as is the Guarani Aquifer Agreement between Argentina, Brazil, Paraguay, and Uruguay.[30]

In the context of increased use and dependence on groundwater, there is a need to improve the governance of this largely unseen but increasingly precious resource. There is a need for an approach that would involve, in part, greater cooperation and coordination between actors (that is, of both surface water and groundwater) and levels of governance. Such a governance system requires a holistic approach that involves potential trade-offs.[31] The Groundwater Governance Project[32] is an attempt to provide a framework for such a holistic approach. One of the main project outcomes was a Shared Global Vision for Groundwater Governance, which sets out targets to be achieved by 2030.[33] These targets include instituting 'legal, regulatory and institutional frameworks … that establish public guardianship and collective responsibility' and the development of 'incentive frameworks' that encourage sustainable use of groundwater.[34] The project also produced a Global Framework for Action to Achieve the Vision on Groundwater Governance (GWGF), which specifies ways in which these targets can be achieved.[35]

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[28] E.g., in the South African National Water Policy there is no explicit mention of conjunctive use and management of surface water and groundwater. Yet, s. 6.4 discusses the establishment of a water conservation and utilization policy in relation to optimum use of water for each of the main user sectors (agriculture, industry and mining) while s. 6.6.3 states that the development and use of all water resources should be undertaken in accordance with the principles of Integrated Environmental Management, thereby placing water use and management in a broader perspective. See, e.g., K. Pietersen, H.E. Beekman & M. Holland, 'South African Groundwater Governance Case Study', WRC Report No. KV 273/11, June 2011, p. 9, available at: http://www.wrc.org.za/wp-content/uploads/mdocs/KV%20273-11.pdf.

[29] UN Water, 'Transboundary Waters', 2020, available at: https://www.unwater.org/water-facts/transboundary-waters.

[30] Agreement on the Guarani Aquifer, San Juan (Argentina), 2 Aug. 2010, in force 26 Nov. 2020, unofficial English translation available at: http://www.internationalwaterlaw.org/documents/regionaldocs/Guarani_Aquifer_Agreement-English.pdf.

[31] F. Nunan et al., 'Governing for Ecosystem Health and Human Wellbeing', in K. Schreckenberg, G. Mace & M. Poudyal (eds), *Ecosystem Services and Poverty Alleviation: Trade-offs and Governance* (Routledge, 2018), pp. 159–73, at 169.

[32] See FAO et al., n. 4 above.

[33] FAO, 'Shared Global Vision for Groundwater Governance 2030 and a Call-for-Action', 2016, available at: https://www.fao.org/publications/card/en/c/49ae1fdc-9f51-4d14-b5e8-bb57d595ff94.

[34] FAO, n. 14 above.

[35] Ibid., p. 21.

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The difficulty faced by any internationally focused instrument that seeks to encourage such actions is that individual groundwater resources need to be considered in their context: an approach that might work in one country will not necessarily work in another where the ecological, cultural, social, and political conditions are different. Additionally, the existing legal provisions (for example, where extractions permits and licences are recognized as private property rights in some jurisdictions but not in others, whereas in other jurisdictions no permits are required at all) and the positions taken by various local stakeholders may also make a uniform approach impossible, certainly in the short term. In response to these challenges, there is a need for a governance approach which strikes a balance between making specific suggestions that give states and stakeholders a 'push in the right direction', while avoiding taking a prescriptive stance that could render a framework unusable.

3. THE ESSENTIAL CHARACTERISTICS OF GOVERNANCE AND OSTROM'S WORK

Governance is a context-specific, dynamic concept. There is no single approach to governance – be it community-based, private sector, or state-led – that can deliver the desired outcomes.[36] Some interpretations of governance see it as the exercise of political, economic, and administrative authority in national affairs at all levels. On this view, it comprises the mechanisms, processes and institutions through which citizens articulate their interests, mediate their differences and fulfil their legal rights and obligations.[37] Specifically concerning groundwater, Foster and Garduño state:

> Groundwater governance comprises the promotion of responsible collective action to ensure socially sustainable utilisation and effective protection of groundwater resources for the benefit of humankind and dependent ecosystems.[38]

Given the 'common pool resource' characteristic of groundwater, collective or collaborative action would seem to offer the best chance to achieve favourable outcomes. This is a key feature of Ostrom's vision on governance.[39] She argues that it is crucial to resolve questions about how to regulate CPR because, by their very nature, if everyone is allowed to use the resource freely, it will eventually be impossible to protect its existence.[40] Ostrom's work indicates that a polycentric approach is preferable to monocentric methods, even in attending to the issue of CPR governance as it provides a greater opportunity for experimentation, choice, and learning across levels of social organization, and also has the tendency to 'enhance innovation, learning, adaptation, trustworthiness, levels of cooperation of participants, and the achievement of more

[36] Nunan et al., n. 31 above.

[37] S. Foster & H. Garduño, 'Groundwater-Resource Governance: Are Governments and Stakeholders Responding to the Challenge?' (2013) 21(2) *Hydrogeology Journal*, pp. 317–20.

[38] Ibid., p. 317.

[39] Ostrom, n. 16 above.

[40] Ibid., p. 49.

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effective, equitable and sustainable outcomes at multiple scales'.[41] Using several case studies, she identified that 'ecological sustainability' was an outcome of successful CPR governance.[42] Ostrom reasoned that:

> [m]ost of the institutional arrangements used in the success stories were rich mixtures of public and private instrumentalities. If this study does nothing more than shatter the convictions of many policy analysts that the only way to solve CPR problems is for external authorities to impose full private property rights or centralized regulation, it will have accomplished one major purpose. At the same time, no claim is made that institutional arrangements supplied by appropriators, rather than by external authorities, will achieve optimal solutions.[43]

Such a characterization reinforces the view that good governance is created by the combined efforts of the public and private sectors. Ostrom cautions against any regime being 'optimal' but nevertheless found that institutional arrangements that relied only on the CPR owners/appropriators could lead to a better outcome. While warning against the risks of applying normative criteria,[44] Ostrom's measure of success is the fact that the users have maintained these institutions over a long period. In exploring the conditions under which these successful institutions had operated and comparing them with examples where efforts to manage CPRs had failed, Ostrom was able to identify her eight design principles for long-enduring institutions: (1) clearly-defined boundaries; (2) congruence between appropriation and provision rules and local conditions; (3) collective-choice arrangements; (4) monitoring; (5) graduated sanctions; (6) conflict-resolution mechanisms; (7) minimal recognition of rights to organize; and for CPRs that are part of larger systems (8) nested enterprises.[45] Throughout, the focus of governance according to the design principles, therefore, involves a range of self-interested rational actors to create, implement and enforce systems that balance the rights and responsibilities of everyone who benefits from the CPR.

Ostrom's design principles have been very influential,[46] and often considered a counterweight to Hardin's 'tragedy of the commons' narrative.[47] Over the years, the design principles have developed further through empirical insights.[48] The principles are not without criticism, for example, with regard to attempts to generalize them across

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41 E. Ostrom, 'Polycentric Systems for Coping with Collective Actions and Global Environmental Change (2010) 20(4) *Global Environmental Change*, pp. 550–7, at 552.

42 Ostrom, n. 16 above, p. 60.

43 Ibid., pp. 182–3.

44 B.E. Singleton, 'What's Missing from Ostrom? Combining Design Principles with the Theory of Sociocultural Viability' (2017) 26(6) *Environmental Politics*, pp. 994–1014, at 996.

45 Adapted from Ostrom, n. 16 above, p. 90.

46 According to Google Scholar, it has been cited by over 40,000 academic works across several disciplines.

47 G. Hardin, 'The Tragedy of the Commons' (1968) 162(3859) *Science*, pp. 1243–8. See also M. Olson, *The Logic of Collective Action: Public Goods and the Theory of Groups* (Harvard University Press, 1965).

48 One review in 2010 analyzed 91 studies that had used the design principles, but there are certainly many more; see M. Cox, G. Arnold & S. Villamayor-Tomás, 'A Review of Design Principles for Community-Based Natural Resource Management' (2010) 15(4) *Ecology and Society*, article 38, available at: https://www.ecologyandsociety.org/vol15/iss4/art38.

CPR institutions.[49] Also, the focus of the design principles on individual actors could lead to resource users being blamed for problems associated with wider socio-economic factors beyond the CPR institution.[50] Indeed, the wider socio-economic factors may be just as important for the likely success of the CPR institution as the actions of individual actors.[51] Accordingly, there is a need to understand the wider context if we are to unpack the barriers to successful CPR institutions.[52] Singleton has argued that this criticism is only partially valid as design principles 1, 2, 7 and 8 'all suggest an awareness that local institutions do not exist in isolation'.[53] Yet, the risk of the design principles being interpreted as ignoring wider socio-economic factors remains.

These and other theoretical criticisms[54] of the design principles underscore the need to apply them with care. Indeed, they continue to be employed by researchers and have been applied to various contexts to help our understanding of CPR governance.[55] The next section uses the design principles as an analytical tool to examine the role of market-based instruments, such as PES, in achieving groundwater governance. It discusses the main features of PES approaches and assesses the extent to which Ostrom's design principles inform the application of PES.

4. PES APPROACHES AND OSTROM'S DESIGN PRINCIPLES

The need to establish linkages with other water resources and other sectors in groundwater governance requires a better scientific understanding of these linkages and lessons from approaches in managing other resources, such as habitats. Such new approaches build on the 'ecosystem approach', which involves 'a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way'.[56] This more integrated approach requires a shift in both the mindset and practices of many of those who manage and use land and groundwater resources. For example, farmers who depend on groundwater ecosystem services are called on to see themselves as 'integrated land managers' who produce food and provide ecosystem services, rather than merely 'food producers'. In the context of groundwater, this framework requires that an ecosystem and resilience-based approach includes 'allowing certain level of (controlled, temporary) groundwater overdraft in

[49] See, e.g., Singleton, n. 44 above, p. 997, and sources cited in F.P. Saunders, 'The Promise of Common Pool Resource Theory and the Reality of Commons Projects' (2014) 8(2) *International Journal of the Commons*, pp. 636–56, at 641, 648.

[50] N.D. Peterson & C. Isenhour, 'Introduction: Moving Beyond the "Rational Actor" in Environmental Governance and Conservation' (2014) 12(3) *Conservation and Society*, pp. 229–32, at 230.

[51] S.B. Longo & R. Clausen, 'The Tragedy of the Commodity: The Overexploitation of the Mediterranean Bluefin Tuna Fishery' (2011) 24(3) *Organization & Environment*, pp. 312–28.

[52] N.D. Peterson, 'Choices, Options, and Constraints: Decision Making and Decision Spaces in Natural Resource Management' (2010) 69(1) *Human Organization*, pp. 54–64.

[53] Singleton, n. 44 above, p. 998.

[54] Ibid., pp. 997–1001.

[55] See, e.g., Cox, Arnold & Villamayor-Tomás, n. 48 above.

[56] Definition from Decision V/6 of the Convention on Biological Diversity 5th Conference of the Parties, Nairobi (Kenya), para. 1, available at: https://www.cbd.int/decision/cop/?id=7148.

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order to make room for farmers to generate income and transition into other non-groundwater-dependent livelihoods'.[57] This means that a balance needs to be struck between groundwater use and income generation for farmers.

The idea of PES is based on this increased recognition of the role of the 'natural' environment in providing a range of goods and services of great practical, economic and spiritual value to society, either directly or indirectly. A starting point in the shift in policies and practices to reflect the value of land (and groundwater) in providing ecosystem services is to calculate in economic terms the value of such services and to ensure that this is properly taken into account when decisions that affect the state of groundwater are being taken. Such an approach would address some of the groundwater governance challenges highlighted in Section 2 above by ensuring that the provision of groundwater ecosystem services is integrated with other land uses and there is coordination with other water sources. This is significant because available evidence shows that the spatial layout of ecosystems is important for the interactions that give rise to ecosystem services. For example, linkages between groundwater, surface water and rainfall within the river catchment area mean that impacts on any one of these can affect hydrological processes within the catchment and the ecosystem services linked to these processes, such as clean water provision. Equally, the social value of groundwater services (such as the thermal spas in Salto (Uruguay)[58]) relates spatially to where they are consumed; hence the need for context-specific groundwater management.

PES approaches offer one potential method for addressing the need for collective action, and combining private and public instruments to resolve CPR problems. Accordingly, the remainder of this article explores the the role that PES approaches can play in groundwater governance, evaluating how PES (which rely heavily on outside structures for enforcement) could be structured to fit with Ostrom's design principles, which allow for governance within the relevant community.

4.1. *Using PES to Address CPR Problems*

There are different and evolving understandings of PES.[59] Generally speaking, PES is a system whereby there is recognition that land and natural resources, such as groundwater, provide benefits for landowners and the wider community such that payment is provided to ensure the maintenance of these services. This requires calculating the benefit of that service and its market value compared with any activity that will have to stop or start to protect that service. This allows for transactions between those

[57] CGIAR & IWMI, n. 15 above, p. 7.

[58] See A. Pesce, 'Thermal SPAs: An Economical Development Alternative along Both Sides of the Uruguay River' (2002) 23(3) *Geo Heat Center Bulletin*, pp. 22–8; H. Hussein, 'The Guarani Aquifer System, Highly Present but Not High Profile: A Hydropolitical Analysis of Transboundary Groundwater Governance' (2018) 83 *Environmental Science and Policy*, pp. 54–62, at 59.

[59] C. Sattler & B. Matzdorf, 'PES in a Nutshell: From Definitions and Origins to PES in Practice – Approaches, Design Process and Innovative Aspects' (2013) 6(C) *Ecosystem Services*, pp. 2–11.

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seeking the benefits of the service and those who have to behave differently to ensure the continued provision of the service.[60]

At the heart of PES approaches are heterogeneous players in market transactions for ecosystem services, without complex regulatory interventions. Buyers and sellers are separate entities and may be organized differently. For example, groups of farmers (providers) act together, allowing flooding on their lands to prevent flooding downstream. The downstream entity paying for such services (the buyer), however, is separate from that community; it could be another community, or a municipality, or even a single landowner. Similarly, the farmers might act in common, to allow flooding for the sake of a migratory bird habitat and the buyer could be another community, such as a birding group, a local or national association, or even a single philanthropist.[61] In both examples the sellers or buyer, or both, are engaging in their collective action, but they are separate entities connected through a market transaction (contract) or subsidy (government) scheme.

The heterogeneity of many groundwater aquifers and users means that in any given scenario, there may be several diverse groups of buyers and sellers getting together as separate entities to decide, on the one hand, who should pay how much and to whom and, on the other hand, what services (actions) should be provided in return for payments. While there are several major user types (municipalities, manufacturers, and so on), the greatest volume of groundwater is pumped for agriculture, and there may be a great number of agriculturists spread over a large territory, given the size of the aquifers that they all exploit. In addition, most ecosystem concerns revolve around leaving enough groundwater in place so that it comes to the surface in rivers or wetlands. However, riverine and wetland ecosystem services are also extremely diverse (for example, flood control, habitat conservation for a great variety of aquatic and terrestrial species, fishing, boating, hunting). This means that those who might provide or pay for ecosystem services related to groundwater are a large and/or very diverse set. The market for groundwater-related ecosystem services is therefore likely to be made up of large numbers of farmers on the one side, and groups of birders, ecologists, hunters, fishers, etc., on the other side, all of whom want enough groundwater back in the ground to sustain rivers and wetlands. The same would be true if the payment went in the opposite direction, as in irrigating farmers paying for upstream ecosystem conservation to keep groundwater in place.[62]

4.2. *Applying Ostrom's Design Princicples to PES for CPR*

The following assessment of the design principles focuses on these kinds of subgroup and their efforts to resolve their collective action issues. It does not attempt to capture all the subgroups in each groundwater aquifer, but aims to show on a broad conceptual

[60] M. Aguilar-Støen, 'Exploring Participation in New Forms of Environmental Governance: A Case Study of Payments for Environmental Services in Nicaragua' (2015) 17(4) *Environment, Development and Sustainability*, pp. 941–58, at 944.

[61] The author is indebted to an anonymous *TEL* reviewer for the examples outlined here.

[62] The author is indebted to an anonymous *TEL* reviewer for the examples and context outlined here.

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level how PES fits with the design principles if each subgroup were to organize itself for collective action.

Design Principle 1: Clearly defined boundaries

According to Agrawal,[63] this principle requires a clear definition of the contents of the CPR that the community uses, boundaries around the community of users, and the effective exclusion of external unentitled parties. This is essential as a first step for achieving the sort of collective action to which Ostrom refers.[64] In setting clear boundaries, the aim is to help to 'internalize the positive and negative externalities produced by participants, so they bear the costs of appropriation and receive some of the benefits of resource provision'.[65] Clearly defined boundaries are necessary in order to achieve expected level benefits from any scheme. Concerning groundwater, this will mean having clearly defined boundaries of the spatial layout of the aquifer, defining who the community of users are, setting limits on abstraction rates and having a clear system in place to exclude unentitled parties.

The starting point for any PES scheme is to identify the limits of the ecosystem services that are being paid for[66] and who can sell the services.[67] It is about paying for benefits (services) from the land (or groundwater) and, more specifically, linking the suppliers of the benefits, such as upstream land managers, to the beneficiaries, such as the downstream communities who use water. In fact, the very categorization of PES schemes as a market-based approach to dealing with environmental challenges[68] means that in order for it to be successful, as with any economic instrument, clear boundaries within each community group need to be set. Given that PES schemes are very much driven by benefits to be derived (hence their characterization as win-win solutions), the impact of losing those benefits through lack of clear limits as to who can participate in and benefit from the PES scheme would certainly reduce the incentive to participate. However, as explained by Ostrom, clear boundaries alone would be insufficient to ensure success as it may still be possible for a limited number of community users to take more than the allocated units.[69] This underscores the importance of clarifying land and tenure rights.

Those who receive payments under PES schemes usually have proprietary rights over the land that they are (not) using to further environmental protection.[70] This is problematic in some cases, as PES schemes that rely on proprietary rights have sometimes

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63 A. Agrawal, 'Common Resources and Institutional Sustainability', in E. Ostrom et al. (eds), *The Drama of the Commons* (National Academy Press, 2002), pp. 41–86.

64 Ostrom, n. 16 above, p. 91.

65 Cox, Arnold & Villamayor-Tomás, n. 48 above.

66 C.T. Reid & W. Nsoh, *The Privatisation of Biodiversity? New Approaches to Conservation Law* (Edward Elgar, 2016), pp. 77–130.

67 W. Nsoh & C.T. Reid, 'Privatisation of Biodiversity: Who Can Sell Ecosystem Services?' (2013) 25(1) *Environmental Law and Management*, pp. 12–20.

68 G. Bennett, N. Carroll & K. Hamilton, 'Charting New Waters: State of Watershed Payments 2012', Forest Trends, 24 Jan. 2013, p. 1, available at: www.ecosystemmarketplace.com/reports/sowp2012.

69 Ostrom, n. 16 above, p. 91.

70 K. McAfee & E.N. Shapiro, 'Payments for Ecosystem Services in Mexico: Nature, Neoliberalism, Social Movements, and the State' (2010) 100(3) *Annals of the Association of American Geographers*, pp. 579–99, at 582.

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been designed so that payments are made only to people who have individual titles to land, rather than to communities who own an area of land in common, thereby disadvantaging Indigenous communities.[71] Similarly, water rights will need to be clarified to identify who has duties and who has rights under the PES scheme.

Therefore, in addition to setting clear boundaries, there must be a system of rules that limits how much everyone within the subgroup can take or sell as far as it is necessary to achieve the desired benefit. Such clear boundaries and rules are achieved in PES schemes through the use of contracts that are signed by everyone involved in the project, thereby defining who will directly contribute to the scheme and benefit from it.[72] Here, boundaries around the community of users are determined based on which activities might provide the necessary services (for example, groups of farmers acting together to allow flooding on their lands) and who might seek to benefit from these services (for example, the government, another community, municipality or a private entity). For groundwater, this will be based on a degree of proximity to the aquifer, but there is also the issue of the congruence with surface waters which may be more remote, further extending the scope of user groups that might be involved.

Related to the issue of setting boundaries around who can or cannot participate in PES schemes is the question of whether payment should be based on 'inputs' (work done to maintain or enhance groundwater levels) or 'outputs' (the actual benefits delivered, such as the quantity and quality of groundwater benefited).[73] While the advantage of an input-based structure is that it will be less difficult to determine the work that is required in order to receive payment, it is argued that an output-based mechanism would support environmental protection better because a real benefit will have to be established before payment is made. Conversely, if the latter structure is less appealing to potential participants than the input-based mechanism, there may be less participation (see Principle 3 below), which may weaken efforts to improve the protection of the resource. Irrespective of which approach is adopted, it will be up to the separate groups of heterogeneous players to decide on the boundaries to govern their collective actions for the best outcome.

Design Principle 2: Congruence between appropriation and provision rules and local conditions

Ostrom's second design principle refers to the appropriation and provision of common resources that are adapted to local conditions.[74] There are two separate conditions under this principle. The first condition is that both appropriation and provision rules have to match the local situation.[75] This places emphasis on the local conditions

[71] J.C. Rodríguez-de-Francisco & R. Boelens, 'PES Hydrosocial Territories: De-territorialization and Re-patterning of Water Control Arenas in the Andean Highlands' (2016) 41(1) *Water International*, pp. 140–56, at 150.

[72] See, e.g., Aguilar-Støen, n. 60 above, p. 947.

[73] Nsoh & Reid, n. 67 above, pp. 15–8.

[74] Ostrom, n. 16 above, p. 92.

[75] Ibid., p. 89.

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of the CPR, such as its spatial and temporal heterogeneity. The second condition is that there must be congruence between the appropriation and provision rules. For groundwater, this means that the approach to managing abstraction/recharge has to match the resource conditions and must continue to match the local conditions even when the situation has moved on from its original form.

Successful PES approaches are designed on an adequate understanding of the local conditions. This involves having a well-defined ecosystem service (or a land use likely to secure that service) but will also involve establishing ecosystem service baselines and the scope for additionality, among others. At the heart of identifying the local conditions is the issue of costs in obtaining detailed knowledge about the local context, including identifying the source(s) of problems that the groundwater is facing and what needs to be done about them. Indeed, the GWGF emphasizes the role that scientific knowledge should play in designing frameworks to protect groundwater.[76] Importantly, it also stresses the need to disseminate this knowledge in a way that non-scientists can understand.[77] Sharing the knowledge will further encourage action because the more people understand the effects of their actions, the more they might be willing to put in more effort to protect the resource.

An adequate understanding of the local conditions will determine the kind of PES design that is best suited to deliver the desired outcomes: general subsidy, direct contracts, auctions or paying a third party (intermediary).[78] PES approaches that adopt a flat subsidy design cannot clearly distinguish between those parties who can provide high-value services and those who provide low-value services.[79] According to Salzman, this is because they often operate by allowing any landowner or occupier within a particular area to participate regardless of whether they provide valuable services.[80] The public goods character of groundwater and the diffuse nature of the users (farmers, municipalities, manufacturers, birding groups, ecologists, mushroom gatherers, duck hunters, duck lovers, fishers, etc.) may mean that a flat subsidy design may be the most suitable. Allowing any user within a particular area to participate regardless of whether they provide valuable services may benefit from reduced costs in identifying the landowners or occupiers with whom to enter into contracts. Yet other designs of water-related PES schemes have been shown to deliver the desired benefits to protect the aquifer by controlling the abstraction of groundwater and ensuring its sustainable use. The Vittel PES programme in France is an example of a scheme in which the direct

[76] FAO, n. 14 above, p. 34.

[77] Ibid.

[78] Reid & Nsoh, n. 66 above, pp. 109–15.

[79] See, e.g., the Environmental Services Payment (Pago de Servicios Ambientales (PSA)) Program in Costa Rica: FONAFIFO, 'Environmental Services Payment (PSA) Program', 2015, available at: https://www.fonafifo.go.cr/en/servicios/pago-de-servicios-ambientales; G.A. Sánchez-Azofeifa et al., 'Costa Rica's Payment for Environmental Services Program: Intention, Implementation, and Impact' (2007) 21(5) *Conservation Biology*, pp. 1165–73; S. Zbinden & D.R. Lee, 'Paying for Environmental Services: An Analysis of Participation in Costa Rica's PSA Program' (2005) 33(2) *World Development*, pp. 255–72.

[80] J. Salzman, 'Creating Markets for Ecosystem Services: Notes from the Field' (2005) 80(3) *New York University Law Review*, pp. 870–961, at 918–9.

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contract design approach has been used.[81] The objective of the programme was to provide a high level of water quality by reducing nitrate rates in the aquifer. Therefore, depending on the local context, several PES approaches can be tailored within certain limits to deliver the desired outcome. Furthermore, once a scheme has been designed based on the initial information about the local context, the challenge will be to update this information continually so that the scheme continues to meet requirements.

Concerning the second condition under this principle – that there has to be congruence between appropriation and provision rules – this is sometimes referred to as a balance between the costs incurred by users and the benefits they receive by participating in collective action.[82] According to Pomeroy, Katon and Harkes, in successful CPR systems 'individuals have an expectation that the benefits to be derived from participation in and compliance with community-based management will exceed the costs of investments in such activities'.[83]

Central to the idea of PES is the need to link costs and benefits more directly – that is, ensuring that decisions about economic development are not prejudicial to the loss of ecosystem services, and that there is a balance between the gain from development and the loss of ecosystem services.[84] While complications may arise in attempting to determine the costs and benefits of specific groundwater ecosystem services, irrespective of which PES approach is adopted, the underlying idea is for the users of the groundwater ecosystem services to weigh the costs and benefits of any potential land-use changes, thereby leading landowners to change the ways in which they think about the benefits that their land produces.[85] For example, groups of upstream farmers act together to allow flooding on their lands to prevent flooding downstream. These benefits include a positive impact on groundwater-dependent ecosystems and such ecosystems generate revenue, which contributes to financial prosperity.[86] Indeed, PES schemes have been

[81] D. Perrot-Maître, 'Private Sector Incentives for Biodiversity Conservation: The Case of Vittel, France', International Workshop on the Removal and Mitigation of Perverse, and the Promotion of Positive, Incentive Measures, Paris (France), 6–9 Oct. 2009, UN Doc. UNEP/CBD/SBSTTA/14/INF/26, pp. 41–3, available at: https://www.cbd.int/doc/meetings/im/wsim-03/official/wsim-03-sbstta-14-inf-26-en.pdf; D. Perrot-Maître, 'The Vittel Payments for Ecosystem Services: A "Perfect" PES Case?', International Institute for Environment and Development (IIED), Sept. 2006, available at: https://pubs.iied.org/pdfs/G00388.pdf.

[82] E. Ostrom, *Understanding Institutional Diversity* (Princeton University Press, 2005), p. 259.

[83] R.S. Pomeroy, B.M. Katon & I. Harkes, 'Conditions Affecting the Success of Fisheries Co-management: Lessons from Asia' (2001) 25(3) *Marine Policy*, pp. 197–208, at 201.

[84] See, e.g., Department for Environment, Food and Rural Affairs, 'An Introductory Guide to Valuing Ecosystem Services', Dec. 2007. See also C.T. Reid, 'The Privatisation of Biodiversity? Possible New Approaches to Nature Conservation Law in the UK' (2011) 23(2) *Journal of Environmental Law*, pp. 203–31, at 220–2; Reid & Nsoh, n. 66 above, p. 8; A.J. Guswa et al., 'Ecosystem Services: Challenges and Opportunities for Hydrologic Modelling to Support Decision Making' (2014) 50(5) *Water Resources Research*, pp. 4535–44, at 4536; O. McIntyre, 'The Protection of Freshwater Ecosystems Revisited: Towards a Common Understanding of the "Ecosystems Approach" to the Protection of Transboundary Water Resources' (2014) 23(1) *Review of European, Comparative and International Environmental Law*, pp. 88–95, at 92.

[85] Salzman, n. 80 above, p. 919.

[86] B. Batubara, O. Batelaan & P. Quevauviller, 'Science-Policy Interfacing on the Issue of Groundwater and Groundwater-Dependent Ecosystems in Europe: Implications for Research and Policy' (2014) 1(6) *WIREs Water*, pp. 561–71, at 565.

noted to overcome the barriers of narrow thinking that can prevent the development of integrated water management,[87] as well as a 'tool for addressing systems in which ecosystems are mismanaged because many of their benefits are externalities from the perspective of ecosystem managers'.[88] Viewed from this perspective, PES approaches as an institutional tool would seem to fit with Ostrom's second design principle.

Design Principle 3: Collective-choice arrangements

Ostrom proposes with this principle that 'most individuals affected by the operational rules can participate in modifying the operational rules'.[89] The principle is designed to allow most resource appropriators to participate in the decision-making process. It underscores the significance of local knowledge in natural resource management, and builds on the fact that 'local users have first-hand and low-cost access to information about their situation and thus a comparative advantage in devising effective rules and strategies for that location, particularly when local conditions change'.[90] This means that for CPRs such as groundwater, this participation will be more effective if the knowledge about changing situations is also shared so that participants can make informed contributions to the process of modifying the rules (for example, on abstraction, or the extent to which upstream farmers can allow their lands to be flooded).

PES approaches are certainly a form of collective-choice arrangement, with diverse groups of 'producers' of ecosystem services on one side and diverse groups of 'beneficiaries' on another, sometimes with an intermediary in between. This mechanism provides 'spaces for negotiation and bargaining' about the operational rules (including rules on who has duties and who has rights under the PES scheme),[91] drawing on the local knowledge of users, and characterized by existing power dynamics.[92] In this way opportunities for collective action are created throughout the process. In a case study in Nicaragua, for example, a foreign governmental aid agency outlined the idea of a PES scheme to the local authorities, who then discussed participation with a local factory; the three organizations then decided which of the local farms should be invited to engage in the project.[93] PES is thus a scheme which can engage both governmental and non-governmental actors. Naturally, there will not be the same initial design process for every PES scheme; however, the idea that one or more parties have to secure the engagement of other parties will be a constant feature.

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87 M. Everard, 'Integrating Integrated Water Management' (2014) 167(9) *Water Management*, pp. 512–22, at 519.

88 M.D. Kaplowitz, F. Lupi & O. Arreola, 'Local Markets for Payments for Environmental Services: Can Small Rural Communities Self-Finance Watershed Protection?' (2012) 26(13) *Water Resources Management*, pp. 3689–704, at 3692.

89 Ostrom, n. 16 above, p. 90.

90 Cox, Arnold & Villamayor-Tomás, n. 48 above.

91 E. Lopez-Gunn & L. Cortina, 'Is Self-Regulation a Myth? Case Study on Spanish Groundwater User Associations and the Role of Higher-Level Authorities' (2006) 14(3) *Hydrogeology Journal*, pp. 361–79, at 373.

92 Aguilar-Støen, n. 60 above, p. 945.

93 Ibid., p. 947.

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Besides relying on 'first-hand and low-cost access to information about their situation'[94] from local appropriators, to ensure low-cost compliance with the rules, the involvement of local users in the decision-making process contributes to the ideas of shared responsibility[95] and stewardship of the natural world.[96] Indeed, the GWGF notes that 'public agencies alone cannot manage groundwater for the common good – institutions typically need to be inclusive of all stakeholders'.[97] By their very nature, PES approaches offer more by way of 'collective action' than the more traditional approach, which relies on public bodies to regulate groundwater exploitation where, for example, groundwater users have to follow the rules set out in legislation; this does not encourage their interaction with other users. The exchange of money for environmental services makes it highly likely that there will be a variety of actors involved in any given PES scenario, engaging as separate entities in respective collective action within their subgroup, but connected through the market transaction (contract) or subsidy (government).[98]

Experience shows that local users are more likely to support decisions in which they feel vested.[99] In fact, concerning the participation of individual actors and local communities, it has been shown that farmers, for example, were inspired to participate in resource governance schemes because they knew that water scarcity has a negative impact on their lives, and the cash payments that they received for participating were of value to them.[100] Although, as Ostrom argues, the presence of effective rules does not guarantee compliance by local users,[101] the use of cash or in-kind payments as incentives to encourage collective action within each subgroup[102] in part shows that PES approaches as an institutional tool can support the governance of groundwater resources and fit with Ostrom's Design Principle 3.

However, while this principle emphasizes the importance of local knowledge in designing effective rules and strategies for each situation, it is worth noting that the available 'low-cost' information may be insufficient. Successful PES schemes also depend on the information held by those outside the users' subgroup, such as the

94 See text to n. 90 above.

95 Declaration of the United Nations Conference on the Human Environment, Stockholm (Sweden), 5–16 June 1972, UN Doc. A/Conf.48/14/Rev 1, Preamble, para. 7, available at: https://sustainabledevelopment.un.org/milestones/humanenvironment.

96 W.N.R. Lucy & C. Mitchell, 'Replacing Private Property: The Case for Stewardship' (1996) 55(3) *Cambridge Law Journal*, pp. 566–600. For a detailed analysis of different concepts of stewardship, see E. Barritt, 'Conceptualising Stewardship in Environmental Law' (2014) 26(1) *Journal of Environmental Law*, pp. 1–23.

97 FAO, n. 14 above, p. 53.

98 E.g., in the Nicaraguan case study '[p]articipants in the project are the municipality of Bele'n, Rivas, eighty-seven campesino families and the sugarcane company': Aguilar-Støen, n. 60 above, p. 946.

99 See, e.g., N. Kosoy, E. Corberab & K. Brown, 'Participation in Payments for Ecosystem Services: Case Studies from the Lacandon Rainforest, Mexico' (2008) 39(6) *Geoforum*, pp. 2073–83.

100 Aguilar-Støen, n. 60 above, p. 947.

101 Ostrom, n. 16 above, p. 93.

102 P.X. To et al., 'The Prospects for Payment for Ecosystem Services (PES) in Vietnam: A Look at Three Payment Schemes' (2012) 40(2) *Human Ecology*, pp. 237–49, at 239.

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government or statutory body or a private entity.[103] On the one hand, if the main buyer of services is the government or a statutory body, key information will be held at a single point and may be available either through annual reports, accounts or other publications, or under freedom of information rules.[104] However, while legislation in some countries may provide for transparent decision making and access to information, other countries (especially in the developing world) do not yet have the adequate statutory reporting rules possessesd by most developed countries. Even where such rules already exist, there is a discrepancy between legislative requirements and implementation in practice. As a result, once collected by the government, environmental information tends to be difficult to obtain.[105]

On the other hand, if the services are bought by the private sector, such as a manufacturer, the transactions will not be subject to such disclosure rules. This can create mistrust within the subgroup and have a negative impact on efforts to resolve their collective issues. This may suggest a need for further measures to be put in place to ensure the collection of data, transparent decision making and access to the information, but these measures must be balanced against the needs of private entities to maintain some confidentiality of potentially market-sensitive information.[106]

Where there is a discrepancy between legislative requirements and implementation, availability and transparency in decision making in PES schemes can be achieved in different ways, such as through workshops.[107] In any case, in order to be effective, it is important for the public or everyone within the same subgroup(s) to understand the data that is made available. In this way, PES schemes can help to drive up standards because local users are more accepting of the rules.

A potential challenge to this argument is that market-based institutional tools such as PES can reinforce social hierarchies and structures.[108] In this sense, participation in a PES project can seem an attractive option for larger stakeholders. This could be a disincentive for potential individual participants, thereby limiting the applicability of this

[103] Greater transparency has been identified as a key element in avoiding what has been described as an 'ecosystem service curse': J. Kronenberg & K. Hubacek, 'Could Payments for Ecosystem Services Create an "Ecosystem Service Curse"?' (2013) 18(1) *Ecology and Society*, pp. 1–12.

[104] Reid & Nsoh, n. 66 above, p. 118.

[105] E.g., Art. 93 of the Bolivian Environmental Statute (Ley de Medio Ambiente No. 1333 of 1992, *Gaceta Oficial de Bolivia*, No. 1740) stipulates that environmental information held or used by the government at national and departmental levels must be public and accessible to any interested person. However, this is often not realized in practice and it can be very difficult to obtain information from the government once data has been collected: N. Asquith & M.T. Vargas, *Fair Deals for Watershed Services in Bolivia*, Natural Resource Issues No. 7 (IIED, 2007), pp. 13, 21, available at: https://pubs.iied.org/13536iied.

[106] Reid & Nsoh, n. 66 above, p. 118.

[107] See, e.g., the Bolivian Los Negros project and the Brazilian Oasis and Extrema Water Steward Programme: T. Greiber (ed.), *Payments for Ecosystem Services: Legal and Institutional Frameworks* (IUCN, 2009), pp. 65–6; K. Barrett, *Brazilian Ecosystem Services Matrix Brings Transparency to Environmental Finance* (Ecosystem Marketplace, 2015), available at: https://www.ecosystemmarketplace.com/articles/brazilian-ecosystem-services-matrix-brings-transparency-to-environmental-finance.

[108] Aguilar-Støen, n. 60 above, p. 955; To et al., n. 102 above, p. 239; S. Wunder, 'When Payments for Environmental Services Will Work for Conservation' (2013) 6(4) *Conservation Letters*, pp. 230–7, at 231; McAfee & Shapiro, n. 70 above, p. 583; S. Balasubramanya & D. Wichelns, 'Economic Incentives Can Enhance Policy Efforts to Improve Water Quality in Asia' (2012) 28(2) *International Journal of Water Resources Development*, pp. 217–31, at 222.

principle. With regard to groundwater, though, there is recognition that PES schemes 'can be set up so that the most vulnerable are protected',[109] thereby dismantling some of the social hierarchies to encourage greater participation. However, there must be an intention to achieve this benefit and such intentions will often depend on who instigates the arrangements for PES.[110] This is demonstrated clearly in the context of Mexico's implementation of PES schemes; while the World Bank did not equate environmental services with poverty reduction schemes, the government's position highlighted social benefits as an important reason to fund PES schemes.[111] Ostrom's argument for the engagement of as many stakeholders as possible should mean that, even if PES approaches are not going to facilitate revolutions in the very structure of society, participants that operate within their subgroups, either as buyers or sellers, should be assured they can make a difference and not endanger the success of the groundwater governance.

Design Principle 4: Monitoring

This principle requires, firstly, the presence of monitors, and, secondly, that the monitors are members of the community or accountable to the community.[112]

As PES is an incentive-based scheme, monitoring not only ensures that participants are complying with the rules and that their decision making about the resource is informed by how the rules are being complied with, it also ensures that participants are incentivized to continue to engage in the scheme. Under most PES approaches, monitoring provisions are a standard feature of the contracts signed by the parties.[113] Such contracts may be between a buyer (such as a government or public agency),[114] on the one side, and sellers (such as landowners or managers), on the other side, or any intermediaries for the management of the ecosystem goods and services on private land. Even in the absence of standard contracts, appropriate monitoring would be necessary to ensure cohesion between subgroups, whether buyers or sellers, when they come together to coordinate their joint efforts.

Under CPR institutions where responsibility falls on the whole community or subgroup of users, setting up a monitoring mechanism with monitors who are part of or accountable to the appropriators is straightforward. Under some PES approaches

[109] FAO, n. 14 above, p. 84.

[110] Wunder, n. 108 above, p. 231.

[111] McAfee & Shapiro, n. 70 above, p. 593.

[112] Cox, Arnold & Villamayor-Tomás, n. 48 above.

[113] Aguilar-Støen, n. 60 above, p. 949.

[114] Because of the public goods character of groundwater, it is likely that some kind of government intervention may be involved, either by providing payments itself or as an intermediary with the public as the buyer. While such involvement by government agencies may reduce transaction costs, it can also weaken the voluntary element of the PES scheme, which is seen as an attraction of this mechanism: V.K. Kolinjivadi & T. Sunderland, 'A Review of Two Payment Schemes for Watershed Services from China and Vietnam: The Interface of Government Control and PES Theory' (2012) 17(4) *Ecology and Society*, article 10, available at: https://www.ecologyandsociety.org/vol17/iss4/art10.

that are governed by public regulation (such as some of the general subsidy schemes[115]), it may be possible to devise a monitoring mechanism that fits with the requirements for this principle, in which accountability is to the community as a whole, but it may not be so straightforward with PES approaches that are a matter of private law arrangements. Under such approaches, monitoring compliance is essentially a matter for the parties, and they must be in a position to carry out this task. They will still be members of the community or subgroup, but accountability may be to other non-community or subgroup parties to the agreement as part of the market transaction. For example, groups of farmers (providers) act together in allowing flooding on their lands for the purpose of preventing flooding downstream, and monitor each other. Together, the farmers are accountable to the downstream entity that is paying for such services (buyer), which is separate from that community and could be another community, municipality, or even a single landowner. This process may be repeated for the other diverse subgroups of birders, ecologists, hunters, fishers and so on that rely on the groundwater aquifer, with monitoring and accountability within and between the subgroups to ensure compliance.

This segregation in monitoring duties may be avoided if a joined-up approach is adopted to ensure that even within different subgroups the various individual agreements reinforce each other to deliver wider community goods and services. In fact, under most PES schemes, such an approach will be necessary to ensure the delivery of services with interlinkages between different resources. For example, the Bolivian Los Negros-Santa Rosa PES scheme has as its overall objective to conserve biodiversity and protect the Los Negros River watershed. To achieve this, the buyers of the services (downstream irrigators), acting in common, negotiated two types of contract with the services providers (upstream farmer-landowners), also acting collectively. One type of PES contract prohibited 'tree cutting, hunting and forest clearing on enrolled lands'; the other type focused on reforestation of deforested areas of land in the watershed.[116] Here, the different contracts reinforce each other to achieve the overall objective, with the monitoring duties falling on parties who are members of the community. While it is not clear if the parties to the contracts feel accountable to the community, the fact that they are all working towards the overall goal of protecting the watershed, which has wider community benefits, would suggest some level of accountability to the community.

Therefore, to achieve the monitoring requirements under this principle with such privately negotiated PES agreements, consideration should be given to the right to have access to relevant information and rights of entry to carry out inspections by monitors who are members of the wider community of users but may fall within a different subgroup. These can either be left as a matter to be negotiated individually (perhaps

[115] E.g., public payments made to farmers under the EU Common Agricultural Policy agri-environment schemes for some of the non-market benefits of ecosystem services: Council Regulation (EC) 1782/2003 Establishing Common Rules for Direct Support Schemes under the Common Agricultural Policy and Establishing Certain Support Schemes for Farmers and Amending Regulations (EEC) 2019/93, (EC) 1452/2001, (EC) 1453/2001, (EC) 1454/2001, (EC) 1868/94, (EC) 1251/1999, (EC) 1254/1999, (EC) 1673/2000, (EEC) 2358/71 and (EC) 2529/2001, [2003] OJ L 27/1, Arts 3–5.

[116] N. Robertson & S. Wunder, *Fresh Tracks in the Forest: Assessing Incipient Payments for Environmental Services Initiatives in Bolivia* (CIFOR, 2005), p. 34, available at: https://www.cifor.org/knowledge/publication/1811.

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supported by guidance) or be provided for by law in the form of more general mandatory or default provisions.[117]

Design Principle 5: Graduated sanctions

This principle emphasizes the importance of a scale of graduated sanctions for resource users who violate community rules. An effective enforcement system will help to instill trust in the institutional framework by ensuring that genuinely severe cases are punished. This will also help in maintaining cohesion among local users while ensuring proportionality between the severity of violations and sanctions.[118]

Under most PES approaches, graduated sanctions of some kind exist as part of the transaction terms (contract) between the provider of the service and the 'buyer'.[119] Such sanctions would often take the form of withholding payments or making payments subject to compliance with specified environmental standards, as is the case with the EU agri-environment schemes.[120] While withholding payments may seem like the obvious kind of sanction to impose for violations that affect the delivery of specified services (especially given the voluntary nature of PES schemes), the use of contracts to set limits of what can or cannot be done by members of the community means that standard remedies under the law of contract or property may also be applicable. These remedies tend to favour compensation in financial terms when rights are breached, but that approach misses the point where the whole purpose of an arrangement is to secure continuing groundwater benefits. The usual alternative is an injunction or a prohibition, ordering parties in actual or threatened breach of their obligations to comply. However, in common law jurisdictions (probably less so in civil law equivalents) the courts have been reluctant to grant injunctions that require continuous supervision by the courts into the future.[121] Accordingly, while injunctions might be obtained to prevent specific harmful acts that violate community rules, there may be doubts over their availability to guarantee the continuing, and even continuous, management steps needed to maintain the groundwater ecosystem services at a particular site, potentially leaving a gap in enforcement. The analysis here assumes that the internal enforcement within each subgroup, which ensures that all members are adhering to the agreed rules, is working: for example, the rules imposed on all upstream farmers to allow flooding on their lands, on the one side, and the rules imposed on the paying community (such as a birding group, local or national association) on who should pay and how much, on the other side. Both groups are then connected through the market transaction (contract) or subsidy (government).

[117] Reid & Nsoh, n. 66 above, pp. 62–3.

[118] Cox, Arnold & Villamayor-Tomás, n. 48 above.

[119] See, e.g., Aguilar-Støen, n. 60 above, p. 949 (on the example in Nicaragua).

[120] In some cases payments are linked directly to outcomes – e.g., farmers on Islay and other parts of Scotland are paid for lost productivity according to the number of geese that feed in their fields during the winter: Scottish Natural Heritage, 'Islay Sustainable Goose Management Strategy October 2014–April 2024', 2014, available at: https://www.nature.scot/doc/islay-sustainable-goose-management-strategy-2014-2024.

[121] *Co-operative Insurance Society Ltd* v. *Argyll Stores (Holdings) Ltd* [1998] AC 1, [11]–[16] (Lord Hoffman).

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The use of remedies such as financial compensation or an injunction ordered by a court will necessitate external enforcement. In the case of groundwater, given the public interest in sustainably managing the resource and the need to connect different subgroups, such external enforcement may be necessary if the parties (for whatever reason) do not take steps to enforce an agreement even though its terms are being broken. While the presence of an external enforcer may be able to coerce the users into complying with the community rules, Ostrom cautions against this because such individual enforcement actions involve 'relatively high personal costs to produce public goods available to everyone'.[122] She argues that the costs of monitoring and enforcement are low in many long-enduring CPRs because local users create their internal enforcement both to deter those who may be tempted to break the rules and to assure those who are voluntarily complying that others are also complying. Therefore, for PES approaches to fit with this principle, the costs of monitoring and enforcement of the community rules must be kept low when the scheme is designed, especially when dealing with a heterogeneous resource such as groundwater and the various user groups that need to be connected. In some cases, spending more time negotiating a consensus rather than imposing sanctions may be sufficient.[123] This is especially important where there is a need to adopt adaptive management steps beyond those stipulated in the contract to maintain the groundwater ecosystem services.

Design Principle 6: Conflict-resolution mechanisms

This principle underscores the importance of the availability of low-cost conflict resolution mechanisms that are easy to access for the survival of CPR institutional systems. As Ostrom states:

> Even such a simple rule as 'each irrigator must send one individual for one day to help clean the irrigation canals before the rainy season begins' can be interpreted quite differently by different individuals. Who is or is not an 'individual' according to this rule? Does sending a child below age 10 or an adult above 70 to do the heavy physical work meet this rule? Is working for four hours or six hours a 'day' of work? Does cleaning the canal immediately next to one's own farm qualify for this community obligation?[124]

As this example shows, a simple rule like this can be misinterpreted both by those who intentionally want to subvert the purpose of the rule and by those who intend to comply with the intent of the rule but make errors. If a CPR institution is to survive, there must be a mechanism for discussing and resolving any misinterpretations of the rules by local users.

PES as an approach to enhancing groundwater governance may involve the obligation to manage land and groundwater resources in a particular way for a given time to provide ecosystem services in exchange for payments. An agreement of some kind between the

[122] Ostrom, n. 16 above, pp. 94–100.

[123] This approach is used in water management practices in the Nkayi District in Western Zimbabwe: F. Cleaver, 'Moral Ecological Rationality, Institutions and the Management of Common Property Resources' (2002) 31(2) *Development and Change*, pp. 361–83, at 374.

[124] Ostrom, n. 16 above, p. 100.

parties should provide legal certainty by ensuring that the parties have the same understanding of their own and the other parties' respective rights, responsibilities and obligations, and where risk is allocated. Such legal clarity is especially important for groundwater ecosystem services that are diverse and may require periods beyond the lifetime of the original parties to the agreement before significant benefits are delivered. However, as the example above shows, even a simple rule that appears clear to everyone on paper may be misinterpreted by some users, thus raising the possibility of dispute and failure later.

As securing benefits through PES approaches lie in contract, it necessarily follows that relying on the external court system to resolve intra- and inter-community contractual conflicts may be easier. While there are issues of costs to contend with, the example of the acequia irrigation communities in northern New Mexico proves just how important such a conflict resolution mechanism can be to a functioning sustainable groundwater governance arrangement. Here, the communities for over 100 years have turned to the 'external court systems under different national regimes to resolve inter-community conflicts'.[125]

While the availability of low-cost and accessible conflict-resolution mechanisms does not guarantee that PES approaches will deliver groundwater benefits, it is also difficult to see how any such scheme will succeed without such conflict-resolution mechanisms, given the complex set of rules across the different subgroups of providers, buyers or both that need to be maintained over the time necessary to deliver the groundwater ecosystem services.

Design Principle 7: Minimal recognition of rights to organize

This principle requires that local users be free to devise their institutions and rules free from challenge by external governmental authorities.[126] It is worth noting that this principle does not rule out a role for external governmental agencies in the governance of CPR institutions but that the role must be carried out in recognition of the rules set by local users for themselves and their ability to enforce the rules. In this way, the risk of imposing rules that do not match the local conditions is avoided.[127]

For PES approaches to succeed as an institutional tool in the governance of CPRs such as groundwater, they must start with recognizing the rules in operation for local users and build on this. In general, PES approaches would rely on local users' knowledge of the local conditions. While external governmental support (perhaps in the form of payments and also in prescribing the management practices to be implemented) may be necessary, this is only additional and is often done with recognition of the local rules and management practices in place. In the Nicaraguan PES case study, for example, a foreign governmental aid agency worked with local authorities and a local factory to identify and support local farms under the PES project.[128]

[125] Cox, Arnold & Villamayor-Tomás, n. 48 above.
[126] Ostrom, n. 16 above, p. 101.
[127] Cox, Arnold & Villamayor-Tomás, n. 48 above.
[128] Aguilar-Støen, n. 60 above, p. 947.

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Similarly, under the EU agri-environment schemes, while some payments are made conditional on compliance with additional environmental standards imposed under EU regulations, this is done in recognition of the local rules in operation (including rules on tenure) among farmers. This means that for a groundwater ecosystem with its interconnected nature, there must be recognition of the local rules in operation within and between the diverse user groups of, for example, farmers, birders, fishers and grazers.

For PES approaches to accord with this principle, they must start by 'recognising local knowledge and existing institutions at an early stage',[129] and then building on them for the long-term sustainability of any scheme. Indeed, the exact nature of any new groundwater governance projects will depend on the broader governmental and legal context already in place. This is especially important in cases where the PES scheme is initiated with the help of funding from an external agency, which may bring with it a presumption that it has the authority to set the rules on certain financial models that may be incompatible with local rules.[130]

Design Principle 8: Nested enterprises

This principle stipulates that for larger CPRs, governance activities are organized in the form of multiple layers of nested enterprises, with small local CPRs at the base level.[131] Cox, Arnold and Villamayor-Tomás highlight the importance of nesting smaller CPR systems into larger systems, especially 'given the high probability that the social systems have cross-scale physical relationships when they manage different parts of a larger resource system and thus may need mechanisms to facilitate cross-scale cooperation'.[132] They also note that institutional nesting is important in accomplishing the user and resource boundaries requirement in Principle 1 in many situations.[133]

Nesting can occur between local user groups themselves (horizontal linkages) or between local user groups and various governmental jurisdictions (vertical linkages). In any case, nesting will be important in designing PES schemes to support groundwater governance. It highlights the linkages between the different operating levels represented by participants in PES projects and from the different subgroups of local users who are in charge of delivering the services to the buyers of the services.[134]

As discussed under Principle 4 above, by their very nature PES approaches target specific local action, at either the individual or community level but with all working

[129] M.D. Turner, 'Conflict, Environmental Change, and Social Institutions in Dryland Africa: Limitations of the Community Resource Management Approach' (1999) 12(7) *Society and Natural Resources*, pp. 643–57.

[130] R.L. Goldman-Benner et al., 'Water Funds and Payments for Ecosystem Services: Practice Learns from Theory and Theory Can Learn from Practice' (2012) 46(1) *Oryx*, pp. 55–63.

[131] Ostrom, n. 16 above, pp. 90, 101–2.

[132] Cox, Arnold & Villamayor-Tomás, n. 48 above.

[133] Ibid.

[134] For an example of a successful PES scheme in groundwater, see B.R. Shivakoti, T. Ichikawa & K.G. Villholth, *Incentivizing Groundwater Recharge through Payments for Ecosystem Services (PES): Success Factors of an Offsetting Scheme in Kumamoto, Japan* (GRIPP, 2020), available at: https://gripp.iwmi.org/natural-infrastructure/water-storage/incentivizing-groundwater-recharge-through-payment-for-ecosystem-services-pes.

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towards an overall goal, such as protecting the recharge of the aquifer, which has wider community benefits. Nesting is therefore at the heart of PES approaches and will be especially important in transboundary catchments where there is a need not only for the kind of horizontal and vertical linkages described above, but also for horizontal linkages between various governmental jurisdictions across borders.

Such nesting across different jurisdictional boundaries can be seen in the US in the New York City Catskill Watershed PES scheme, which was designed to ensure that the city continues to enjoy high-quality, affordable drinking water.[135] The scheme involves agencies at the federal level (the US Environmental Protection Agency) and state level (New York City, eight upstate counties and more than 60 towns and villages crossing multiple jurisdictions, outside New York City).[136] Another example where nesting is seen to operate in PES approaches across large transboundary catchment areas is the Promoting Payments for Ecosystem Services in the Danube Basin, which ran from 2010 to 2014, involving Bulgaria, Romania, Serbia, and Ukraine. With financial support from the United Nations Environment Programme (UNEP), the Global Environment Facilty (GEF) and the European Commission, the project focused on developing and demonstrating national and local-level PES schemes to be integrated into the River Basin Management Plans for the River Danube and its sub-basins.[137] These examples show the importance of integrating nesting in PES approaches for the governance of larger enduring CPRs, such as large-scale transboundary aquifers, with several major user groups, each getting together to decide who should pay and then 'nesting' with other groups to coordinate their joint efforts to pay another group – for example, birding groups getting together and then connecting with rafting, fishing and/or hunting groups to coordinate joint efforts to pay farmers either directly or through an intermediary.

Design Principles: A summary

In many ways, PES approaches may be designed to fit with Ostrom's design principles, as demonstrated by the preceding analysis. However, PES schemes reward bad environmental behaviour in so far as they do not dispute, for example, the right to pollute, but rather attempt to 'construct avenues for reducing environmental impact and the degradation of nature as a result of offenders misbehavior'.[138] The kinds of behaviour that PES schemes should incentivize is therefore a central question. One approach would be to treat PES schemes as additional to conventional regulation, and use

[135] A. Kenny, *Ecosystem Services in the New York City Watershed* (Ecosystem Marketplace, 2006), available at: https://www.ecosystemmarketplace.com/articles/ecosystem-services-in-the-new-york-city-watershed-1969-12-31-2.

[136] Ibid.

[137] V. Stefanova, 'Terminal Evaluation of the Project "Promoting Payments for Ecosystem Services (PES) and Related Sustainable Financing Schemes in the Danube Basin"', UNEP, Nov. 2014, available at: https://www.unep.org/resources/terminal-project-evaluations/terminal-evaluation-unep-gef-project-promoting-pes-and.

[138] K. Nicolaus & J. Jetzkowitz, 'How Does Paying for Ecosystem Services Contribute to Sustainable Development? Evidence from Case Study Research in Germany and the UK' (2014) 6(5) *Sustainability*, pp. 3019–42, at 3022.

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them to target activities that are permitted to provide another layer of incentives.[139] This highlights the importance of effective design and implementation of PES schemes, and their fit with local laws and politics. The Offsetting Scheme in Kumamoto (Japan) shows how the careful application of PES to groundwater in conformity with Ostrom's principles can achieve desired outcomes.[140]

5. CONCLUSION

The challenges of groundwater resources management are considerable – from the non-appreciation of interconnectedness between groundwater and surface water law and policy to the transboundary nature of groundwater. It is clear that no single approach to governance can deliver the desired outcomes. Effective governance needs to include private sector and non-governmental actors, as well as governmental activity. This article considers the potential for PES-style models to provide a new and flexible framework for governing a CPR such as groundwater.

The analysis shows that PES approaches can be designed to fit with Ostrom's principles on governing the commons. PES approaches offer linkages to be established between groundwater and other resources, and are flexible enough to accommodate different contexts and attract different stakeholders. The groundwater governance framework envisages that 'the ideal institutional set-up would integrate linkages and functions of groundwater management vertically between the national level and the local level, and horizontally at each level with other sectors and agencies impacting on groundwater'.[141] This 'ideal' structure essentially demands that various stakeholders at different levels in society are allowed to play a role in groundwater management and that the management is executed in a way that makes it effective, given the effect that it can have on other aspects of the environment, and the effect that those other aspects can have on groundwater.

It is true that 'effective groundwater management and protection without stakeholder participation is hard to achieve – but equally stakeholders alone are unlikely to be able to manage an aquifer without some form of government support'.[142] PES schemes can help to achieve these two cornerstones of groundwater governance, especially in jurisdictions in the global south where it currently receives little regulatory attention, and in other jurisdictions where direct regulation is not quite delivering on the sustainable management of the resource. Rather than operating against it, they would correspond with Ostrom's analysis of best governance practice for CPRs, offering great potential for the future of groundwater management.

[139] Reid & Nsoh, n. 66 above, pp. 39–43.
[140] Shivakoti, Ichikawa & Villholth, n. 134 above.
[141] FAO, n. 14 above, p. 54.
[142] Ibid., p. 58.

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