ELINOR OSTROM, INSTITUTIONS AND GOVERNANCE OF THE GLOBAL COMMONS

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Abstract

This article examines why the governance of the commons is an appropriate frame of reference for analysing the interrelationships between humans and the biophysical world, and describes the critical role played by Elinor Ostrom and her many colleagues in furthering our understanding of this frame of reference as captured in their Institutional Analysis and Development (IAD) Framework.

The paper emphasizes the major insights from the Ostrom research program on the institutional analysis of common-pool resources (CPRs) that are particularly important to governance of the global commons; and summarizes the opportunities, limitations and analytical and governance challenges to extending their analytical framework and eight design principles to examining and finding solutions to global common-pool resource dilemmas.

Their IAD framework fully recognizes that governing, protecting and expanding common-pool resources are essential to the survival of the planet; and "doing nothing" is no longer an option. Just as important, Elinor Ostrom and her colleagues provide the following optimistic messages for avoiding the "tragedy of the commons". Effective and sustainable solutions to protecting natural resource and other CPRs have been found, established and successfully implemented by resource users and other groups in more advanced and developing economies for many decades and centuries. The "tragedy of the commons" is still a major threat, but these tragedies are not inevitable and can be addressed, mitigated and remedied through relatively small and implementable changes to the CPR's "action situation".

Ordinary citizens, resource users and local communities often know more about managing CPRs than politicians and government bureaucrats. In many contexts, the formal laws, regulations, rules and organizations of governments are not needed and sometimes get in the way of more informal and better managed governance systems that are already in place or could be established in the future. Effective, robust and sustainable CPR governance systems rarely involve monocentric governance structures with one dominant center of authority. Instead, they are polycentric governance systems, which are nonhierarchical and encompass multiple independent decision-makers who interact, work and learn together to achieve commonly valued objectives and outcomes. Governments in these CPR contexts are more effective as information providers, facilitators, and partners to local resource and other communities and non-government groups.

Extending the Ostrom framework from local CPRs to climate change and other global CPRs dilemmas requires "better than rational" solutions where the benefits (outflows) to "appropriators", consumers and other beneficiaries are appropriately aligned and reasonably consistent with their contributions (inflows), fairness and equity considerations, and other social norms important to the global scale CPR community. The major challenges for the future are to build on the Ostrom legacy, better understand, learn from, apply and extend her many insights and contributions, and thereby greatly enhance our assessment, governance and protection of the global common-pool resources that are so important to future generations and the survival of the planet.

1.0 Introduction and Background

The purpose of this article is to examine why the governance of the commons is an appropriate frame of reference for examining the interrelationships between humans and the biophysical world and to describe the critical role played by Elinor Ostrom and her many colleagues in furthering our understanding of this frame of reference as captured in their Institutional Analysis and Development (IAD) Framework. Extending and applying their framework to the global commons is becoming increasingly essential to successfully addressing the looming and interdependent challenges of climate change, supporting a growing global population with nourishment, shelter and other necessities, and other global commons dilemmas and "wicked problems".

The "tragedy of the commons", namely the over exploitation and degradation of the commons, was seen by Garret Hardin (1968) and other scholars as the inevitable consequence of the conflict between the human propensity for the pursuit of self-interest and the need to sustain the benefits derived from the preservation of the commons for local and other communities.

Over a period of more than fifty years until her untimely death in 2012, Elinor Ostrom greatly advanced our understanding of the role and importance of institutions of all kinds to examining and managing the relationships between human beings and the biophysical world that sustains us. Her research program and analytical framework indicated that the conventional wisdom of either enclosure through private ownership or government intervention through state ownership and government enforced laws and regulations are inadequate to deal with the "tragedy of the commons".

Through case studies of actual common-pool resource (CPR) governance situations as well as experimental, game theoretic, meta-analysis, and other multi-disciplinary empirical and theoretical research, Ostrom and her colleagues found that "the tragedy of the commons" is not inevitable; and developed and applied an analytical framework for conceptualizing, addressing, and resolving common-pool resource problems.

Based on her research on institutions and the governance of the commons, she was awarded with Oliver Williamson the Nobel Prize in Economics in 2009. This is a noteworthy and remarkable achievement since she was a political scientist and had previously received limited recognition among mainstream economists. In preparing this paper, major emphasis is placed on more recent articles and working papers on the IAD Framework that are especially relevant to applying the IAD framework to the global commons. [1]

[1] The paper includes a quite extensive bibliography at the end in order to facilitate future research by the Club of Rome and other organizations and scholars. In preparing this paper, the following more recent sources were especially important: Ostrom 2007a, 2007b, 2009, 2010, 2011 and 2012, Ostrom and Cox 2010, Michael Cox et al 2010, McGinnis and Ostrom 2008, McGinnis 2011a and 2011b, and Aligica and Tarko 2012. Readers who would like to receive an even more extensive bibliography of Ostrom and related readings should contact Derek Ireland at

2.0 The Basic Building Blocks of the Insitutional Analysis and Development Framework

The purpose of this section is to introduce the basic building blocks of the Ostrom research program and analytical framework, which in our view are most important to extending the research program and framework to the global commons.

For Ostrom and other institutional analysts, **institutions** are essentially the "rules of the game" that facilitate, guide and constrain the conduct of individuals and organizations. "Institutions may be seen as commonly understood codes of behaviour that potentially reduce uncertainty, mediate self-interest, and facilitate collective action" (Ostrom and Cox 2010:4-5).

Institutions encompass the laws, rules and regulations of government as well as the informal rules and social norms that are essential to the fair, efficient, and effective operation and "governance" of families; our personal, social and business relationships with others; neighbourhoods and local communities; companies, business networks, ecosystems, and supply chains; government bureaucracies and non-governmental organizations; and common-pool resources of all kinds and at all spatial scales from neighbourhoods and local communities up to the global commons.

In the Ostrom IAD framework, the term the **"commons"** is "informally used to refer to public goods, common-pool resources, or any area with uncertain property rights. [However, for] analytical purposes it is necessary to be more specific" (McGinnis 2011:174-175). Many of these specifics from the Ostrom research program are addressed in the rest of this working paper.

The term "common-pool resources" has many advantages over the term used previously: common property resources. The property rights regime, encompassing private, public, or common property, often plays a comparatively minor role in determining CPR governance systems and success. Moreover many of the better managed CPRs involve a mix of two or all three property regimes, leading to co-management arrangements.

In simplified form, **governance** in the Ostrom context essentially determines "who can do what to whom, and on whose authority" (McGinnis 2011a:171 – italics in the original). For the most part, Ostrom and her colleagues applied institutional analysis to the governance of natural resource common-pool resources (CPRs) in developing and more advanced economies. However, Ostrom's analytical framework has also been applied to the non-resource "commons" (see Appendix A).

Very early in their research program, Ostrom and her colleagues realized that the tragedy of the commons could be avoided and in fact was being avoided through multiple institutional and governance instruments, and that the conventional dichotomy of either enclosure through private ownership or government intervention through state ownership and government enforced laws, regulations and rules was neither helpful nor appropriate. Based on this insight,

Ostrom defined **four types of goods** in terms of their degree of exclusion and subtractability (which Ostrom prefers over the concept of rivalry used in the conventional economics literature).

		Degree of Subtractability/Rivalry	
		Low	High
Degree of Excludability	Difficult to Exclude	Public Goods	Common-Pool Resources
	Easy to Exclude	Toll or Club Goods	Private Goods

Source: Ostrom, Gardner and Walker (1994, page 7).

Private goods are characterized by the relative ease of excludability and high subtractability, which indicates that when I eat an apple, the apple is no longer available to my neighbour (easy exclusion) and the number of apples available in the global economy is reduced by one (high subtractability). Public goods (such as national defense and world peace) are the polar opposite of private goods. Excluding free-riders and non-contributors from benefitting from the public good is difficult if not impossible while subtractability from the public good is negligible.

Common-pool resources fall between public and private goods. On the one hand, CPRs have high subtractability (like private goods), which often results in overuse, congestion, pollution, or even destruction of a common-pool resource (Ostrom, Gardner and Walker 1994). Therefore, in terms of subtractability, CPRs are different from public goods where the benefit I receive from the military does not subtract from the benefit received by my neighbour.

On the other hand, CPRs are similar to public goods on excludability. This is because excluding free-riders and non-contributors from benefiting from the resource is difficult and costly -- although not impossible in many CPR contexts. There are strong incentives for individuals and organizations to become free riders, because appropriators and other users can benefit from a CPR and public good without contributing to its provision, maintenance, protection, rule-making and rule enforcement.

Therefore, the institutions and governance systems designed by individuals to govern any common-pool resource must address the dangers of both overuse/too much subtractability (including too much pollution in the case of airsheds and watersheds) and too much free riding (Dolsak and Ostrom 2003:8.).

The challenges and opportunities of governing the commons were not fully recognized until Ostrom developed common-pool resources as a distinct type of good that needed its own analytical frameworks and multiple methods of analysis. The analysis of Ostrom and her colleagues includes detailed case studies of actual CPR situations, meta-analyses of completed case studies on CPRs, cooperative and non-cooperative game theory, econometrics, and experiments in the laboratory.

Another major advantage from doubling the types of goods from the restricting and artificial dichotomy of public versus private goods is the recognition that subtractability of use and excludability are not either/or concepts but rather can vary on a continuum from very low to very high. Recognizing that subtractability and excludability are continuous functions is very important to the identification, analysis and governance of common-pool resources with different characteristics (Ostrom 2009:412).

The four-part breakdown also allows greater flexibility, nuance and realism across the four types of goods. For example, the rule-making process and the resulting institutions and rules for governing a common-pool resource are more like **public goods** because: (i) subtractability is not a problem -- my application of the rules does not prevent somebody else from using and benefitting from the same rules; but, (ii) excluding free-riders and non-contributors to the rule-making process from accessing and benefitting from the same rules is even more difficult than excluding free-riders from benefitting from the actual common pool resource.

Because CPR rule-making and governance have many features in common with a public good, increasing the number of CPR participants can add to the inflows and resource stocks that are available to generate benefits for all participants. The economies of scale and scope from CPR rule-making, governance and related public good features can help to offset some of the challenges of greater numbers, heterogeneity, information and transactions costs, and risks of disputes and conflicts, which are associated with larger common-pool resources and social-ecological systems at higher spatial scales (Ostrom 2002: 1328-1336, and Solstad and Brekke 2011 on how the a CPR's public good features can enhance cooperation among users of the common-pool resource).

Once common-pool resources were identified as a distinct "good" with its own characteristics and challenges, the Ostrom research program turned its attention to applying the IAD framework and multiple theoretical, empirical and experimental tools to a wide range of natural resource and other common-pool resources. At the outset, most of this research focused on natural resource CPRs such as: lakes, rivers, groundwater basins, irrigation, and other water systems, forests, grazing pastures, and lobster and other fisheries. These CPRs have often (but not always) been managed successfully by local communities in more advanced countries and especially in numerous developing and emerging market economies where formal laws, regulations and other institutions are often less developed, enforced and trusted. These were the subject of the many case studies of actual CPR experiences conducted by the Ostrom Team over the past quarter century.

This research was then extended by the Ostrom Team to multi-country and global CPRs such as integrated water management systems that cross national borders and the global atmosphere/climate change. And in recent years, Ostrom, her colleagues and other scholars have applied the CPR concept and IAD framework to less tangible common-pool resources such as the American health care system, social capital, the information commons and business reputation, networks and ecosystems including global supply chains, which arguably could take on greater importance as we move from local to global CPR management (see Appendix A).

Common-pool resources and their effective governance have many features in common regardless of sector, spatial scale and other attributes. This allows scholars to conduct meta-analysis type studies that compare the experiences, successes, failures and lessons from many different common-pool resources. The **typical common-pool resource** includes:

(i) a resource stock ("stock of assets");
(ii) inward and outward flows into and out of the resource stock (i.e. provision of inputs and generation of outputs/appropriation from the stock);

(iii) "rules-in-use" to ensure that the resource stock is protected, maintained, replenished and preferably expands through time and is not diminished and "polluted" through over use and inappropriate use; and,

(iv) some formal or informal governance entity to: enforce the rules; ensure that the provision of inputs are adequate to maintain the stock; prevent over use, misuse and "pollution" of the stock; ensure that the benefits and costs are distributed in a manner that is consistent with local conditions and social norms; and apply "graduated" financial, social and other penalties to non-cooperators, non-contributors, free-riders and "polluters" of the common-pool resource.

The successful management of CPRs at all spatial scales throughout the world has often involved what Ostrom and her colleagues call **polycentric governance systems**, which apply the subsidiarity principle and encompass multiple decision makers operating at different geographic scales, with different structures, functions, norms, values and interests – who find ways to cooperate and coordinate their activities in order to achieve common goals.

Multi-layered polycentric governance systems generally work much better compared with:

(i) command-and-control monocentric systems owned and/or operated by government,
(ii) treaty and other obligations under a single international agreement,
(iii) decentralization to a local government,
(iv) privatization and related market based solutions; and,
(v) other simpler (and arguably simple minded) "panaceas" that apply a single governance-system "blueprint and cure-all" to complex and diverse CPR and related problems.

The more complex and wicked the problem, the greater the tendency for international organizations, governments, businesses, civil society groups, and individuals to seek out and apply simpler heuristics, strategies and monocentric governance solutions that have rarely been successful (Ostrom 2012:70-72 and Weston and Bollier 2013).

Polycentric governance solutions are especially needed when the "CPR spaces" to be governed involve: substantial risk, uncertainty, complexity, non-linearity and dynamics; multiple individual and organizational (corporate) actors; multiple interests, tiers, layers, spatial scales, dimensions, human-environmental interactions, and resource and non-resource CPRs; multiple formal and informal policy, regulatory and governance systems and subsystems; and "super wicked problems". In short, polycentric governance solutions are especially needed when the Ostrom IAD framework is extended from local CPRs to the global commons.

Aligica and Tarko (2012: 251) summarize polycentricity as follows.

> "Polycentricity emerges as a nonhierarchical, institutional, and cultural framework that makes possible the coexistence of multiple centers of decision making with different objectives and values, and that sets up the stage for an evolutionary competition between the complementary ideas and methods of those different decision centers. The multiple centers of decision making may act either all on the same territory or may be territorially delimitated from each other in a mutually agreed fashion".

Compared with unitary top-down monocentric governance systems, polycentric systems are more inclusive, flexible, adaptable and resilient, better facilitate adaptive learning that is shared among all participants, and are better able to accommodate fundamental change and external shocks. Such governance systems as well provide greater space to individuals, households, neighbourhoods, smaller communities, and other citizen groups, indigenous people and ethnic minorities and other "outsiders" to contribute to rule making and ensure that the rules are appropriately monitored and enforced and are contributing to CPR objectives and the well-being of participants.

The Ostrom research program emphasizes that successful CPR governance is based on:

(i) communication, graduated sanctions, and a common vision;
(ii) trust, reciprocity of trust, fairness, cooperation, and reputations for fairness and trustworthiness;
(iii) social cohesion and capital and mutual obligations;
(iv) shared information, knowledge, learning, beliefs, and "mental models" (ways of thinking about the world); and
(v) the ability to build and utilize "political capital" to influence the decisions of and secure support from governments (Birner and Wittmer 2003).

Perhaps most important for the global commons, analysts and decision-makers must go beyond the rational agent model of conventional economics in order to identify and facilitate CPR choices, decisions and governance regimes that are **"better than rational"** (see e.g. Ostrom 1998a and Appendix C).

3.0 IAD Framework and Eight Design Principles Important to CPR Management Success

Elinor Ostrom's legacy is extraordinarily important for the future of the planet. Her research program emphasizes why common-pool resources at all spatial scales need to be governed, protected and expanded. Her research program reminds all of us that "doing nothing" is no longer an option and practical governance solutions are now available. Ostrom and her colleagues then provide us with the analytical frameworks, design principles and other tools, instruments and insights that are needed to examine in detail and find solutions to local and global CPR dilemmas.

Ostrom's experimental and field research illustrate that the "tragedy of the commons" of Garret Hardin (1968) is still a major threat, as illustrated by the "roving bandits" that irresponsibly exploit valuable marine species in coastal waters. However, in many contexts, these CPR tragedies are not inevitable, and often can be avoided through small changes to the "action situation" such as better communication, more frequent interactions, graduated sanctions, and easy to identify "markers" of non-cooperative activity (Ostrom 2007).

Her guidance on scaling up and broadening the reach of the IAD framework and eight design principles to climate change and other global CPR dilemmas captures the insights from related literatures on:

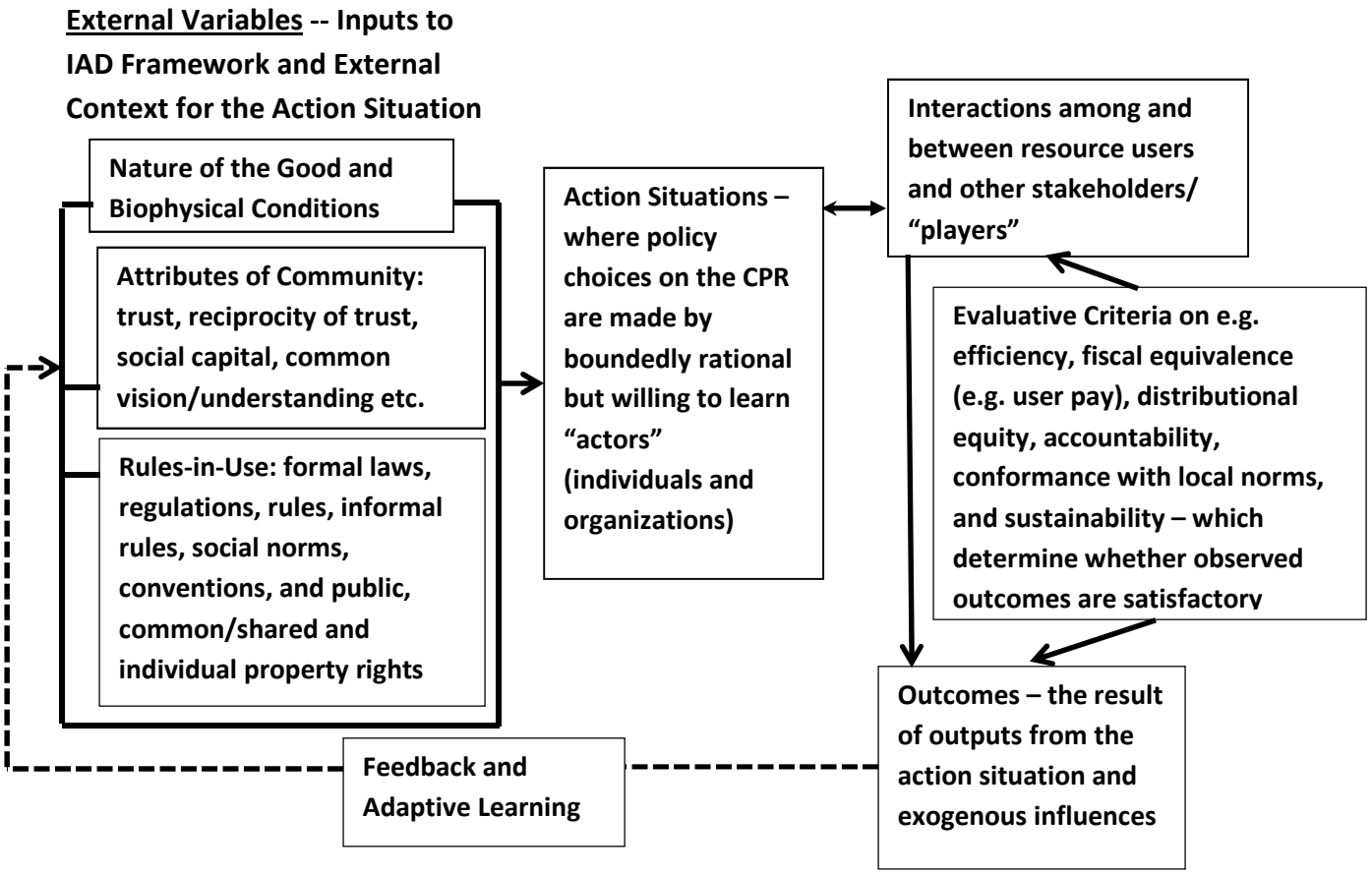
(i) social-ecological systems and “super wicked problems”;
(ii) behavioral, institutional, evolutionary, innovation, network, and regulatory economics;
(iii) game theory and complexity science;
(iv) epistemic communities and public policy and administration networks;
(v) market institutions and the sociology of markets; and
(vi) the expanding corporate management, strategy and marketing literatures on business reputation, strategy, groups, networks and ecosystems -- including national and global supply chains, industrial and technology clusters and long-term contractual and personal relationships between e.g. producers and their suppliers, business customers, final consumers, and other trading partners (see e.g. Ireland 2008 and 2013b, and Ireland and Kofler 2012 and 2013).

The major challenges for the future are to build on the Ostrom framework and legacy; better understand, learn from, apply and extend her many insights and contributions; and thereby greatly enhance our ability to assess, govern and protect the global common-pool resources that are so important to future generations and the survival of the planet.

Accordingly, the IAD framework is now being extended in ways that are highly relevant to protecting the global commons, such as to: (i) geographically larger non-metropolitan local public economies such as eco-regions; (ii) complex institutional linkages that cut across geographic scales; and (iii) social-ecological systems (SES) frameworks, which give greater attention to the biophysical and ecological foundations of institutional systems and can contain several individual resource and non-resource CPRs. The SES framework requires multiple levels of analysis that place greater weight on the interrelationships, interactions and governance linkages between different common-pool resources (see e.g. Ostrom and Cox 2010).

Exhibit I on the next page attempts to summarize the basic components of Ostrom’s Insitutional Analysis and Development (IAD) Framework.

Exhibit I: Basic Components of the IAD Framework

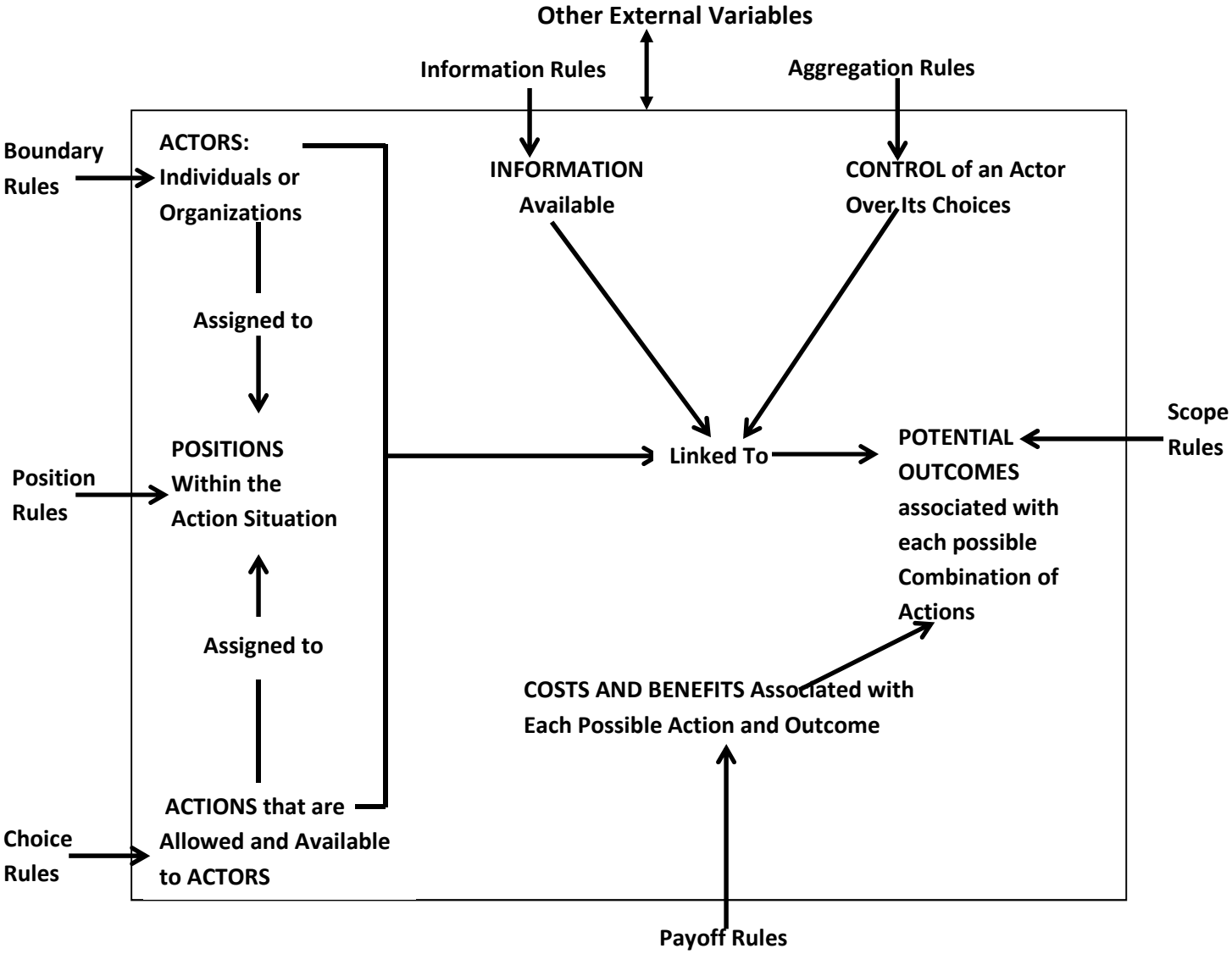


Sources: Modified from McGinnis (2011a) and Ostrom (2009:415)

The core of the IAD framework is the "action situation" illustrated in Exhibit II on the next page, which applies the methods and insights from cooperative and non-cooperative game theory.

Action situations are the social spaces where individuals and organizations "interact, exchange goods and services, solve problems, dominate one another and fight" and therefore are used to "describe, analyze, predict, and explain behavior within institutional arrangements" (Ostrom 2011a:11).

Exhibit II: The Internal Structure of an Action Situation



Source: Modified from Ostrom (2011a:10-20)

As noted in Exhibit II, formal and informal "rules-in-use", including routines, customs, conventions and social norms, play an important role in Ostrom's IAD framework and in determining the structure and outcomes of an action situation. "Rules are shared understandings among those involved that refer to enforced prescriptions about what actions (or states of the world) are required, prohibited, or permitted" (Ostrom 2011a:17-21).

Boundary rules influence the number of participants, their attributes and resources, the individuals and groups who are included in and excluded from the CPR group and its obligations and benefits, and the opportunities and conditions for entry and exit by participants.

Position rules indicate how a member of the group can later be "promoted" to become a member with a specialized task or a group manager and leader. Choice rules determine the actions that are allowed and not allowed to be undertaken by different actors. Payoff rules

influence the distribution of benefits and costs and establish the incentives, deterrents and possible sanctions that are associated with different actions and actors.

Scope rules place limitations on potential outcomes, and, through their backward linkage effects, influence how specific actions are related to specific outcomes. Aggregation rules influence "the level of control that a participant in a position exercises" and whether certain actions require prior permission from other members. Information rules "affect the knowledge-contingent information sets of participants" and e.g. indicate the information that is to be proprietary and secret versus the information to be shared with the general public.

Rules are not only important in themselves, but as well can have substantial lock-in, self-reinforcing, cumulative, increasing return, feedback, path dependence and related positive effects. These positive effects through time can further expand user cooperation and support for and user benefits from successfully managing and protecting a common-pool resource. Therefore, positive effects are especially important to scaling up the Ostrom IAD framework from local CPRs to multi-region, multinational and global commons (Levin et al 2012:134-139).

The Ostrom research program and IAD framework generated eight design principles that are important to the success of local CPRs and to "scaling-up" the Ostrom framework to address global CPR challenges and social dilemmas including broader social-ecological systems. The eight principles as modified by Michael Cox et al (2010) are as follows.

The Eight Principles	Brief Explanations of Each Principle
1A User Boundaries	Clear boundaries between legitimate users and nonusers must be clearly defined
1B Resource Boundaries	Clear boundaries are present that define a resource system and separate it from the larger biophysical environment
2A Congruence with Local Conditions	Appropriation and provision rules and related rules on the distribution of costs and benefits are congruent with local social and environmental conditions
2B Appropriation and Provision	The benefits obtained by users/appropriators from a common-pool resource (CPR), as determined by the appropriation rules, are proportional to the amount of inputs that are required and provided in the form of labor, material, or money, as determined by the provision rules.
3 Collective-Choice Arrangements	Most individuals affected by the operational rules can participate in modifying the operational rules
4A Monitoring Users	Monitors who are accountable to the users monitor the appropriation and provision levels of the CPR users
4B Monitoring the Resource	Monitors who are accountable to the users monitor the condition of the resource

The Eight Principles	Brief Explanations of Each Principle
5 Graduated Sanctions	Appropriators who violate operational rules are likely to be assessed graduated sanctions (depending on the seriousness and the context of the offense) by other appropriators, by officials accountable to the appropriators, or by both.
6 Conflict-resolution Mechanisms	Appropriators and their officials have rapid access to low-cost local arenas to resolve conflicts among appropriators or between appropriators and officials
7 Recognition of Appropriators' Rights to Organize	The rights of appropriators to devise their own institutions are not challenged by external governmental authorities
8 Nested Enterprises	Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of "nested enterprises" -- which encompass individuals as well as organizations

Meta-analyses of CPR case studies, as well as experimental, game theory and related research that has been conducted over the past three decades, have indicated that the potential for CPR management success is significantly enhanced when all or at least most of these eight design principles are satisfied. Success is not guaranteed but the probability of success increases and the risk of failure diminishes when these design principles are satisfied to at least some degree.

Other factors that are important to CPR management success for all spatial scales from the local through to the global commons include:

(i) Reliable information on the immediate and long-term costs and benefits of the allowed actions, which is available to all CPR actors.

(ii) Effective communication among a reasonably significant proportion of CPR participants.

(iii) Size, productivity, and predictability of the resource pool – which are important to determining the payoffs and benefits to participants.

(iv) Potential for and extent of mobility of the resource units: fish swim, caribou and other wildlife travel hundreds or even thousands of miles each year, while groundwater resources, grazing pastures and forests have limited or no mobility.

(v) Existence and enforcement of "collective-choice rules" that the users have the authority and ability to adopt in order to change their own operational rules.

(vi) Importance to CPR actors of building and maintaining a reputation as a trustworthy participant and reciprocator.

(vii) Some of the major attributes of the resource appropriators and other CPR participants such as: the number of members, the existence and quality of leadership and social capital within the group based in part on previous success in solving CPR and related collective action problems, members' knowledge of the common-pool resource and of the broader social-ecological system (SES), and the importance of the CPR and SES to the livelihoods and quality of life of the members (Ostrom 2011a:23 and 2011b:4, and Weston and Bollier 2013:181-191).

Through their research, Ostrom and her colleagues provide the optimistic message that, while solutions are not always obvious and simple, there are governance solutions to CPR challenges and social dilemmas that generally start from the agency and engagement of "nested and empowered" individuals, households, neighbourhoods, local communities, and other non-governmental organizations.

Non-government agency, engagement and governance solutions are then recognized, facilitated, and appropriately supported and valued by government ministries and agencies and international organizations – which fully understand that their appropriate role in polycentric governance systems is to be a partner, investor in public good research, and provider of technical assistance, information, learning, and, when needed, assistance with conflict resolution that complement the expertise, information, learning and governance tools held by local communities and other non-government groups (Ostrom 2012:81-82).

4.0 Alternatives to the Ostrom IAD Framework

The Ostrom research program and analytical framework clearly indicate why "on their own" the simple panaceas of: (i) enclosure through private ownership and related market-based solutions; and (ii) government intervention through state ownership and state enforced laws, regulations and rules, do not work.

Totally open access can occur through either private ownership of the CPR, or common ownership where the resource is owned by everyone and therefore in essence by nobody (leading to extensive free-riding, over exploitation and the tragedy of the commons). Under either regime, all appropriators are acting based on their rational self-interest and thus are attempting to maximize their own utility and benefits from the resource with no consideration for the impacts on other appropriators and the community and society more generally.

Entry is easy, and exclusion is difficult or not even attempted because of the laissez-faire attitude of the appropriators and local society. Unless the common-pool resource is very abundant, the outcome will be high subtractability, leading to severe resource depletion and ultimately resource exhaustion.

Turning to **government ownership and management** of the resource, some scholars and advocates have argued that a well informed and motivated government planner (the omniscient and totally benevolent social planner of early textbooks on public goods and policy) should be able to provide the best of all possible worlds in terms of well-designed rules that: (i) are fairly

and effectively enforced and monitored, (ii) strike the right balance between ease of access and exclusion to protect the resource, and (iii) result in efficient and sustainable resource use that has the support of all appropriators and the general community.

However, the research and analytical framework of Ostrom and her colleagues indicate that this best of all possible worlds is rarely achieved in government owned and managed CPRs. Government planners often suffer from a number of constraints and deficiencies such as:

(i) limited or the wrong information, limitations of cognition, time, effort, incentives, and motivation and their own behavioral biases such as being overly impressed with their knowledge, expertise and status;
(ii) greater interest with advancing their careers than protecting and promoting the public interest;
(iii) ignoring the often superior knowledge of resource appropriators and other local CPR actors;
(iv) applying rules (such as annual allowable catch) that are too general or are not appropriate to the CPR and community characteristics and resource and social conditions; and
(v) being subject to political influences, lobbying and rent seeking by "vested interests" and corruption -- leading to too much access and resource use by appropriators, companies and other groups with political connections and too little or no access by political outsiders and other disadvantaged groups (see e.g. Cooper and Kovacic 2012 and Camerer et al 1989).

The result often is limited monitoring and enforcement by government officials who are underpaid and lack motivation, leading to CPR failures that are similar to the "tragedy of the commons" under the open access management regime. Government ownership and management can often lead to "action situations" where nobody takes responsibility and is held accountable for protecting and managing the resource in the community and broader public interest.

The failure of governance regimes based on state control and ownership, private ownership and enclosure and other top-down approaches that ignore local needs and learning illustrate three major strengths and advantages of the CPR concept and polycentric governance.

First, the governance approaches that emerge from Ostrom's IAD framework minimize free-riding and "internalize" and reduce the costs and risks of the negative environmental and related externalities of government, private and market-based solutions to CPR and related social dilemmas. This takes place through bottom-up governance processes based on subsidiarity and polycentric governance, which engage, empower and bring together individuals, households, neighbourhoods, and like-minded communities at local and other spatial scales that are better positioned to address the challenges of "complex adaptive systems".

Second, the IAD framework provides governance alternatives to state intervention, private ownership/enclosure and the market, which are practical, feasible, desirable, inclusive, flexible, adaptable and have proven to be effective. These alternatives result in healthier competition

between different systems of governance, which can inform, guide, influence and shape the conduct and decisions of governments and their policies, laws, regulations and multilateral agreements -- as well as private owners and markets.

Third, these alternatives make more salient the importance of similar social norms and values of cooperation, trust and reciprocity of trust to government and business success and to market processes and outcomes that are deemed to be both efficient and fair -- and perhaps in some contexts may drive a "wedge" between the state and the market where they are too closely interconnected and mutually supportive (Weston and Bollier 2013).

5.0 Extending the IAD Framework and Design Principles to the Global Commons

5.1 Potential Strengths of the Eight Design Principles

In recent years, Ostrom and her colleagues have wrestled with how the IAD framework and the eight design principles can be "scaled-up" and applied perhaps in modified form to global common-pool resources and related "super wicked problems" such as climate change, the global food system, the integrated management of water systems that cross national boundaries, marine fisheries, and other global commons dilemmas. Some of their major findings on the opportunities, challenges and limitations for "scaling-up" the eight design principles listed in the previous section are as follows.

Well-defined user and resource boundaries under principle 1 are more difficult to establish for the global commons. Applying the IAD framework to the global commons will therefore require less rigid and more conceptual, flexible, fluid and "fuzzy" resource, social, geographic, user and/or actor based boundaries that encompass: (i) more informal adhoc arrangements between participants; and (ii) "self-identification" by harvesters, appropriators, contributors and beneficiaries as members of a specific global CPR. Nevertheless, a looser conception of user and resource boundaries cannot lead to an open access resource that is entirely free of well-defined user and resource boundaries (Michael Cox et al 2010:43).

Establishing congruence between appropriation and provision rules and local conditions under Principles 2a and 2b become conceptually different, more challenging and even more consequential for the global commons such as climate change – which are characterized by multiple users and other affected groups, multiple tiers, layers and geographic scales, even more complex polycentric governance systems, and in many cases multiple resource and non-resource CPRs and social-ecological systems and the interactions and interrelationships between them.

Nonetheless, congruence and consistency between the appropriation and provision rules and conformity between the rules of appropriation and provision and the "local conditions" -- defined broadly to encompass ideology, beliefs, culture, conventions, material incentives, livelihood, social norms, and related strategies and "shared mental models" of the "relevant communities" – are still very important to differentiating one global commons from another and to global CPR governance and success. In addition, congruence and consistency with "local conditions" at the appropriate spatial scales should still be capable of measurement and evaluation to determine

the contributions of Principle 2 to global CPR success and failure (Michael Cox et al 2010:43-46).

Achieving Principle 2 may represent the greatest challenge to scaling up from local to global CPRs. CPR governance success depends to an important degree on the extent to which the benefits (outflows) to "appropriators", consumers and other beneficiaries are appropriately aligned with: (i) their contributions (inflows) to the global CPR; (ii) fairness and equity considerations and preferences, and perspectives on distributive and procedural justice and fairness; and (iii) other social norms and ethical values that are important to the CPR group. Theory and empirical evidence clearly indicates that this is much easier for smaller CPR groups, but is not impossible for larger common-pool resources especially when the potential contributions from the Internet, social media and the digital economy are built into CPR governance models and systems.

Principle 2 and many other principles are relevant as well to non-resource and less tangible CPRs including market institutions, business reputation, networks and ecosystems, and national and global supply chains. Solutions to climate change and other global commons dilemmas will often encompass multiple resource and non-resource CPRs. Effective governance of each CPR and of the interactions and interrelationships between them would add substantially to the individual and societal payoffs and benefits from the overall common-pool resource and social-ecological system.

The Ostrom research program emphasizes that CPR governance success is a "positive sum game" for its members and society, which potentially can and should benefit from the successful governance of more business and market oriented CPRs that are driven by social norms and preferences. Positive interactions with and feedback effects from non-resource CPRs can lead to potentially larger payoffs for the global commons, which are generated by market incentives and outcomes, business reputation effects, interdependence and spillovers, and the successful management of complex business networks and ecosystems and national and global supply chains – as long as these non-resource CPRs are appropriately shaped and channeled by CPR governance principles to protect, maintain and expand global common-pool resources (see Weston and Bollier 2013 and Appendix A).

Principles 3 to 7 on collective choice arrangements, monitoring arrangements and effectiveness, graduated sanctions, conflict-resolution mechanisms, and minimum recognition of the rights of appropriators to establish their own institutions, take on even greater importance and become even more challenging for the establishment, operation and success of resource and non-resource CPRs at the global scale.

Principle 3 on collective choice arrangements reminds us that successful management of the global commons requires the establishment of **complex multi-tiered, multi-layered and multi-scale polycentric governance systems** – which are designed and implemented to ensure that individuals, households, local communities and other entities that are affected by the operational rules at the lower tiers and scales have the ability to participate in, influence and contribute to the modification of the operational rules at their own as well as the higher tiers and scales.

Principle 7 builds on principle 3 through emphasizing that international organizations, external governments and other entities at the higher tiers **do not challenge, impede and eliminate** the rights of individuals, local communities and other entities at the lower tiers to organize and create their own institutional arrangements and solutions to lower tier common-pool resource challenges.

These two principles are important to ensuring loyalty to, compliance with, and a sense of responsibility, accountability, self-determination, and empowerment regarding, the global CPR rules-in-use by participants at the lower tiers and spatial scales, and to ensuring that the CPR rules take full account of the often superior knowledge and experience of users and other local "players".

Externally imposed rules, which do not correspond to local conditions at the lower tiers, ignore local expertise, and ignore and "disenfranchise" local participants, often result in failure for smaller and more local CPRs – leading to failure for the global governance of complex adaptive CPR and related systems that depend on local CPRs and on individual commoners and their agency and empowerment for their ultimate success (see as well Weston and Bollier 2013:112-120 and 256-259).

As we move from the local to the global commons, **monitoring and monitors under principle four**, which are effective, trusted by, and credible and accountable to all users and other stakeholders at all tiers and scales, take on even greater complexity and importance. This could be another major challenge and impediment to "scaling-up" the Ostrom framework and principles (see e.g. Ostrom and Cox 2010, Levin 1992 and 2010 and Ireland 2013c).

Graduated sanctions under principle 5 will be even more important and essential to the success of global CPRs – especially when sanctions are combined with building consensus, trust, reciprocity of trust, social capital and shared information, knowledge, expertise, and mental models, and with the well-established, reputable and cost-effective conflict resolution mechanisms under principle 7.

Graduated sanctions are particularly important when complex and incomplete monitoring and information asymmetries and failures increase the risk of applying "disproportionate" sanctions to the "wrong" appropriator or other participant who may be important to the success of a global commons (Michael Cox et al 2010:46-48). Inappropriate and poorly applied penalties and other extrinsic incentives can undermine and "crowd-out" the intrinsic incentives and motivations of individuals and groups to comply, contribute, and "do the right thing" (discussed later in this section).

Principle 8, whereby successful CPR systems require that "governance activities are organized in **multiple layers of nested enterprises**", is also more important, more complex and especially more challenging when the Ostrom framework and principles are extended to governing the global commons, which encompass multiple and diverse CPRs, participants, beneficiaries, functions, tiers, scales, formal and informal rules, property rights regimes, governance systems and "nested enterprises" (Ostrom 1990:90)

When applied to global CPRs, the nested actor/enterprise principle would encompass:

(i) vertical linkages and interactions between local groups at lower tiers and scales and governmental and non-governmental organizations including international organizations at higher tiers and scales; as well as

(ii) horizontal linkages and interactions across user and other groups and resource and non-resource CPRs, at the same or similar spatial scales, which are conducting similar or different functions – including in different communities, sub-national regions, and nation-states – and are facilitated by social media, the Internet and other information and communications technologies (see e.g. Wing and Schott 2004 and Weston and Bollier 2013:205-208).

Larger-scale common-pool resource (CPR) and social-ecological system (SES) dilemmas are certainly more challenging, but the Ostrom research program and other scholars that are building on the IAD framework have identified many examples of cooperation between CPR groups and communities that emerge through more spontaneous "bottom-up" processes (Michael Cox et al 2010:48-49; Tarko 2012:62 and Weston and Bollier 2013).

Other examples are provided by the many metropolitan region climate change action plans that grew out of the Toronto Conference of 1988 and are now in place in many North American, Latin American and other cities; these action plans provide good illustrations of polycentric adaptive CPR and related governance solutions in urban regions that bring the global and local together (see e.g. Torrie 1999).

Moving from local to global CPR dilemmas and solutions that encompass and empower multiple nation-states at different stages of economic and institutional development suggest that the formal rules, regulations, obligations, and governance systems of sub-national and national governments and international treaties, agreements and organizations will take on additional importance. Nonetheless, the informal rules, regulations and governance structures emphasized in the Ostrom IAD framework will continue to be fundamental to the governance of global CPRs and of the local CPRs that are embedded within the global commons.

This is especially true for developing and emerging market economies at earlier stages of economic, social, political and institutional development, where CPR members and other market participants and member of society have to depend more on informal rules and governance systems and their own agency, experience and learning because of the limitations in their country's formal institutions, governance and property rights systems.

Fortunately, the Ostrom research program has given major attention to CPR governance and successes in **developing and emerging market economies** and indicates that more advanced economy governments, scholars and stakeholders have much to learn from the historical and current CPR governance successes in the developing world. These past and current success stories in developing and emerging market economies indicate that these countries will often not be impediments; but rather can be expected to be major contributors to the establishment and implementation of polycentric governance regimes to protect the global commons.

5.2 Possible Limitations of the Ostrom Framework and Principles

The possible limitations to Ostrom's IAD framework and eight design principles should also be noted. Some critics believe that critical social variables should be given greater attention. Singleton and Taylor (1992) argue that a fundamental feature of the successful CPR systems in Ostrom (1990) is that each involves a "community of mutually vulnerable actors" (Michael Cox et al 2010:49). These communities of mutually vulnerable actors could emerge and arguably are already emerging at the global scale because of climate change, extreme weather events that are becoming more frequent and devastating, the vulnerability of global food, water management, and other systems, and other global super wicked problems that increase the risk of "catastrophic events" at the global scale.

Some scholars have criticized the eight design principles for not taking sufficient account of external trends, conditions and constraints. For example, market integration, globalization and rapid economic growth and development can lead to:

(i) greater heterogeneity and inequality between CPR participants;
(ii) greater pressures on and risks of over-utilization of tangible and intangible common resource pools;
(iii) major increases in income and employment risks, uncertainty and insecurity that make economic well-being and survival more salient than environmental security and the global commons to many current and future "commoners";
(iv) reductions in cooperation, trust and reciprocity that can be associated with greater inequality and less perceived and actual fairness in economic and social systems;
(v) loss of local control over resources by user groups; and
(vi) reduced dependence of local users on common-pool resources because of alternative income opportunities and greater opportunities for exit – leading to reductions in common understanding, vision and interests, shared vulnerability, trust, reciprocity of trust, and cooperation at local and other tiers and geographic scales (Michael Cox et al 2010:49-50 and Steins et al 2000).

A final criticism and risk relevant to extending the Ostrom IAD framework to the global commons is that the eight principles would be viewed by international organizations, governments and stakeholders "as something of a magic bullet or institutional panacea and thus be misapplied as a prescription for improving the governance of CPRs in particular settings" (Michael Cox et al 2010: 52-53). These authors conclude that the design principles are well supported by the evidence, but that a probabilistic rather than a deterministic interpretation and application of the principles is warranted. This cautious approach is especially needed when examining and finding solutions to the global commons.

5.3 Viewing the Global Commons as Closed Polycentric Governance Systems with Multiple Tiers, Layers, Spatial Sales and "Nested and Empowered Enterprises"

Ostrom and her colleagues are well aware of the challenges to CPR governance and success when the common-pool resource "action situation" is larger, more complex, and involves a large number of resource appropriators and other participants that are vastly different in terms of their endowments, material interests, and social attributes (see Exhibits I and II above).

Governing a large watershed CPR and similar CPR situations, which encompass thousands of participants and potential appropriators and beneficiaries and are divided into major rivers and lakes, tributaries and sub-tributaries, provide special challenges as well as opportunities (Ostrom and Walker 2003, pages 58-61).

In this action situation, CPR management could begin at the tributary and sub-tributary level. After success at the subgroup level, different subgroups may begin to work together by sharing water, information and experiences, and addressing common problems that span more than one tributary in the watershed. These successes have been found by Ostrom and her colleagues in field settings in several countries including Nepal, the Philippines, and Spain, and have lasted for better than one hundred years in every case and in one case for more than a thousand years.

These success stories "illustrate that when individuals can break up a large social dilemma into lots of smaller nested dilemmas, they can use face-to-face discussions in much smaller initial associations to eventually solve, through nested and empowered organizations, a much larger problem that would be almost intractable for self-organized groups without such a strategy". External authorities and the more formal government-managed institutions need to be supportive of the efforts of sub-groups to build and manage natural resource and other CPRs (Ostrom and Walker 2003, pages 60-61).

In addition, heterogeneity among participants may be less of a problem when the CPR or broader social-ecological system is managed by the community compared to when the system is managed by a government agency. Left to their own devices, heterogeneous groups that share common interests and values can in certain contexts find solutions to their CPR dilemmas and collective action problems. Community based systems promote communication and positive intrinsic motivations to cooperate and comply among its members (see e.g. Bray 2009 and Bowles and Gintis 1998 and 2002).

In contrast, government based systems, which are founded on formal laws and regulations that are enforced by distant government agencies, promote anonymity, individual over group action, adversarial over cooperative behaviour, defection, antagonism, litigation, and more negative extrinsic over more positive intrinsic motivations to comply and contribute to the CPR -- which takes us back to the rational agent model of conventional economics.[2]

[2] In the regulatory and behavioral economics literatures, extrinsic incentives and motivations to comply are external to the individual, user/appropriator, company or other organization and therefore result from interventions by regulators, business customers, final consumers, other market participants and other

Even among heterogeneous CPR groups with significant differences in culture, ethnicity, wealth, and economic and political power, communication can increase identity and solidarity, can create at a minimum the shared perception of a consensus in favor of cooperation, and can in fact lead to actual commitments to cooperate (Ostrom et al 2002, Chapter 3).

Group learning through information sharing, doing things together and having shared successes can in time take precedence over and dominate the cultural and other differences within the group. In these contexts, the major role of government is to establish a policy and regulatory framework and provide facilitation, coordination and information and research services that promote positive motivations to cooperate and communicate with each other, group learning, mutual monitoring, graduated sanctions, shared benefits and successes, and social capital creation at the local level.

To summarize, a natural extension to the global commons of the Ostrom IAD framework and CPR action situation in Exhibits I and II would include the following features, based on the more recent Ostrom literature reviewed in this theme paper.

A "meta" global commons CPR would encompass conventional resource based as well as non-resourced based CPR action situations (see Appendix A and Weston and Bollier 2013) at the same and different spatial scales, tiers and layers, which are interlinked, interconnected and intertwined into a **single closed global polycentric CPR governance system**. The closed system would encompass multiple and diverse CPR action systems that are governed by individual families and households, neighbourhoods, local communities, metropolitan regions, provincial, state and other sub-national entities, and nation states, ending with multi-country and international CPR action situations of various kinds.

The major drivers for each action situation within the closed global polycentric system would be individual, collective and shared learning, agency, engagement, empowerment, responsibility and accountability, which are taking place within and between action situations at the same and different spatial scales. The action situations would be interconnected in a manner that:

(i) informs, promotes and gives value and legitimacy to learning, agency, engagement and empowerment of every CPR action situation at every spatial scale from the lowest to the highest tier in the global system;

(ii) establishes graduated sanctions and related extrinsic incentives and motivations to comply with CPR rules and contribute to the public good that complement, augment and

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CPR members, which originate from outside the individual or organization. Extrinsic motivations include contingent monetary rewards from complying such as avoiding fines and other penalties with financial implications from regulators, and avoiding losses in reputation that would decrease revenues, profits, incomes and social status within a local community or other group.

Intrinsic incentives and motivations to comply are internal to the individual, user/appropriator, company or other organization and are associated with e.g. the pride, self-satisfaction and self-confidence resulting from a job well done; self-identity, self-esteem and self-reputation from "doing the right thing"; and the duty/obligation to comply with laws, regulations, social norms and CPR and related principles.

"crowd-in" intrinsic incentives and motivations to comply and contribute that are internal to participating individuals and organizations; and,

(iii) the potential for the "crowding-in" of intrinsic incentives and motivations is increased through cumulative feedback, network, demonstration, positive externality, reputation and related effects;

whereby individuals and groups within the various CPR action situations benefit from positive information, knowledge and learning on the compliance with rules, the contributions to public goods, and the governance successes of individuals and groups within their own and other action situations within the closed global polycentric system (see as well Appendix C, van Dijk et al 2008, Weber and Khademian 2008, and Ireland and Kofler 2012 and 2013).

Viewing the global commons as a closed appropriation, rule-making, polycentric governance, and information system with manifold interconnected CPR action situations at various spatial scales, tiers and layers could provide a useful and potentially important foundation for future research on successfully extending the Ostrom IAD framework and eight design principles to global social dilemmas and "wicked problems".

6.0 Concluding Comments

The ten most important insights for the global commons from the Ostrom research program, institutional analysis and development framework and eight design principles are as follows.

1. Governing, protecting and expanding common-pool resources are essential to inter-generational equity and the survival of the planet.

2. The tragedy of the commons is not inevitable for either local CPRs or the global commons, and represents the wrong starting point for analysing common-pool resources and developing solutions.

   The Ostrom IAD framework and research illustrate that effective, robust and sustainable governance solutions are available. These solutions can and do generate substantial benefits for resource pools, the environment, economy and society. However, simple and simplistic governance systems based solely on privatization, private enclosure, markets, state ownership and control, and other top-down governance regimes are not the answer.

3. Ordinary citizens, resource users and local communities often know more about managing CPRs – compared with politicians, bureaucrats and so-called experts and people in authority in the public and private sectors.

4. Solutions to local common-pool resource dilemmas and the global commons require complex polycentric governance systems.

   Which: (i) are non-hierarchical, (ii) apply the subsidiarity principle, (iii) encompass multiple decision makers operating at different geographic scales, (iv) are supported by the Internet,

social media and other advances in information technology, and (v) develop, expand and evolve through time by means of accumulated learning, adaptation, experience, trust, reciprocity of trust, mutual obligations and advantage, learning by doing and monitoring, and by extending key insights and lessons to related resource and non-resource CPRs at the same or different geographic and other scales (see Appendix A).

5. These polycentric governance solutions: (i) are nonhierarchical and encompass and empower multiple independent decision-makers who interact, work and learn together to achieve commonly valued objectives and outcomes; (ii) are based on the superior knowledge of local resource harvesters and other stakeholders as well as cooperation, shared learning and "mental models", trust, reciprocity of trust, and social norms; (iii) would never be identified through applying conventional economic, political science, law and economics, regulatory and other models based on perfect information, rationality, self-interest and will-power; and (iv) therefore are "better than rational" (see Appendices B and C).

6. As pointed out by climate change and other global CPR dilemmas, the major challenge to extending the Ostrom framework to the global commons is to identify and implement polycentric governance solutions, which allocate costs and benefits in a manner that is consistent with social norms and is deemed to be fair and equitable by all contributors, beneficiaries and participants.

7. The major role of governments and international organizations is to provide encouragement, support and facilitation to non-government CPR governance initiatives and to make public investments in science, technology, product, process, organizational and governance innovations, and other public goods, which are needed to enhance the productivity, efficiency, fairness and sustainability of common-pool resource production, consumption and distribution.

   These investments in public goods should include "investments" of time and effort in enabling policies, laws, regulations and guidelines that support and empower CPR governance solutions and the rights of "commoners"/local people to collectively manage and control their resources. These public good investments should be designed to allow CPR governance solutions to "compete" on more equal terms with proposed solutions based on the state, market and private ownership.

8. More generally, protecting the commons at all spatial scales, from the local to the global, requires that the "governance of the commons by commoners" be placed on a more equal footing with the state and the market whereby: (i) governments, international organizations, the legal system, and market institutions and participants (firms, consumers, market regulators etc.) learn from and are influenced and shaped by successful polycentric governance of the commons; and (ii) more fully recognize that many of the CPR principles and social norms of trust, reciprocity of trust and the appropriate mix of cooperation and

competition are essential to business governance and success in the knowledge-based global economy.

The second requirement is illustrated by the growing importance of business groups, networks and ecosystems, national and global supply chains, technology and industrial clusters, long-term contractual and personal relationships with suppliers, business customers, and other trading partners including consumers, the digital economy and e-commerce of various kinds (business to business and business to consumer), and crowdsourcing, co-creation and co-production with users and consumers, and other forms of consumer and customer engagement.

These informal business arrangements typically involve "nested enterprises" (individual companies and their officials) within a broader CPR type governance framework based on formal and informal rules, trust and reciprocity, protecting and enhancing corporate reputation for social responsibility, and related social preferences and norms (Weston and Bollier 2013, Ireland 2008 and Ireland and Kofler 2013).

9. Many of the CPR governance success stories from the Ostrom and related literatures have taken place and are taking place in developing and emerging market economies.

   Their CPR governance experience and successes place into serious question the conventional wisdom that developing and emerging market economies are and will be major constraints to successful governance of the global commons. Instead, individuals, governments, businesses, and civil society groups in the OECD economies will have much to learn from the past and current experience of developing, emerging market and transition economies.

10. The Ostrom IAD framework is based on a bottom-up approach, which starts from the individual and recognizes that in the final analysis the individual as consumer, householder, family member and "commoner" is the major driver and arbiter of the global economy (see e.g. Laird 2009); and the individual voter/citizen is the major driver of the political process even in countries that fall short of the western democratic model.

    Therefore, future work on governing the commons and scaling up the IAD framework should place greater attention on the behaviour of the individual as user/appropriator, beneficiary, consumer, voter, citizen, and employee of companies, government ministries and agencies and other organizations, and how education, engagement and empowerment of the individual can work together and contribute to protecting the global commons through individual agency and action and through influencing the conduct and decisions of companies, governments, international organizations, NGOs and other organizations (see Appendix C).

Appendix A: Extending the Ostrom Analytical Framework to Non-Resource Common-Pool Resources (CPRs)

As noted in the main text, recent research and articles on governance and regulation have explicitly or implicitly extended the Ostrom CPR model comprised of:

(i) inputs/inflows, resource stocks and outputs/outflows,
(ii) the interactions between inflows, stocks and outflows when e.g. appropriators, consumers and other beneficiaries are also contributors to the inflows (leading to "co-production");
(iii) the risks of stock depletion and "pollution" because of non-contributions, free riding, opportunism, shirking, and other non-cooperative behaviour by appropriators and other beneficiaries; and,
(iv) polycentric governance systems that can often include individual (private) property rights, common/shared (private) property rights and/or public property rights (government control and ownership) within the same governance system;

to policy, regulatory and other non-resource governance systems and regimes.

In all of these non-resource CPRs, governance success depends to an important degree on the extent to which the benefits (outflows) to "appropriators", consumers and other beneficiaries are appropriately aligned with their contributions (inflows), fairness and equity considerations, and other social norms and ethical values that are important to the CPR group.

These extensions therefore illustrate that the common-pool resource concept of Ostrom can be applied to formal and informal regulatory and governance systems and related "action situations" of various kinds, including:

1. Formal and informal governance systems of companies, business groups, networks and ecosystems, national and global supply chains, legal, accounting and other professional partnerships, and long-term contractual relationships between a company and its suppliers, business customers, final consumers and other trading relationships which often involve both commercial and personal dimensions.

   These governance systems include voluntary codes of conduct and related forms of self-regulation and co-regulation that promote compliance with laws, regulations and social norms and contributions to public goods in a growing number of national and global industries, markets, supply chains and professions (see e.g. Webb 2004, Ireland 2008 and Ireland et al 2011 and 2012).

2. Informal governance of the Internet and the digital economy, and the voluntary contributions of large numbers of individuals in all regions of the global economy to Wikipedia, open-source and free software, video game modifications and enhancements, and other forms of widely distributed participation, engagement and "virtual commoning" through the open platforms provided by Internet technologies and the digital economy.

3. The Peer to Patent expert network established by the US Patent and Trademark Office and other methods used by governments and other organizations to use Internet technologies to benefit from the "wisdom of the crowd" (Weston and Bollier 2013: 243-245 and Chapter 6).

4. Cross-border contracts and formal and informal contractual relationships that facilitate international trade -- including between people who do not know each other personally and have infrequent transactions and other contacts with each other.

5. Applying the concept of polycentric governance to the American health care system and other complex systems of governance (McGinnis 2011b).

6. Formal and informal institutions and rules of the game that facilitate market efficiency and fairness and reduce information, transactions and other costs -- as captured in new institutional economics; the expanding literature on the management and governance of business groups, networks and eco-systems, and national and global supply chains; and the economic sociology literature on the social structure of markets.

7. Reputation management within an industry or market because of reputational interdependence and positive and negative reputational spillovers from one company to another in the same industry and market.

8. Consumer, user and household creation, co-creation and co-production and the crowdsourcing and other engagement techniques now used by innovative and other companies to improve their R&D, innovation and new product development programs, and reduce the risk of innovation failure -- through utilizing and benefiting from the interest, expertise, wisdom, and energy of their final consumers, business users and customers and other trading partners.

9. Strong and stable competition, consumer and compliance cultures within companies and industries where compliance goes beyond the statutory and regulatory standards and social norms and therefore goes beyond the standard predictions of conventional economics and law and economics – thereby extending the "beyond rational" concept of Elinor Ostrom and her colleagues to the compliance culture and performance of industries and other business entities and groupings.

10. Global epistemic communities and global public policy and administration networks, which transcend national borders because of shared norms, values and professional interests and challenges.

11. Concept of the information and knowledge commons which treats information as a common-pool resource.

12. Management of condominiums and similar commercial arrangements that e.g. can often involve a mix of individual, common/shared and public property rights.

13. Application of the Ostrom IAD framework on common pool resources to sport rules as a better way to reduce doping and other misbehavior and non-compliance in track and field, other Olympic sports and other sport activities, leagues and associations -- for which both formal and informal rules, as well as extrinsic and intrinsic motivations to comply, are important to successful governance (Castronova and Wagner 2009).

The conjecture of the authors, which requires much greater theoretical and empirical research and integrated policy analysis using the Ostrom IAD and SES frameworks, is that governance of the global commons and related "super wicked" problems and complex adaptive systems will often require more attention to non-resource common-pool resources and the complex linkages, interactions and feedback effects between resource and non-resource CPRs, which:

(i) in some contexts can facilitate and make more robust and sustainable global commons governance regimes because of for example the potentially higher commercial, reputational and other payoffs that can be generated by business networks and ecosystems, supply chains and other non-resource CPRs;

which are associated with the potentially higher financial, reputational, status, self-identity and related costs and risks faced by business networks and similar corporate entities from not contributing and "being seen to not contribute" to public goods and the governance of the global commons and other CPRs;

(ii) while in other contexts, can impede the protection and governance of the global commons, because of e.g. the greater challenge of developing consensus on core values, beliefs, interests, incentives and objectives when the number and diversity of participants, groups and individual CPRs to be protected at different scales and layers expands significantly.[3]

The following provides some additional ideas and insights regarding the potentially more positive linkages, interactions and feedback effects between resource and non-resource CPRs and commoners in complex and adaptive systems that require polycentric governance.

Participation and contributions by conventional and virtual commoners to resource and non-resource common-pool resources and related CPR and public good activities could expand and

[3] A number of the references in the bibliography explicitly or implicitly apply the Ostrom IAD framework to non-resource CPRs. These include: Dolsak and Ostrom 2003, Hess and Ostrom 2003 and 2007, Aligica and Tarko 2012, Weston and Bollier 2013, Bollier and Watts 2002, North 1990, May 2004 and 2005, Jochim and 2010, Richter 2005 and 2008, Haas 2002, Pennington 2012, Tarko 2012, Aligica and Boettke 2009 and 2011, Leeson 2008, McGinnis 2011b, Ford 2012, Rajko 2012, King et al 2002, Barnett and Hoffman 2008, Sparrow 2000 and 2008, Nelson and Winter 1982, Horton 2006 and 2011, Moore 2006, Iansiti and Richards 2006, Farrell 2006, Dobson 2006, Heintzelman, Salant and Schott (2009), Ireland 2008 and 2013b, Ireland et al 2011 and 2012, Pal and Ireland 2009, Ireland and Webb 2010, and Ireland and Kofler 2012 and 2013.

accelerate greatly in the coming years, as a result of exponential growth in the Internet and social media in all parts of the globe, as well as population aging and early retirement of the more educated, informed, engaged and prosperous baby boomers.

As the number of conventional and virtual commoners in the global economy expands and they become better informed, connected, engaged, and empowered, the global community of individual commoners of all kinds could reach a tipping point that could make a fundamental difference to the political economy of climate change and other global commons dilemmas.

Individual agency and processes take on even greater power and become even more consequential, when social media, the Internet and electronic word-of-mouth advertising are used to involve and empower thousands and even millions in speaking badly about, retaliating against and applying sanctions to companies, governments, and other organizations that pollute the environment, destroy the commons and place the survival of the planet at risk.

Corporations and their bankers and investors are becoming more aware of these risks to corporate financial performance and survival; and therefore many companies are now monitoring Twitter, Facebook etc. every day to anticipate future threats to their reputations and financial performance.

In many respects, the Internet and social media are important "game-changers" through: promoting new forms of digital commons, adding greatly to the number, agency, voice and empowerment of conventional and virtual commoners; and providing easy and low cost channels for individual consumers, voters, citizens and commoners to retaliate against and sanction non-complying and non-contributing companies, governments and other organizations (Weston and Bollier 2013:205-208).

Through the combined effects of

- "commoner" education, engagement and empowerment,
- supported by the Internet, social media, other information technologies,
- and powerful positive insights from the behavioral literatures on social norms and the aversion to betrayal,

individual attitudes through time can be permanently altered to reach the "tipping-point" in terms of numbers, voice and strength of commitment.

Consistent with the Ostrom IAD framework and eight design principles, individual consumers, voters, citizens and "commoners" will have the will, capability, means and agency to apply graduated sanctions including: voice, exit, naming and shaming, threats of and actual boycotts, stigmatization, and ostracism, to:

(i) companies and supply chains that green-wash and pollute; and
(ii) politicians and government officials that allow companies and other organizations to destroy the commons;

and thereby provide a significantly stronger commoner voice to debates that are now dominated by governments, businesses and other "vested interests.

The Ostrom framework and behavioral literature suggest that the "better than rational" sanctions and retaliations against companies, industries and supply chains that green-wash, pollute, and are involved in other environmentally and socially irresponsible products, production processes, technologies and conduct will be particularly prominent and severe among the following groups that are likely to be much larger and more influential in the future:

(i) Consumer leaders, consumer creators, co-creators and co-producers of new highly valued products; other individual consumers and business users and customers that participated in crowdsourcing, peer to patent and other consumer and user engagement processes, which assist these companies to create, produce, commercialize and market more innovative and environmentally and socially responsible goods and services.

Their "better than rational" sanctions and retaliations are linked to the aversion to betrayal and related behavioral biases, when consumer trust and loyalty is betrayed by irresponsible producers and sellers that have proved to be "untrustworthy reciprocators".

(ii) Individual consumers, voters, citizens and commoners who are making their own contributions to protecting the commons, and making other contributions to mitigating or adapting to climate change and to other public goods, through their own actions and participation in neighbourhood and local community CPR projects, and their contributions to climate change mitigation and adaptation and other global commons initiatives in their cities, metropolitan regions, and rural municipalities and regions.

The better than rational sanctions of these commoners would be linked to individual preferences for fairness and equity and the aversion to inequality and betrayal, when "rich companies" with the support of government are undermining their individual efforts to preserve the commons in their local communities, cities and regions.

Companies that use consumer and user creation and co-creation, crowdsourcing and other techniques to increase sales and profits will raise expectations and will be held to a higher standard by their consumers and other trading partners, stakeholders and commoners – and will betray their trust at their peril (see e.g. Bertels and Peloza 2008).

Appendix B: Multi-Disciplinary CPR Analysis for Identifying and Designing Polycentric Governance Solutions

The Ostrom research program has emphasized the importance of examining and finding solutions to local and global CPR problems and that such solutions are available and have been successful in many different contexts in developing and more advanced economies. This requires however that analysts and organizations go beyond the more conventional benefit-cost, microeconomic, macroeconomic and related economic, social and political analysis techniques.

CPR examinations and solutions using the IAD framework require analytical tools that:

(i) are multidisciplinary and comprehensive and encompass all market participants, CPR members, users and beneficiaries, members of society, spatial scales, and formal and informal governance systems and institutions;
(ii) employ methodological pluralism approaches that e.g. combine the best features of qualitative (e.g. individual case studies and meta-analyses of completed case studies), quantitative and experimental research methods, and of inductive and deductive methods;
(iii) presume disequilibrium in order to learn from situations where markets, systems and other entities are not in equilibrium, and perhaps will never be in equilibrium or at least will not approach equilibrium for the foreseeable future;
(iv) use cooperative and non-cooperative game theory that takes account of frequent interactions, information asymmetries and other information failures, behavioral attributes and biases, social norms, and individual and organizational preferences for equity, fairness, cooperation and ethical conduct; and,
(v) apply risk based dynamic simulation and related more dynamic approaches including behavioral, adaptive learning and evolutionary theories and models in order to e.g. identify the disturbances and external shocks that have the strongest impacts on CPRs and social-ecological systems through time (Ostrom and Cox 2010:9).

These multidisciplinary and pluralistic methodologies and approaches would take full account of:

- Inputs, inflows and investments in common-pool resource and related stocks, the outputs/outflows that are generated from these stocks, and the interactions between inflows, stocks and outflows.

- Actions, outcomes and positive and negative externalities, demonstration and feedback effects occurring at all spatial scales from the local through to the national, continental and global.

  For example, while climate change is a global CPR dilemma, actions by individuals, families neighbourhoods, governments and non-government groups at the local, city and sub-national region levels can result in substantial reductions in greenhouse gas emissions; and generate bottom-up climate change awareness, learning and consensus across stakeholders that can support climate change mitigation and adaptation strategies at the

same and higher spatial scales (Ostrom et al 2012:86-87, Levin et al 2012, Divecha 2009 and Dietz et al 2003).

- The extrinsic (largely negative) and intrinsic (largely positive) motivations, incentives and beliefs of individuals, companies and other organizations – including reputation effects, interdependence and spillovers -- that, in many contexts can result in contributions to CPR governance and public goods and compliance with regulations, rules and social norms that often go beyond formal regulatory requirements and expectations (see e.g. Bénabou and Tirole 2006, 2007, 2010a and 2010b, King et al 2002 and Barnett and Hoffman 2008);

- Network, interactive, cumulative, non-linear, cross-scalar, and feedback effects and consequences -- including between parameters that appear unrelated when conventional tools and models are used.

  And the additional risks, ambiguities and complexities, including the higher probability of catastrophic events, which arise when natural and human systems are "coupled together" into complex common-pool resource and social-ecological systems that encompass multiple geographic scales, sectors and markets.

- Expanding on the previous point, events, trends, interactions and relationships that appear to be less obvious and consequential and to be unrelated and counterintuitive when market, resource and other systems are presumed to be in equilibrium.

  But which over an extended period of time and through aggregation, interaction and cumulative, network and feedback effects can become highly interrelated and reach a tipping point with substantial negative consequences for the global commons.

- Limitations of highly technocratic market, efficiency and "rational agent" based policy, legal, and regulatory approaches and solutions (as proposed e.g. by the "new public management" advocates) when CPR and related social dilemmas are complex, multi-tiered, multi-jurisdictional and "super wicked".

- The important differences and their implications for the global commons between the more advanced OECD economies and developing and emerging market economies with respect to for example:

  (i) trajectories and stages of economic, social political and institutional development;
  (ii) importance and effectiveness of formal versus informal rules, institutions and governance systems;
  (iii) protection and clarity of private, public, common and other property rights;
  (iv) provision of public goods;
  (v) enterprise culture, management and governance;
  (vi) social and political capital and business-government relations; and

(vii) negative and positive developing and emerging market economy experiences, models and lessons for CPR governance, which are different from but in some contexts more positive than those of the more advanced economies.

- The role that information asymmetries and related information challenges, social preferences and norms, trust and reciprocity, behavioral biases, and heuristics/rules of thumb can play in many but not all contexts in generating CPR and related conduct, decisions and outcomes that are "better than rational" and that would never be predicted or even identified by conventional economic, political science, law and economics, regulatory and other models based on perfect information, rationality, self-interest and will-power.

Perhaps most important, future research would need to address and fully understand the highly complex, diverse and "polycentric" governance systems that will be needed to manage global common-pool resources, social-ecological systems, and other global social dilemmas and super wicked problems. In some contexts, these polycentric governance systems would need to encompass:

(i) private entrepreneurship and innovation and market institutions, incentives, disciplines, transactions and relationships in some sub-systems;
(ii) public sector entrepreneurship and innovation and government rules, regulations, institutions, incentives and disciplines in other sub-systems;
(iii) the quality of institutional linkages between different but related CPR management schemes within broader social-ecological systems (SES), which cut across geographic scales and multiple tiers;
(iv) and the many informal governance regimes and "action situations" of companies, business groups, networks and ecosystems, local resource groups and other neighborhood and community groups, local, national and multi-national civil society groups, epistemic communities, and public policy and administration networks;
(v) which lie between and fill in the gaps between the market and the state, mitigate market and government failures, and address and solve the CPR and related problems that markets, governments and multi-national organizations cannot effectively address on their own.

Examining and finding solutions to local and global CPR and SES challenges and dilemmas would also address how individuals and organizations actually behave, and how their attitudes, beliefs and conduct can change through time because of: (i) the penalties applied to free-riders and non-contributors; (ii) the expanding risks and threats that result from CPR depletion; (iii) CPR successes at the neighborhood and local community scales that are then imitated and replicated elsewhere; (iv) the cues, frames, default options, codes of conduct and lock-in effects provided by formal and informal institutions including laws, regulations, and social norms and conventions; (v) stakeholder engagement in making improvements to the formal and informal rules that make them fairer and more informative, transparent, effective, and empowering; and (vi) other time sensitive and dynamic parameters noted in the Ostrom, super wicked problem and related literatures (see e.g. Levin et al 2012).

Appendix C: Individual Behaviour and Agency and Polycentric Governance of the Global Commons

One of the major strengths of the Ostrom IAD framework is that it starts from the bottom of the pyramid through emphasizing the behaviour, actions, decisions, agency, engagement and empowerment of the individual user/appropriator, beneficiary, consumer, voter, citizen, and official of a company, government agency or other organization.

This focus on the individual becomes especially important as the institutional analysis and development moves upward from the local to the global commons and from natural resource to other commons (see e.g. Weston and Bollier 2013). Individuals could develop much greater awareness, understanding, support and agency for governing the commons at all spatial scales to the extent that:

- Individuals become more aware, engaged and empowered through working with their neighbours, friends, colleagues and the local community to preserve a locally valued public good or common-pool resource and to contribute to local community, city and metropolitan region strategies on climate change mitigation and adaptation.

- Consumer leaders, other final consumers and business customers become engaged in and contribute to the development of innovative and environmentally and socially responsible products, productions processes, organizational innovations, and advanced technologies through consumer creation and co-creation, crowdsourcing and other consumer engagement techniques, and other opportunities for consumer engagement, co-creation, co-production, and agency made possible by the Internet, social media and other channels.

- Final consumers, business customers and other market participants are using social media and the Internet to apply "graduated sanctions" including naming and shaming and other forms of voice and exit to injure and when needed to threaten the reputation and financial solvency of big-box stores, retail chains, individual retailers, producers and other supply chain participants -- which are placing products on the market and are using production processes and technologies that are socially irresponsible and not safe for individuals, the environment and the planet.

For these and other reasons, there is an expanding behavioral, environmental and business management literature and experience on how the risk of regional, national and global consumer boycotts targeted at companies that pollute, green-wash and are not "trustworthy reciprocators" of consumer loyalty, trust and faith is increasing exponentially. In the future, threats of boycott and other consumer actions will have major and determinative influences on company profitability and survival, shareholder value, corporate ability to access financing from banks and other external lenders, and the frequency with which borrowers default on their loans and other financial obligations (see e.g. Webb 2004).

Recent advances in behavioral psychology and economics and the behaviour of the firm, government bureaucracies and other organizations over the past several decades provide both

negative and positive insights regarding the ability of individuals at the bottom of the "pyramid" to make a major contribution to governing local and global commons.

On the negative side, individuals tend to be myopic, have time variant and time inconsistent preferences, place more weight on current benefits over future costs, and have difficulty with probabilities, discount rates and assessing future events and outcomes (called hyperbolic discounting in the behavioral literature). These biases lead to greater emphasis on current pleasure compared with future pain (than predicted by conventional Bayesian economics).

Individuals as well:

(i) are time constrained – including and especially the growing number of men and women who work at e.g. two or three jobs at less than minimum wage in order to put bread on the family table;

(ii) experience in many contexts procrastination, overconfidence, too much optimism, illusion of control, and information, choice and cognitive overload;

and can be manipulated through undesirable framing, priming, salience, anchoring, availability, confirmation, conformity, status quo, reference dependent preferences and decisions, peer pressure, and related behavioral effects, preferences, biases and heuristics (see e.g. Thaler and Sunstein 2008 and Ireland 2013a);

(iii) are averse to losses, risks, uncertainty, ambiguity, complexity, disappointment and regret;

and therefore can make poor decisions in contexts where the potential for losses, disappointment and regret, as well as individual concerns with risk, uncertainty, ambiguity and complexity are prominent and can be manipulated and exploited;

(iv) have problems understanding complex cause and effect relationships;

(v) are overwhelmed and discouraged by the complexity, discourse, and disputes associated with climate change and other global commons dilemmas, and by the judgemental approaches ("consumers and voters are too stupid to understand") that are adopted by some commons and climate change advocates; and,

(vi) therefore at times are more comfortable with and impressed by the simplifications and simple-minded rhetoric of the climate change deniers compared with the complexities of the future effects of climate change and global warming on the health and quality of life of themselves and their children and grandchildren and the survival of the planet.

On the positive side, the decisions of individuals are influenced by: (i) social preferences, norms and contexts, (ii) the views and decisions of others including neighbours, friends and relatives, and consumer, industry, science and technology, and other leaders (it is too bad that Steve Jobs never showed us how to effectively market climate change), (iii) self-esteem, self-identity,

and self-reputation and aversion to guilt when an individual fails to meet the expectations of others, (iv) a reputation for doing the right thing, and for maintaining and enhancing their personal reputation by being seen to do the right thing (e.g. being seen by your neighbours when putting out recyclables and buying a smaller hybrid car), (v) altruism and doing good works, (vi) the extent of self-determination, empowerment, and control over a situation, and (vii) a large number of other social norms and values that are totally neglected by conventional economics including rational/public choice economics applied to governments and other organizations and their officials.

Accordingly, most individuals care about fairness and equity including inter-generational equity (e.g. their grandchildren); and there is growing theoretical, empirical and experimental evidence that preferences for fairness and equity influence the conduct and decisions of individuals and organizations including companies and their managers and employees.

Moreover, the frequent interactions of individuals as consumers, citizens and "commoners" with other individuals and groups with different information challenges, behavioral attributes and biases and social preferences can have offsetting effects and generate debiasing and related learning benefits for all participants.

In CPR governance and related contexts that are informed by Ostrom's eight design principles, these frequent interactions, offsetting biases and debiasing benefits can have positive impacts on consumer preferences and decisions that affect the governance of local and global commons (see e.g. Cooper and Kovacic 2012 and Ireland and Kofler 2013).

Many of the more positive social values, preferences and norms and intrinsic motivations to do the right thing, which are major drivers of local CPR governance and other non-market situations, are also important to market transactions and relationships between businesses and the relationships that businesses have with consumers, companies within the same business group, network, ecosystem, national and global chain, other trading partners, governments, and civil society in the knowledge-based economy -- where competition and cooperation are both important to corporate financial performance and survival. The first to recognize this was Adam Smith who wrote *Moral Sentiments* many years before the *Wealth of Nations* – making Smith the first behavioral economist (Ashraf et al 2005).

As noted earlier, recent advances in the behavioral literature explore the extrinsic incentives and motivations (external to the individual and group) and intrinsic incentives and motivations (which are internal to the individual and group) to comply with CPR and other rules and contribute to the public good, and the important interactions between them.

This literature provides additional evidence on the market, institutional and other contexts where the Ostrom CPR action situations and polycentric governance systems are successful because graduated sanctions and related extrinsic incentives and motivations to comply and contribute complement, support, augment and "crowd-in" the intrinsic incentives and motivations to "do the right thing" through complying with CPR and related rules and social norms and contributing to the public good (Bénabou and Tirole 2003:492, Frey and Jegen 2001, Weibel and Rost 2007:7-

12 and 25-26, van Dijk et al 2008, Solstad and Brekke 2011, Ireland 2013c and 2013d and Ireland and Kofler 2012 and 2013).

The core challenge for the Club of Rome and other environmental NGOs and think-tanks is to provide the key information (in plain language), messages, signals, cues, frames, default options, and opportunities to make individual consumers, voters etc. more aware, understanding and supportive of climate change initiatives, and to provide opportunities to individuals to become engaged in and empowered by personal involvement in local and other CPR governance initiatives.

Ostrom makes very clear that public education and engagement are important but not sufficient. Empowering the individual consumer, citizen, voter, and commoner is essential to individual agency and satisfaction with their efforts and contributions and to changing individual preferences, norms and conduct that influence the governance of the commons.

Through education, engagement and empowerment working together and supported by other powerful positive insights from the behavioral literature including the aversion to betrayal, individual attitudes through time can be permanently altered to reach the "tipping-point" where individual consumers etc. will apply graduated sanctions – including voice, exit, naming and shaming, threats of and actual boycotts, stigmatization, and ostracism – to companies that green-wash and pollute and to politicians and government officials that allow companies and other organizations to pollute the environment and destroy the commons.

The Ostrom framework and the behavioral literature indicate that the "better than rational" sanctions and retaliations against companies and supply chains that green-wash and are involved in other environmentally irresponsible products, production processes, technologies and conduct will be particularly prominent and severe among:

(i) consumer leaders, other individual consumers and business users and customers that participated in crowdsourcing and other consumer engagement processes to assist these companies to produce more innovative and environmentally and socially responsible products (linked to the aversion to betrayal and related biases); and

(ii) individual consumers, voters, citizens and commoners that are making their own contributions to protecting the commons through their own actions and participation in neighbourhood and local community projects – which are linked to preferences for fairness and equity and aversion to inequality when "rich companies" with the support of government are undermining their individual efforts to preserve the commons.

Through time, graduated sanctions and retaliation could be extended to politicians and governments that protect, support, fail to regulate, and subsidize the environmentally irresponsible behaviour of corporations. These themes from Ostrom further illustrate the important linkages and interactions between the education, engagement and empowerment of the individual to governing the commons at all spatial scales.

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In preparing this paper, the authors reviewed a very large number of books, articles, and working papers that were authored and co-authored by Elinor Ostrom, her colleagues, and by other scholars whose research is also important to examining and finding solutions to common-pool resource dilemmas and to governing the global commons. The references and selected bibliography emphasize those documents that are more recent and are deemed to be most important to extending the Ostrom legacy to the global commons. A more extensive bibliography is available from Derek Ireland at djirel@sympatic.ca

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