Why Global Social Welfare Functions could not be Pre-defined? Towards Adaptive, Decentralized and Democratically Anchored Global Governance of Tropical Forests

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Abstract

In this paper, we argue that the "scientific management" view of global governance and consequent arrangement of international organizations could be misguided, and even dangerous, to adequately cope with global climate change, food insecurity, biodiversity loss and other such global governance crises. We question one of the central assumptions in top-down scientific management models of global governance. This assumption states that a global social welfare function under constraints could be used as a proxy to design institutions and their organizational functions. International climate policy mechanism known as "Reduced Emissions from Forest Degradation and Deforestation" (REDD), and its variant REDD+, provides an example of this top-down scientific management approach. We draw theoretical implications from REDD+ case study to argue for a shift in global governance approaches from "Pareto Optimization" and predefined "Fitness Landscapes" to a complex systems perspective. A complex systems approach to global governance could provide an alternative way to design the functions and capacities of international organizations. Under this view, human civilization is called upon to be open to the partially unknowable Adjacent Possible, not to control, but to enable and adapt, and partially shape what will emerge. Furthermore, the social-ecological systems could transition in and out of multiple stable states, or even exist far from equilibrium. A complex systems perspective could open up the discussion for many alternate policy designs, including proactive management of critical phase transitions in social-ecological systems at local scales, decentralized policy making, self-organization from local to global scales, and adaptive, democratically-anchored, international policy making.

Key Words: Global Governance; Climate Policy; REDD+; Tropical Deforestation; Pareto Optimization; Fitness Landscapes; Complex Systems; Alternate Stable States; Phase-Transitions

Introduction

Since the Enlightenment, human civilization has increasingly lived with the presumption that via reason and knowledge, we would have the *power to manage*. It is the so-called "General Motors" view of scientific management from 1950 onwards. In this paper, we argue that it is a profoundly inadequate model for how businesses, societies and civilizations evolve. If one looks at the United Nations and other post-second world war Bretton-Woods Institutions such as World Bank and International Monetary Fund (IMF), there seems to have been, since its inception, the same mid-20th Century faith that such management might even occur with some eventual form of a centralized world governance structure that would "know" and "allocate" and "manage". We argue in this paper that this view of global governance and this arrangement of international organizations is misguided, and even dangerous, to adequately cope with global climate change, food insecurity, biodiversity loss and other such global governance crises.

Our argumentation is based on questioning one of the central assumptions in top-down scientific management models of global governance. This assumption states that a global social welfare function under constraints could be used as a proxy to design institutions and their organizational functions. In this paper, we argue that we cannot pre-state what new "salients" of economic or civilizational activities will arise, from what little or large triggers. Further, we cannot optimize over a state space of a pre-defined social welfare function as a well-formulated decision problem. Instead, we argue that a complex systems approach to global governance might provide an alternative way to design the functions and capacities of international organizations. Under this view, we are called upon to be open to the partially unknowable Adjacent Possible, not to control, but to enable and adapt, and partially shape what will emerge. This is the profound opposite from General Motors 1950, from dictatorship, from a controlling global governance managed by the elites who "know". Under this complex systems perspective, we begin to see democracy in a new light, a framework of freedoms and procedures that allows and enables

adaptability and shaping of the possibilities where we will go. We elaborate this perspective in the light of specific triple global crises currently known as global climate change, global food insecurity and global biodiversity loss. We chose these triple global crises because centralized decision making by international organizations, such as world bank, IMF and World Trade Organization (WTO), has used maximization of economic growth as one of the primary decision criteria in adaptively-updated predefined global social welfare functions that have led to many unintended environmental and social effects, including global climate change, global biodiversity loss, ecosystem degradation, and increasing food insecurity.

Emphasis on maximizing economic efficiency for global production of goods and services has led to strongly centralized "free trade policies" that are enforced by international organizations such as WTO. Environmental impacts of such free trade policies have not been internalized through imposition of Pigovian taxes in the conduct of international trade. The powerful industrial North and transnational corporations have been able to negotiate terms of trade that maximize their profits and retain current socio-political power patterns, while Greenhouse gas (GHG) emissions resulting from global industrial complex, mining, deforestation, wasteful consumption, and fossil energy burning continue to accumulate in coupled atmospheric and oceanic systems. Global climate change science is unable to predict an accurate timing of critical phase transition; however all global circulation models agree that business as usual path of GHG emission trajectory will sooner or later cause a phase transition in the coupled atmospheric system; after which socio-political policy actions and behavioral changes by themselves will not be adequate to stop run-away climate change because natural biogeochemical cycle would have degenerated to the point that reduction in anthropogenic GHG emissions would be inadequate to stop global warming effect from playing havoc in the global socio-ecological systems. Protection of free trade through centralized global institutions and maximization of economic growth will only exacerbate GHG emissions. On the other hand, international climate policy experts are well aware of the fact that any strong action by a handful of nation-states would shift global industrial

production to the nation-states that do not take any meaningful action on regulating GHG emissions.

In this article, we thus argue that the management of global climate, food and biodiversity crises pose a fundamental *normative* or *value ambiguity* challenge, i.e., experts in centralized international organizations do *not* and can *not* know the space of variables and strategies over which the optimization decision problem is to be stated. To elaborate this further, we discuss global crisis of human-induced global climate change as a value ambiguity problem. Both the mitigation and adaptation to global climate change requires deep, long term foresight, and unwavering collective/normative human action at the global scale. Yet, the complexity of managing global climatic change, and its impacts on irreversibly changing the evolutionary pathways of biological, technological and economic systems remains a deep puzzle, beyond the reach of positive sciences. From a normative standpoint, which is an essential component of any governance effort to deal with the complexity of complex systems, we argue in this article that the international organizations need to move beyond the positivistic goals of managing and controlling global socio-ecological systems, and that management and international organization sciences need to move beyond "optimization-envy". We argue that there is a need to accommodate both facts (understanding) and values (normative prescriptions) for managing global environmental and social crises. Furthermore, management and international organization sciences will need to let go of reductionism, and replace it with the acknowledgment of normative (or value-laden) complexity of managing complexity.

International climate policy mechanism known as "Reduced Emissions from Forest Degradation and Deforestation" (REDD), and its variant REDD+ that was recently negotiated at the Conference of Parties (COP)-16 in Cancun under the aegis of United Nations Framework Convention on Climate Change (UNFCCC) negotiations, provides an example of this top-down scientific management approach, which typically assumes that a social welfare function could be *defined*, and maximized under constraints in different countries. We use REDD+ policy

mechanism as an example of recent global climate change policy to shed light on how and why global governance on climate change, food and biodiversity has failed and why REDD+ is also very likely to meet the same fate as previous efforts in this domain, known as "debt for nature swaps" and so forth. Further, complementing REDD+, recently United Nations Environment Programme (UNEP) in CBD (Convention for Biodiversity) COP 10 has promoted TEEB (The Economics of Ecosystems and Biodiversity) approach as another policy mechanism to internalize the economic value of ecosystem services for improving the defined social welfare functions and reducing deforestation in tropical countries. REDD+ and TEEB approach follow the underlying model of social welfare maximization under local constraints. Unfortunately, these models ignore the implications of international free trade, mandated under WTO policy mechanisms. Further, social and ecological values that could not be priced in dollar/monetary terms are also not represented in such models. Next, in section 2, we present REDD+ mechanism and elaborate the failures in the global governance caused by such "optimization-envy" models that govern the design of international policy mechanisms such as REDD+. In section 3, we draw theoretical implications from REDD+ case study to argue for a shift in global governance approaches from "Pareto Optimization" and predefined "Fitness Landscapes" to a complex systems perspective and, in Section 4, present arguments for adaptive, decentralized, and democratically-anchored global governance of forest, food and social-ecological systems.

2. The Case Study of REDD+: A Multi-Stakeholder Perspective

In general, REDD+ has been conceptualized as a "win-win-win " policy mechanism for mitigating climate, protecting biodiversity and conserving indigenous culture by institutionalizing payments on carbon ecosystems services from global to local communities. The Union of Concerned Scientists (UCS), for example, assert that REDD is an option that "not only averts global warming's worst consequences but also generates enormous co-benefits for biodiversity conservation and sustainable development" (Boucher 2008). UN REDD Program (2009a; 2009b)

states that REDD policy is an effort to create a financial value for the carbon stored in forests, offering incentives for developing countries to reduce emissions from forested lands and invest in low-carbon paths to sustainable development. The UN-REDD Program focuses on the multiple benefits which can be provided by REDD, specifically the ecosystem benefits. According to UN-REDD Program definition, multiple benefits of REDD, in addition to its contribution to climate mitigation, include forest conservation, which will protect biodiversity and provide ecosystem services.

The position of some other stakeholders is a bit nuanced than UN's REDD program. For example, according to the Climate Action Network (2007), emissions from tropical deforestation must be reduced to keep global temperatures from increasing more than 2°C by 2050. Global warming will contribute to the destruction of tropical forests overtime and will negatively impact forest biodiversity. REDD+ projects can help preserve biodiversity which improves the resiliency of the forests in turn. If an international agreement includes provisions for REDD+, the systems must be developed at the national level to address the issues of leakage and calculating baselines. Industrialized countries would compensate the tropical countries for their opportunity costs and provide funding for capacity building (Climate Action Network 2007). In particular, governments need help monitoring and measuring degradation activities because it requires different technology and is more expensive than measuring deforestation.

Although the idea behind REDD+ may be simple (compensate developing countries for sustaining tropical forests), actors in the policy arena do not necessarily agree on how REDD+ policy should be designed, the costs and benefits of implementation, and whether REDD+ is the best approach to reduce emissions. Deforestation is an inherently complex problem; there is no single solution available because "no body knows best" (Lebel et al. 2004). Any attempt to solve the deforestation problem generates unintended consequences that will undoubtedly impact the

implementation of solutions in the future (Hirsch et al. 2011). Global deforestation and degradation is the result of an increasingly global economy; the demand for particular goods from developed countries has encouraged the conversion of tropical forests to other agricultural uses, including growing soybeans, raising cattle, and producing crops for new biofuel technologies (Mardas et al. 2009). Far from being a win-win, REDD+ policy will be an intervention in a highly complex system, and will inevitably involve trade-offs; therefore it is important to question "win-win-win" discourse.

In general, REDD+ payments are calculated by measuring an opportunity cost of foregoing deforestation that generates a variety of ecological valuation puzzles. Opportunity cost of REDD+ is defined as the cost that will be incurred in retaining existing tropical forests. "Retention means sacrificing the opportunities that would be gained by converting the forest to other uses, such as crops or pasture" Boucher (2008). Opportunity cost is thus considered as the minimum amount that would need to be paid to keep the land in forest. Major thrust of economic analysis of REDD+ program has been to calculate this opportunity cost ($), which is typically divided by carbon density of the forest (e.g. tons per hectare) to calculate the minimum cost of REDD+ that is expressed in units of money/area (e.g. $/hectare). The measurement of opportunity costs requires heroic assumptions, such as future prices of soybean or other crops that could have been grown on the deforested lands. It is due to these inherent uncertainties about future counterfactuals that different economic models come up with different opportunity costs for REDD+. Global models produce REDD+ cost curves that are typically higher than regional or local models (Boucher 2008; Nabuurs et al. 2007). While this inconsistency is still being debated, this version of opportunity cost ignores other costs associated with implementation of REDD+ such as administration or capacity building costs. There have been no reliable global studies that estimate administration or capacity building costs. A more subtle methodological problem in the calculation of REDD+ costs in terms of carbon abatement (e.g. $/tCO2) concerns about the

underlying assumptions whether a single buyer or a cartel is assumed to set the market price (typically area under the abatement curve), or a global carbon market price be used to determine the price of REDD+ payments. The uncertainties about the non-linear curvature of carbon abatement curves further complicates the calculation of REDD+ payments.

Notwithstanding difficult challenges and uncertainties in measuring carbon abatement curves and opportunity costs, the calculation of carbon densities poses even more daunting challenges (Ramankutty et al. 2007). It is due to these measurement problems that the overall contribution of REDD+ to global climate change GHG flux is still contested. According to IPCC's fourth assessment report (Nabuurs et al. 2007), tropical deforestation contributes about "20%" of global GHG emissions. There are, however, important methodological issues that underlie this "narrative" of 20% estimate. DeFries et al. (2002) and Achard et al. (2002; 2004) used remotely sensed tropical deforestation data to estimate carbon releases and found that Houghton (2003a; 2003b) and Fearnside (2000) have overestimated carbon emissions from land-cover change by up to a factor of two, mainly because of different estimates of the rates of tropical deforestation. The differences among these studies can be ascribed to modeling different geographic ranges and time periods, different types of land-cover changes, different assumptions about land-cover change and different carbon cycle models/fluxes. There are considerable scientific uncertainties about quantification of several key elements for an accurate and complete analysis of carbon density estimates in tropical forests. These include rates and dynamics of land-cover change, initial stock of carbon in vegetation and soils, mode of clearing and fate of cleared carbon, response of soils following land-cover change, influence of historical land-cover legacies and the representation of processes in the models used to integrate all of these elements (Ramankutty et al. 2007). Recently, Van der Werf et al. (2009) argued that 20% estimate needs to be revised downwards to 12% as GHG emissions from fossil fuels are increasing faster than tropical deforestation. Differences in carbon density calculations will inevitably effect the

calculation of REDD+ payments, which can be potentially used by the developed countries to underestimate REDD+ payments or by the developing countries with tropical forests to overestimate the REDD+ payments.

Calculating a baseline upon which to compare subsequent activity is essential to valuing reductions in carbon emissions. Depending on the method of calculation used, data may not be available for all countries. Reference levels can either be based on historical or projected rates of deforestation in a particular country or region. Historical baselines aim to measure any reductions in deforestation below past trends. A variation on this approach is the historical adjusted baseline; this method incorporates factors that may impact the rate of deforestation in the future due to development pressures and adjusts the historical baseline accordingly. One caveat of the historical adjusted baseline is that it could actually provide financial incentives to countries that achieve a net increase in deforestation, as long as the rate of deforestation is below the adjusted baseline. Projected baselines require the most sophisticated data because the method relies on econometrics to assess the future rate of deforestation in a country or region based on the social and economic driving forces of deforestation. Again, the projected baseline approach is susceptible to allowing financial rewards to countries that actually contribute to a net gain in deforestation (Parker et al. 2009).

An important REDD+ policy design problem is whether carbon offsets or credits are issued at the national or the project-level? On the one hand, national-based approaches are favorable because REDD+ efforts will be weakened unless incentives to convert forests to other land uses are eliminated (The Forests Dialogue 2008). A national approach is also more conducive to establishing baselines and addressing leakage, however, project-based and/or community based approaches may be appropriate if a country is not ready to implement a national REDD+ policy and take on the responsibilities of monitoring forest activity (Climate Action Network 2007). Further, it has been empirically demonstrated through an analysis of IFRI

database that community based governance of forest commons is more effective in the long run than national level governance approaches (Chhatre & Agarwal 2009). On the other hand, a national-based approach to developing and implementing REDD+ policy is preferable to minimize the possibility of leakage within a country or across the countries. It is argued that monitoring emissions reductions at a national level discourages leakage, or the displacement of deforestation and degradation activities, to other parts of the same country. But there is a trade-off here as national governments are generally in conflict on tenure right issues with many local and indigenous communities. There are significant disagreements even about the definition of local and indigenous communities in REDD+ negotiations (e.g. Schroeder 2011). In addition to these definitional issues, there are significant power asymmetries and long-standing conflicts between indigenous communities and national governments, and the implementation of REDD+ projects by national governments could further exacerbate these conflicts depending upon who is defined as "indigenous" by the national governments for transferring REDD+ benefits.

REDD+ policy will undoubtedly require an exchange of resources among relevant actors, but the allocation of REDD+ policy benefits and burdens among actors is not determined at this time. A more thorough/complete review of the projected costs and benefits identifies some incommensurate puzzles in terms of the impacts an international REDD+ policy may have on individual stakeholder groups, especially three target populations: developed countries, developing countries, and local and indigenous people. Developed countries are by-and-large expected to provide the bulk of the financing for any REDD+ mechanisms, which are put into place. Financing is the crux of the success for REDD+ proposals; without monetary support, developing countries will not be able to effectively reduce emissions from land use practices. Although the pressure to finance REDD+ could be seen as a burden on the developed countries, it is also a benefit to these actors because it is arguably less costly to pay for REDD+ projects in developing countries rather than invest significant financial capital to reduce fossil fuel driven

emissions from energy sectors through improving their own infrastructure and technology. The pressure for developed countries to finance REDD+ has also provided them with extreme bargaining power. Developing countries are dependent upon the developed world to support their actions; until concrete figures of anticipated financial compensation are provided, it is unreasonable for anyone to expect developing countries to implement REDD+ policies on a broad scale.

Each developing country that chooses to participate and support REDD+ efforts will need to assess their institutional capacity for implementation and monitoring efforts. Other national land use policies may need to be revisited to ensure that the efforts for REDD+ are not undermined and land use tenure rights may need to be better defined. This undeniably places the burden for action on developing countries, although not all countries will be eligible to participate. Depending on a country's historical rate of deforestation and the amount of forest cover they have, only some developing countries may be rewarded. It is arguably unfair to countries that have kept deforestation under control previously to be excluded from any REDD+ mechanisms now. This approach could also create perverse incentives for countries with high forest cover and traditionally low rates of deforestation to negatively change their land use practices. "The governance and administration of the REDD mechanism will be critical to ensuring the equitable distribution of benefits among and within countries with tropical forests" (Thies & Czebiniak 2008).

Amidst this power tussle among developed and developing countries, it has been widely recognized that indigenous populations are the most vulnerable and most likely to loose in the long run. There have been growing calls for increased participation of indigenous groups in REDD+ deliberations to provide a "narrative" of legitimacy to the policy design process. The REDD+ Social & Environmental Standards Committee has consistently advocated for all relevant stakeholder groups to be involved in program design, implementation and evaluation through

effective consultation or more active participation. Will mere participation of indigenous groups in REDD+ deliberations change the ultimate winners and losers remains to be seen, with colonial history presenting ample evidence that the rights of indigenous populations are least likely to be protected in any compromised policy design? There are particularly concerns in those tropical areas where land use rights are already contentious in the wake of colonial and imperial history.

One of the central issues with respecting the involvement and perspectives of the indigenous populations is the fact that in many cases they lack legal land rights to ancestral homes and are socially and economically marginalized in their own societies. A significant proportion of the world's forests are owned by states themselves and most fall under state control in some way, even if only in relation to land-use zoning laws. "Government decisions about land-use zoning and forest management often do not take adequate account of the rights of Indigenous groups living in such areas, particularly when these conflict with perceived national interests or opportunities for financial gain." (Barnsley 2009). Indeed, "self-serving central government-oriented REDD plans are already emerging" (Griffiths 2009). Because indigenous value systems are disregarded in the initial stage of conceptualizing the problems, indigenous peoples are excluded from a position in the process of policy formation and administration. This represents a lapse in respect for human rights as it renders a community powerless to design their own future.

Indigenous communities left to the mercy of outside interests is a clear example of how the dominant theoretical framework defines the problem, through the politics of knowledge, and therefore controls the *process* of addressing those problems. The resulting mechanisms of policy administration preserve the old, unequal power dynamic. In order to ensure the inclusion of a pluralistic set of values and the consideration of multi-scalar cost-benefit analysis the fundamental infrastructure of REDD+ policy design could be re-conceived to include the utilization of adaptive governance techniques and the mandate that funding of projects is contingent on the protection of indigenous communities' tenure and land use rights. In this vein,

Annex I on the REDD+ agreement reached during COP16 negotiations at Cancun includes the "guidance and safeguards for policy approaches and positive incentives" to protect the rights of indigenous communities. In part, it states:

> *Activities referred to in…[the] decision should… be implemented in the context of sustainable development and reducing poverty, while responding to climate change....the following safeguards should be promoted and supported: …Respect for knowledge and rights of indigenous peoples and members of local communities, by taking into account relevant international obligations, nation circumstances and laws, and noting that the United Nations General Assembly has adopted the United Nations Declaration on the Rights of Indigenous Peoples; (d) The full and effective participation of relevant stakeholders, in particular, indigenous peoples and local communities in actions referred to in paragraphs 70 and 72 of this decision…"*

The outstanding question is whether or not these words and the subsequent actions of all involved parties will meet these safeguards and affirmations while leading to the reduction of deforestation and eventually a positive change for the world's climate. To ensure these safeguards, for example, any financing or funding support from the World Bank, or any other similar politically charged organization, could be seriously reconsidered. In numerous open-ended interviews with global environmental policy experts, many interviewees reached the same conclusion: allowing the World Bank to implement REDD+ financing would be a mistake. One expert warned of possibility of conflicting interests. "The World Bank's assets are largely based in the United States and other developed nations," the expert stated. "It would not be out of character for the Bank to promote corporate interests over those of indigenous communities." According to REDD-Monitor.org, the indigenous people themselves have similar fears. Egberto

Tabo, General Secretary of the Coordinating Body of Indigenous Organizations in the Amazon Basin, at the World Bank session of the Indigenous Peoples Global Summit on Climate Change, noted that the World Bank is funding some of the most destructive projects in the Amazon forest. He spoke of "The genocidal legacy of World Bank investments in the past" (Lang 2009). A Native American woman closed the conference with a dramatic admonishment directed towards the World Bank, "Please understand we do not trust you. You are bad. You create systems that destroy us inside and out" (Lang 2009). An organization that can elicit such impassioned emotional responses from the very people it is supposed to be helping would undoubtedly create unnecessary tension and distrust between stakeholder groups and result in a loss of legitimacy for the REDD+ program as a whole. The issue of tenure and property rights for indigenous communities also remains unresolved, casting a long shadow of doubt on the efficacy of REDD+ policy to conserve tropical forests.

While the implementation policy for protecting the rights of indigenous communities is still being debated (and expected to be extensively discussed in COP 17 and COP 18 meetings in 2011 and 2012, among other venues), REDD+ faces a fundamental challenge from the international trade regulations mandated under WTO arrangements; and food and agricultural subsidies provided by World Bank, regional development banks, and other international organizations promoting standard "western" style of neoliberal governance policies in tropical forested developing countries under the garb of "food security" and "economic development". The REDD+ policy mechanism is designed on such a counterfactual basis that the calculation of opportunity costs, forest densities and carbon densities will remain uncertain so long as free trade and economic growth policies continue to promote the spread of mono-agriculture in tropical forests. These mono-cropping agricultures are either promoting the replacement of old growth forests in tropical countries with food system input crops (e.g. growth of soybean and palm oil plantations in tropical forests during the last fifty years) or biofuel energy inputs (e.g. corn for

ethanol). In theory, the replacement of old growth forests with mono-crops will conserve the carbon density of the forests; however, in practice, it could trade-off biodiversity (as animal habitats will be lost due to mono-cropping practices) as well as indigenous communities (as their habitats will be lost), perhaps as unintended consequences. The global social welfare functions that are assumed in the design of WTO and REDD+ policy mechanisms do not adequately internalize the loss of biodiversity and cultural diversity, which in turn could have cascading effects on the loss of tropical forests. Finally, the uncertainty regarding the impact of global climate change, e.g. shifting of precipitation patterns over Amazon and other tropical systems, further aggravates the efficacy of REDD+ investments, which instead could be used to reduce GHG emissions in fossil fuel intensive developed countries. There is thus large value ambiguity and system uncertainty for designing a REDD+ policy mechanism that could effectively promote biological conservation and cultural diversity, while at the same time other international organizations are promoting food security, agricultural subsidies and biofuel energy investments.

3. From Pareto Optimization to a Complex System's Perspective on Global Governance

From a multi-stakeholder perspective of REDD+ case study, we have demonstrated that: first, there are many stakeholders; second, different stakeholders have differential power; and, third, different stakeholders have different "valuation" or utility functions that are often in conflict, with the powerful winning. Reframing these conclusions formally; let us consider a continuous policy space. Now let us take any "one" stakeholder and its utility function over the policy space. This yields a "fitness landscape" or "payoff landscape". Let us do the same for each different stakeholder and we have N landscapes over the strategy space for N stakeholders. In general these N fitness landscapes will *not* have global optima, or even local peaks, at the same locations on the strategy space. Now, as we pointed out above, these diverse landscapes, plus diverse power capacities from the World Ban, to local hunter gathering peoples, yield a complex "tug of war"

about policy. A natural solution concept in the above N landscape case, where *we cannot say the relative values of the N different utility functions of the N stakeholders*, is that of Global Pareto Solutions. A global Pareto solution is a point on the landscape such that no local move on the continuous policy space can *increase one utility function among the N, without decreasing at least one other utility function amount the N.*

Formally, given the set of N stakeholders, a game in normal form could specify a strategy set and a utility function for each stakeholder, For stakeholder j, we denote by S^j the strategy space for the jth stakeholder; and define $S:=\Pi_{j\in N}S^j$ as the strategy space for all N stakeholders. Further, it is postulated that a preference relation among the strategy spaces for jth stakeholder is represented by a utility function $u^j : S \times S^j \dashrightarrow \mathbf{R}$. This implies that when all the stakeholders have chosen their strategies $s := (s^1,\ldots..,s^n) \in S$, stakeholder j will enjoy the utility level $u^j(s, \xi^j)$ when a stakeholder changes a strategy from x^j to $\xi^j \in S$. A game among N stakeholders in normal form could now be defined as a list of specified data $\{S^j, u^j\}_{j\in N}$. A *Nash Equilibrium* of a such a stakeholder game in normal form $\{S^j, u^j\}_{j\in N}$ is an *n*-tuple of strategies $s^*:= (s^{1*},\ldots..,s^{n*}) \in S$ such that for every $j\in N$, $u^j(s^*, s^{j*}) \geq u^j(s^*, \xi^j)$ for all $\xi^j \in S$. In standard social welfare analysis, the real number $u^j(s^*, s^{j*})$ is the utility that jth stakeholder currently enjoys, and in equilibrium there is no incentive for her to change her strategy s^{j*} by herself. In general, Nash equilibrium of such a game is considered as a *descriptive* concept, i.e. it describes what the "fitness landscape" would be when N stakeholders play the game, assuming that each stakeholder has a nonempty, convex, compact subset of strategy space, and a continuous quasi-concave utility function. In contrast to descriptive concept, a *normative* concept such as Pareto optimality is typically defined to signify a desirable "fitness landscape" or outcome space of a game. These normative concepts, such as Pareto optimality, are typically used as "targets" by the "General Motor" style rational planners situated in the World Bank, WTO and other international organizations. This in turn leads to the emphasis on "win-win-win" rhetoric in the creation of international policies such as REDD+ described above. Formally, a Pareto optimal strategy bundle $s^* \in S$ for a game in normal form $\{S^j,$

$u^j\}_{j \in N}$ could be defined by stipulating the condition that if it is not true that there exists v € S such that $u^j(v, v^j) \geq u^j(s^*, s^{j*})$ for every j € N. It can be demonstrated in environmental governance conundrums such as REDD+ that the Nash Equilibrium of prisoner dilemma type of games is not necessarily Pareto optimal. Institutional political economists that support current WTO and REDD+ policy regimes would thus argue that the design of REDD+ (i.e. transfer of benefits from developed to developing countries) would move the global governance of tropical forests from less optimal to more Pareto optimal situations; and by implication, fitter landscapes, in the long run, by incentivizing the developing countries to conserve tropical forests, protect biodiversity and maintain carbon stocks.

Given the case study of REDD+ described above, as well as generic crisis facing international organizations in terms of dealing with global climate change, global food insecurity as well as global biodiversity loss, we argue that such rationalist and normative arguments based upon the logic of Pareto optimality and Nash equilibria lead to poorly defined international institutions that create perverse incentives for local and indigenous communities, as defined for REDD+ above, displace biodiversity through the removal of old growth forests, engender inequities due to century old property right and tenure conflicts, assume technological methodologies that cannot objectively assign baselines, and above all, place a monetary value on natural and biological systems that trivializes the worth of biodiversity and social-ecological systems through assumption-laden game theoretical and institutional design frameworks.

Due to these invalid assumptions, and lack of reality-checks, we argue that Pareto optimal fitness landscapes could not be predefined by rational and/or centralized planners. This in turn implies that global social welfare functions could not be pre-defined by rational planners. In fact, from a long-term inter-temporal perspective, we argue that the strategy spaces and utility functions of different stakeholder groups over N policy spaces could not be pre-stated. We emphasize this unprestatibility by arguing that the utility functions and strategy spaces of different stakeholder groups are not *fixed*; rather they are very highly context dependent. The

utility functions and strategy spaces of different stakeholders change with changes in technology, boundary conditions, biological evolution and other endogenous and exogenous drivers of change in the social-ecological systems that are typically ignored when modeled by Pareto optimizing rational planners. In the context of REDD+ policy design, if we consider a scenario where the global food prices are tripled, this will indirectly also triple the opportunity costs for REDD+ payments for developed countries, which might change optimal decision in favor of other carbon abatement technologies. In another scenario, a technological innovation (e.g. carbon sequestration from coal fired power plants and/or more cost effective production of solar cells) could change the optimal strategies for GHG polluting countries that could dry up REDD+ payments. Further, in a more cynical scenario, global climate change could initiate perverse positive feedback loops through unintended consequences, whereby higher CO_2 in the atmosphere could lead to less precipitation in the tropical forested systems, which in turn could lead to precipitous decline in forest systems, which in turn could speed up the concentration of CO_2 in coupled atmospheric and oceanic systems, further aggravating the global carbon cycle. The capacity of tropical forests to absorb CO_2 under high CO_2 concentration scenarios is still a very contested and uncertain issue among biology and ecology experts. Given these economic, technological and biological uncertainties in future scenarios, predefining inter-temporal global social welfare functions and acting upon them through international institutional mechanisms such as WTO and REDD+ appears very naïve and dangerous.

On the other hand, we argue that global governance need to incorporate a complex systems perspective in designing and supporting international policy and institutional mechanisms. Under a complex systems perspective, social-ecologoical systems could transition in and out of multiple stable states (Scheffer 2009), or even exist far from equilibrium (Kaufmann 1993; Kaufman 1996). Instead of arguing over the design of inter-temporal global welfare functions, or assuming that economic growth is the dominant criteria in setting up utility functions for macroeconomic policy making, a complex systems perspective opens up the

discussion of many alternate policy designs, including proactive management of critical phase transitions in social-ecological systems at local scales, decentralized policy making, self-organization from local to global scales, and adaptive policy making by focusing upon adjacent possible while keeping larger scale impacts of policies, institutions and international organizations in the context that we discuss in the next section.

4. Towards Adaptive, Decentralized, and Democratically Anchored Global Governance of Tropical Forests

Adaptive governance, which highlights transparency and the integrated participation of diverse stakeholder groups in all stages of planning and implementation, addresses the importance of process and power relationships (Norton 2007). "History shows that any global plans to save the world's forests devised without the full knowledge and agreement of forest peoples and local communities are doomed to failure" (Griffiths 2009). Instead of evicting populations from a conservation area, adaptive governance would encourage the utilization of their extensive knowledge of the forest ecosystem and manpower to help preserve biodiversity and aide conservation efforts, all the while respecting human rights. For example, Indigenous leaders in Guyana are involved in an ongoing debate with international organizations, like the World Bank, to gain recognition for the legitimacy of the local communities to be integrated into the management and protection of their ancestral homes. Guyanese case needs to be studied further whether empowering indigenous peoples through transference of tenure rights leads to better tropical forest conservation or some other un-intended consequences. Such forest governance approaches could potentially prevent carbon sequestration methods like mono cropping, which destroy biodiversity and the degradation of nutrient-rich soil, from becoming legitimized. Other ecological ills, like the contamination of water sources, could be avoided by utilizing low-impact indigenous biodiversity management techniques that do not rely on intensive

chemical fertilizer use. Through an equitable and democratic process policies can be formed that recognize the multi-dimensional needs and support-functions of the forest, thereby creating policies fit to the appropriate scale of the issue and with greater local investment in the outcome because the interventions are internally driven. Ideally, through adaptive governance practices, priorities that were once thought to be incompatible, like climate change mitigation or protection of the rights of indigenous people, may find *local* Nash solutions, yet always open to change with contextual changes.

Of course, such idealized scenarios can only be possible if appropriate enforcement and accountability mechanisms are institutionalized. There is always a danger that rights will be violated in the interest of inward investment or corruption. "Thus, without clear tenure and use rights, sustainable forest management will be impossible and carbon finance may increase social conflict" (Griffiths 2009) . That is why making project funding legally contingent on safeguarding indigenous rights, with evaluation of compliance by an impartial authority, is necessary. Altering the business-as-usual approach to conservation management is no easy task and is most likely to be met by tough opposition from the current beneficiaries. "If human rights violations are to be avoided, adoption of a rights-based approach to forest policy and management must accompany, and in many cases precede, implementation of climate-oriented interventions" (Seymour 2008). The issues surrounding the mitigation of climate change have impacts on human society and are not just issues of ecological sustainability. To create truly sustainable solutions, issues of social equity and environmental justice must also be addressed that are not explicitly modeled in global social welfare functions. In the case of the REDD+ program there is a lot of ground to cover when it comes to achieving success in almost all of the aforementioned areas, especially social equity and human rights protection. Strategies for the future could incorporate an adaptive, decentralized and democratically anchored approach, which will require fundamental transformation in ideological assumptions driven by the scientific management

model of global governance adopted by international organizations. Ensuring the rights of indigenous populations is an essential component in this transformation.

Highlighting this process of the marginalization of indigenous peoples, are the Penan of Sarawak, East Malaysia (Brosius 2006). The Penan who have historically been nomadic tribes with a forest range in East Malaysia are being pushed into settlements within the forest so the Government can harvest the rest of the forest and then replant with palm oil plantations and other agricultural ventures. Under the current REDD+ design, Malaysia can still earn carbon credits for their development practices of planting palm oil that replaced native forest and the displacement of the tribes. Under such centralized scenarios of REDD+ design, payments are made to national governments only after the displacement of indigenous peoples, such as the displacement of Penan and the loss of tropical forest biodiversity.

On the other hand, an adaptive, decentralized and democratically anchored global governance of tropical forests could provide adequate voice and empower the indigenous communities, and restrain national governments and international organizations from trading off old-growth tropical forests and biodiversity for the sake of maintaining global carbon cycle. Rich industrialized countries could rather focus on their local carbon footprints and not use elusive carbon offsets from tropical forests to sustain their ecologically disrespectful lifestyles. Furthermore, international organizations, such as WTO, need to be fundamentally reformed that do not incentivize destruction of tropical forests through the ideological knowledge of marketization of tropical forests and free trade of minerals and soils available in tropical forests. Currently, WTO free trade reform process is based on a flawed assumption that global social welfare functions could be maximized if each country of the world maximizes their economic growth. As we have argued above, this pre-statement of a global utility function fails to adequately address human rights of indigenous communities, social equity; and in fact sustains the domination of global north over south that typically contains the majority of remaining

tropical forests and biodiversity contained therein. Inter-organizational coordination among international organizations could prevent such massive failures, where WTO is promoting deforestation, while UN-REDD program is promoting forest conservation; where world bank is promoting unfettered economic development, while the International Union for Conservation of Nature (IUCN) is promoting biodiversity conservation; where IMF is promoting globalization and corporatization, while global capacity to sustain such globalization is diminishing faster than anticipated by many global environmental policy experts.

5. Conclusions

We have demonstrated that global social welfare functions could not be pre-defined to "scientifically manage" global stock of tropical forests. Instead, we have argued that adaptive, decentralized and democratically anchored global governance could be used as guideposts to adequately cope with global environmental and social crises. Normative underpinnings of managing complexity, informed by complex systems based understanding of global climate change, global biodiversity loss and global food insecurity could guide us towards adaptive governance-based interventions in local to global communities. In turn, this will create room for open-ended and value-laden adaptive governance strategies to cope with global climate change, global food and biodiversity loss and other such problems. Iterative nature of adaptive risk governance could also provide opportunities to the local managers of complex systems to use creative problem solving skills based upon the community values and the constantly evolving knowledge of the partially unknowable adjacent possible states of social-ecological systems that could be dynamically managed with the evolving knowledge of adjacent possible states containing both intended and unintended consequences.

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