Quotes Table E: Key criteria identified in large-scale system analyses (design-principle-based)

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| **22 Key criteria of robust natural resource governance systems identified in the literature:** | **Design principles for Global Commons (Stern 2011)** *- International level* | **Institutional diagnostics: dimensions of fit interplay and scale (Young 2002)** *- International level* | **Gari et al. (2017) Analysis of global applicability of Ostrom's DPs** | **Fleischman et al. (2014) Governing large-scale SES** |
| **1 Clearly defined rights of users to utilize resources** |  |  | Table 2 & 3: Important | 1A. Clearly defined boundaries: Actors who have rights to withdraw resource Table 2: Importance of clear social boundaries moderately supported in four large-scale CPR cases, except Indonesian forests. |
| **2 Clearly defined resource boundaries** |  |  | Table 2 & 3: Important | 1B. Clearly defined boundaries: The boundaries of the CPR are well defined. Table 2: Clearly defined biophysical boundaries present in all cases, but ICAAT |
| **3 Congruence or fit of appropriation rules with local ecology and local culture (i.e. sustainable use of resources)** | Devise rules congruent with ecological conditions |  | Table 2 & 3: Important | 2A. Congruence between appropriation and provision rules and local conditions. Table 2: Present in three of four cases. |
| **4 Balance between costs expended / investments made into a resource and benefits received from resources (equitable resource use)** |  | Emphasis on equity (e.g., those who contribute to damage and can pay are made to pay; those who contribute to damage but cannot pay are provided with assistance to come into compliance) | Table 2 & 3: Important Table 6: Equity (including lack of corruption and conflicts of interest) | 2B. Congruence between appropriation and provision rules and local conditions (proportionality) Table 2: Present in two of the five cases. |
| **5 Collective choice arrangements (individuals affected by the rules can participate in making and modifying the rules)** | Allow most users to participate in developing rules | Flexibility in rules and procedures (responsiveness to actor heterogeneity in internal economic/political systems);   Issue linkages - expanding scope of institutional arrangements (legislative bargaining) | Voluntary community participation (DP 3) | 3. Collective-choice arrangements: Most individuals affected by the operational rules can participate in modifying those rules. Table 2: Important but absent in all but Montreal Protocol |
| **6 Monitoring resource conditions and appropriator behavior** |  | Monitoring procedures; Certification, authoritative interpretation;   Systems of implementation review--structure of monitoring and sanctioning system | Table 2 & 3: Important | Table 2: Present in all cases (albeit weakly in forests and ICAAT) |
| **7 Monitoring the monitors** | Hold monitors accountable to users | Monitoring procedures | Table 2 & 3: Important | Table 2: Important but absent/limited |
| **8 Graduated sanctions** | Apply graduated sanctions | Sanctions, deterrence;  Systems of implementation review--structure of monitoring and sanctioning system is congruent with the risk presented by rule violations and incentives to cheat | Table 2 & 3: Important Table 6: Graduated sanctions P. 13: Enforcement of social norms that prevent corruption. | Table 2: Important but absent in all but Rhine River and Great Barrier Reef |
| **9 Conflict resolution mechanisms** | Develop low-cost conflict resolution mechanisms | Invest resources into the development of management structures, incl. administrative arrangements, funding mechanisms, and dispute resolution mechanisms | Table 2 & 3: Important Table 6: Strong conflict resolution methods | Table 2: Present in all but ICAAT |
| **10 Minimal recognition of rights to organize** | Ensure that external authorities permit users to devise their own rules |  | Table 2 & 3: Autonomous community management (DP 7)  Table 6: Non-coercive presence of government (incorrectly labeled as DP8) | Table 2: Important but only present in Rhine River |
| **11 Nested enterprises: governance activities are organized in multiple layers of nested enterprises** | Establish nested layers of organization | Coordination mechanisms & institutional linkages (institutional nesting and agreed-upon divisions of labor) | Table 2 & 3: Important Table 6: Government-community collaboration | Table 2: Important and present in three cases. |
| **12 Institutional adaptability/ variety/ flexibility** | Plan for institutional adaptation and change (iterative risk management); Engage a variety of institutional types | Early warning devices/rapid response capability (system adaptability to changing SES conditions) |  |  |
| **13 Social learning** |  | Social learning, adaptability, precautionary approach to deal with uncertainty about SES properties and behavior |  |  |
| **14 Long-term commitment and shared understanding** |  |  |  |  |
| **15 Leadership** |  |  | Table 6: Strong leadership |  |
| **16 Capacity building (e.g., training, resources)** | 8 Invest in science ("can help improve understanding of the system and its interactions with users so that those affected by changes know what to monitor and sanction") | Capacity building, technology transfer |  |  |
| **17 Knowledge building (e.g., learning, information sharing )** | Invest in science; Integrate scientific analysis with broadly based deliberation |  |  |  |
| **18 Prior Networks** |  |  |  |  |
| **19 Trust and Social capital** | treats as basis for adaptation and change (.5) |  | Table 6: "Social capital (strong group consciousness, mutual trust and a high moral standard)" |  |
| **20 Resource dependence** |  |  | Resource conditions affect effectiveness of DPs, including livelihood dependence on resources | Resource dependence, in particular economic dependence - high dependence increases likelihood of overexploitation |
| **21 Group size** | Table 1 Number of resource users Tens to thousands, Millions to billions; challenges in applying Ostrom design principle of user participation in creating rules "size of appropriating group" |  | Group size and heterogeneity (p. 12) | Small group and homogenous |
| **22 Group homogeneity vs. heterogeneity** | Table 1 Cultural and institutional homogeneity Local = Homogeneous and Global = Heterogeneous; and p. 217 | heterogeneity can be a problem at larger scale (p. 171 and 180) | Group size and heterogeneity (p. 12) | Group size and homogeneity - homogeneity fosters better collective action |