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Good Governance: A Framework for Implementing Sustainable Land Management, Applied to an Agricultural Case in Northeast-Brazil

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Abstract: Land management needs to cope with persistent environmental and societal changes. This requires functional governance systems. The purpose of this research is to develop a good governance framework for the implementation of sustainable land management. Good governance theory is extensive, although its operationalization remains difficult. We derived a set of good governance attributes from the literature: (i) the functionality of the regulatory framework, (ii) the legitimacy and accountability of the actors, (iii) the fairness and transparency of the decision-making processes, and (iv) quality control and adaptiveness. These constitute a framework which, supported by guiding questions, facilitates the evaluation of governance attributes to assess sustainable land management practices. We applied the scheme to a case study in Northeast Brazil regarding sustainable land management where biological pest control is considered to be a biodiversity-related ecosystem service. Since its adoption often falls short of expectations, we scrutinized its governance system. First, experts answered our guiding questions, and second, we involved local stakeholders in the discussion of good governance attributes through the participatory approach of constellation analysis. Trust in agricultural consultants and issues of the practical application of pest control turned out to be crucial. The workshop participants requested a model farm to build more trust and experience. There was considerable demand for policy at the national planning level to formulate and monitor the content of the agricultural advisory program. Our conceptualized framework of good governance questions provides systematization for planning and steering the implementation of sustainable land management practices.

Keywords: good governance; biological pest control; constellation analysis; irrigated agriculture; sustainable land management; stakeholder involvement; Brazil

1. Introduction

Sustainable land and water management aims for a balance between the use and conservation of natural resources. In a larger area—e.g., an entire catchment—different stakeholders may make decisions that contradict each other. If a neighborly negotiation is no longer possible, a formal or informal regulatory system on this level is needed to resolve conflicting objectives. The decisions at one level often affect conditions and decisions at other levels and sectors. In democratic systems, governance structures increasingly include societal actors besides governmental organizations at multiple levels. We are here primarily interested in the environmental governance process. Process and content are

interlinked, and we consider the quality of both to be pivotal. Our focus on process attributes is based on the assumption that the process conditions must first improve before the associated thematic evaluation can take place in a comprehensive manner [1]. Hence, we focus on the attributes that promote the making of fair and just decisions for water and land management. Nevertheless, these cannot be scrutinized completely separately from other governance attributes, such as the efficient and sustainable use of resources.

All governance efforts, we postulate, should be directed towards the common good. Effective governance can resolve the allocation of resources and their quantities [2] and is also about preserving and promoting the quality of resources, as well as avoiding or limiting negative impacts. Therefore, governance processes are deeply political, particularly where rivalries for limited resources prevail. Governance also invariably includes a kind of self-governance by social actors and public–private partnerships in social conflicts, which leads to new forms of policy on multiple levels [3]. The control of prevention, mitigation, and adaptation by societies in response to environmental changes can be described as a general objective of governance [4,5]. Good governance means on the one hand achieving this objective, and on the other hand that the processes comply with the attributes imposed on them, such as inclusion, accountability, and participation [2]. The systems of governance usually reflect the political and cultural circumstances at national, regional and local levels. Optimum competence is ensured through relationships and networks between different sectors, the government and civil society. Therefore, good governance addresses the efficient use of resources and the responsible exertion of power along with participation, consensus-oriented and transparent processes, and effective and sustainable performance [2].

A significant part of governance is the design of policies and strategies, their adoption and monitoring, and adaptive analysis to ultimately overcome weaknesses [6], in this case within processes of sustainable land management. Good governance of natural resources aims, among other things, to achieve an equitable and ecologically compatible distribution and use of resources such as water. This entails providing access to water for all social classes with transparent decision-making and fair participation mechanisms [7]. This necessitates an institutional framework with an infrastructure and legal capacity [8]. Environmental governance links the political sphere with the requisite research on sustainability and environmental justice [9,10]. Grindle [11] and Gisselquist [12] emphasize good governance as an essential driver of sustainable development and poverty reduction.

For the specific case of Brazil, it has been said that it is a governance laboratory [13]. This is primarily due to several innovations enacted by the government (e.g., agrarian reform, the Forest Code, and the Water Act), social movements, and the large quantity of natural resources which have attracted global interest and foreign investors. In the São Francisco watershed, a committee was set up in which the participation of civil society, water users and other water-related sectors allows a joint debate [14,15]. While this example of participation addresses governance issues of accountability and legitimacy [16], there are several difficulties worldwide in the participation of such committees [17–19]. Studies by Rasul and Sharma [20] and Villamayor-Tomas et al. [21] revealed difficulties in terms of justice, equality and transparency in decisions in the water–energy–food nexus. Molle and Berkoff [22] described such difficulties pertaining to the value of water, for example, in irrigated agriculture. Many authors have addressed the good governance concept [11,23,24], but the challenge remains putting theory into practice. The purpose of the paper is to develop and exemplarily apply a framework of good governance attributes as a generalizable format for the implementation of innovative practices of sustainable land management (SLM). In our study, we test good governance attributes for decision-making processes for biological pest control as case study. At the local level, a transdisciplinary approach has been taken to reveal perceptions and knowledge related to sustainable farming practices.

Our research questions were as follows: Which attributes can we distinguish to frame implementation processes of novel practices? How far are the derived attributes of good governance relevant for addressees of novel practices? How can the attributes be used in the process of the implementation of SLM practices?

2. Literature Review

2.1. The SLM Practice: Biological Pest Control in Irrigated Farming

The semi-arid northeastern region of Brazil, our study region, is characterized by recurrent and prolonged droughts. Nevertheless, the irrigated farming of fruit crops in the São Francisco Valley, partly for export production, with a significantly high consumption of pesticides [13,25], constitutes one of the largest fruit growing regions in Latin America [26]. The costs of irrigation are only worthwhile if the returns are high. This is generally achieved through the selection of cash crops in combination with extensive use of fertilizers and pesticides [13]. Chemical effects on the water, soil and biodiversity and entire ecosystems are discussed repeatedly as negative outcomes [27,28], as are consequences for human health [29].

However, in the production systems of the study region, the use of herbicides and insecticides is not necessarily improving yields [30]. Moreover, chemical pesticide-free land management is a sustainable alternative, which can sustain the provision of ecosystem services (ES). For example, biological pest control has the potential to reduce pesticide use by limiting the expansion of pest species and thus reducing yield losses [31]. Besides other faunal groups, amphibians and reptiles have great potential to serve as biocontrol agents of several arthropod pest species and therefore play a pivotal role in the functioning of ecosystems [32–34]. In contrast, arthropod pests are known to constitute a serious threat to food security and the economy, even with pesticide use [35].

While numerous studies reveal negative effects of several pesticides on anuran tadpoles in laboratory experiments [36–40], only a few field studies are available. However, the impact of pesticides on natural environments and the demands of amphibians for structural habitat heterogeneity in agricultural areas [41] probably affect the potential of amphibians to serve as biocontrol agents. Due to the complex interrelationships of biodiversity and ES, promoting diversity also promotes several ES. For example, weed diversity in crop plantations has the potential for an enhanced use of complementary plant–plant interactions [42], reduces the likelihood of insect herbivores to find and stay on host plants [43], or promotes biocontrol agents [44].

Whereas many local farmers have difficulties understanding the relationships between management and ecological processes promoted through biodiversity (personal conversation), they were aware of the function of frogs and toads as biocontrol agents of several arthropod pest species, although little is done to promote this ecosystem service to guarantee more efficient pest control [45]. Hence, we decided to focus on 'biological pest control' as an SLM practice, which promotes various ES. The SLM practice of biological pest control entails fostering habitats of pest predators in and around irrigated agricultural plots to reduce pest species. In order to provide adequate habitats for these useful faunal populations, farmers must refrain from their usual management strategies—for instance, indiscriminately removing vegetation and applying chemical pesticides—and adopt a new management system.

2.2. Good Governance Attributes for Implementing SLM Practices

Implementing SLM practices requires knowledge about possible economic benefits or losses, legalities, as well as existing factors such as pests, diseases, and plant biodiversity. Technical elements, such as the existence and quality of drainage systems, are important considerations, especially where irrigation is being used.

At this juncture, good governance is crucial for implementing innovative practices in a transparent manner, emphasizing adaptiveness and quality control. It is likewise necessary to assess the contextual factors of the SLM practices (e.g., the purpose and possible effects of SLM practice, the functions and ecosystem services involved, external effects). The potential for conflicts arising from the content and the demands of the intended change should be assessed in advance [11], providing clues as to what is needed to implement good governance.

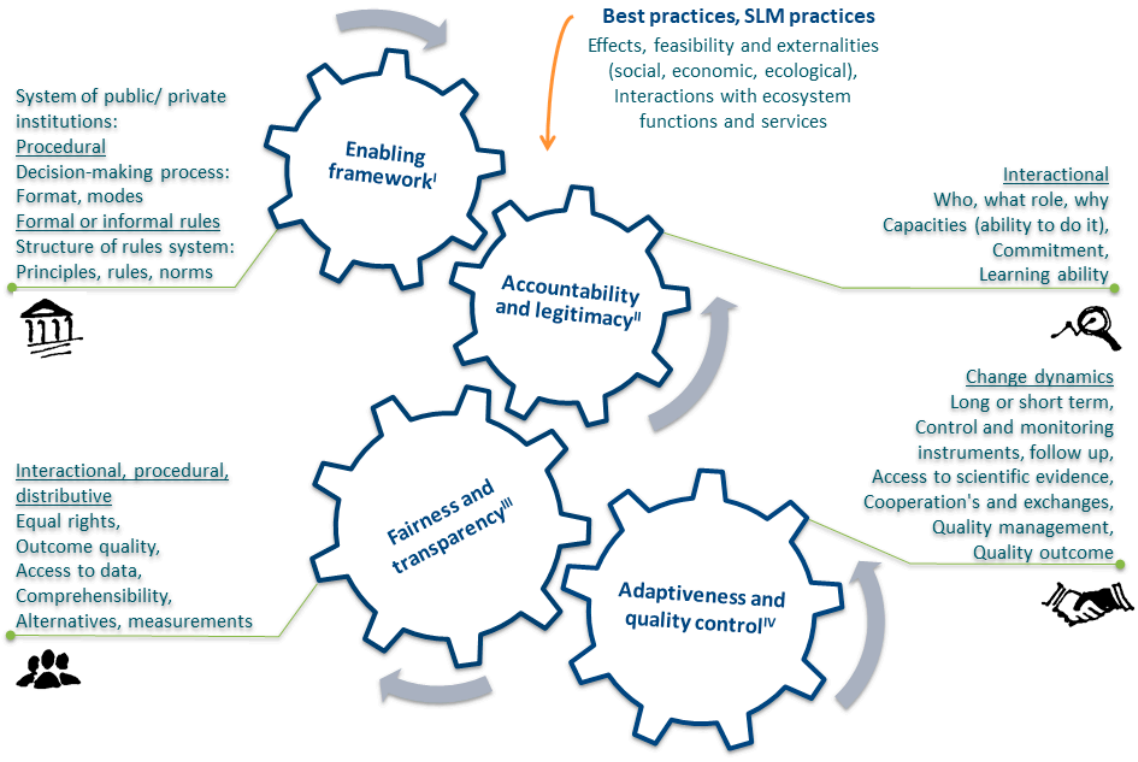
We first provide an overview of the conceptual definition and perception of good governance attributes based on the literature. Keywords used in databases such as Scopus were "good governance"

in combination with "accountability, fairness, justice, transparency"; "watershed, sustainability, Brazil, São Francisco, environment"; and "good water governance, watershed governance, sustainable governance, environmental governance". We then formulated questions to guide the evaluation of governance.

Good governance needs to be treated as a multifaceted concept. Various governance attributes have been proposed for SLM implementation, from which several attributes also apply beyond SLM. Biermann, Biermann et al., and Mattor et al. [3,4,46] describe governance in a matrix of six "As": architecture, agency, adaptiveness, accountability, and allocation & access. Our condensed framework features four main categories ((1) enabling framework, (2) accountability & legitimacy, (3) fairness & transparency, and (4) adaptiveness & quality control) involving the abovementioned "As", which we will explain further.

2.2.1. Enabling Framework

In the concept of the six "As", Biermann et al. [5] consider "architecture" as the overarching system of public and private institutions that are relevant and active in a range of world politics. This includes organizations, regimes and other standards (e.g., principles or regulation mechanisms) as well as the decision-making processes. Grindle, Ostrom and Mattor et al. [11,46,47] describe the formal and informal system and the structure of the decision-making process: How is the decision-making process conducted, and what is the formal and informal legal framework? Are laws and regulations suitable for the governance case? Who is involved in the process and in what role? The good governance system is embedded and is stimulated by an enabling framework. In this sense, this gear (Figure 1) implies the starting operation; it is meant to set all the other wheels in motion.



I. Modified from: Biermann et al. 2009; Biermann et al. 2010; Mattor et al. 2014
II. Grindle 2007; Ostrom 2009; Biermann et al. 2010; Engle et al. 2010; Biermann et al. 2011
III. Singh 2006; Biermann et al. 2011; Grigg 2011; Mitchell 2011, Ostrom 2011; Venot et al. 2013; Gross et al. 2014; Mattor et al. 2014; van Laerhoven 2014
IV. Pahl-Wostl 2009; Biermann et al. 2010; Engle and Lemos 2011; Mattor et al. 2014
SLM: Sustainable Land Management

Figure 1. Graphical abstract: good governance in decision-making processes for sustainable land management (SLM).

2.2.2. Accountability and Legitimacy

Governance bound to the regulations introduced above must be legitimate and accountable; our second dimension. Accountability and legitimacy are connected to the following questions: Who is responsible and how do they address accountability? Do those who are accountable accept this responsibility [48]? Biermann and Gupta [48] distinguish four dimensions which must be considered:

- Normative: There are sufficiently clarified norms of behavior;
- Relational: There is a connection between those who demand accountability to those from whom it is required;
- Decisional: The decision of those who consider the accountability regarding whether the standards have been complied with;
- Behavioral: Deviant behavior can be sanctioned.

The same authors also assume that legitimacy and accountability improve with the inclusion of non-state actors. Governance institutions have to be designed so that they allow a balanced consideration of different perspectives. Venot and Clement [49] mention that the role of the stakeholders and the role of the authorities have to be discussed and defined, as well as the legitimacy of the participants as a prerequisite of an enabling framework. Governance mechanisms are legitimate if they are perceived and respected in their policy objectives and respectively established norms. This output legitimacy is an essential criterion of governance effectiveness [48]. Questions about the existing capacity and the guarantee of capacity-building in the system, including in the institutions and organizations, play a role here, as with the roles of the public and private sector and civil society within participation processes on local environmental governance [50].

Biermann et al. [3] emphasize the agents, referring to the informal actor-associations or key actors in renewal processes, and how they are integrated into the decision-making process and how they mobilize. For example, key actors can induce changes as brokers (positive) or opinion enforcers (negative).

2.2.3. Fairness and Transparency

Allocation and access refer to fair and just outcomes of decision processes, aiming for equitable distribution and access; i.e., who gets what, when, where and how. In relation to environmental governance, fairness and justice form a framework regarding decision-making, but also imply actors' interaction and accountability along with the equitable distribution and use of resources. Therefore, we designate as a further dimension fairness and transparency. A related guiding question is as follows: How are the decision-making processes designed? Gross and Dumaresq [51] describe this as interactional justice—the way people treat each other and how they are treated by the authorities. Procedural justice in the decision process begs the following questions: Is participation possible? Is there enough comprehensible information for the involved participants? Will questions be answered? Is there transparency in decision-making and is the appropriate information disclosed? Is access to information guaranteed? Evidence is also important as pertains to the observance of the underlying value system [7].

Mitchell [52] distinguishes between the transparency of governance and transparency for governance. The former is aimed at increasing accountability while the second aims to change the negative conduct of a policy. Actors convey transparency, provide information, receive information, and address other actors. Efforts to achieve transparency, in this sense, are measures to reduce asymmetric information structures. This in turn leads to the individuals concerned using transparency to change the behavior of decision-makers (disclosure-based: targeted actors = government or public/private sectors; information recipients = population) or for general information provision. Such a process lends itself to a change in behavior of the parties concerned (education-based: targeted actors = information recipients).

Transparency involves the actors' aims and objectives. The standards and legitimacy of those objectives include accountability and exposure to the consequences of the alternatives. For Biermann and Gupta [48], the transparency of governance processes and findings is a prerequisite for a legitimate and accountable system of governance. Such a system requires different transparency policies depending on the respective targets, which produce accountability and legitimacy in different ways. The participation of different population groups or minorities is also a requirement due to fairness for access to participation processes as well as to information. Do women participate [53] and local cultural groups such as indigenous tribes? How and to what extent can civil society be mobilized? Furthermore, can distributive justice be identified? What is needed to achieve equitable distribution and access to resources for all involved parties [46,51]?

2.2.4. Adaptiveness

Pahl-Wostl, Biermann et al. and Mattor et al. [3,46,54] recognize adaptiveness as another pertinent criterion for good governance. The term adaptiveness (adaptivity) includes controlling the adaptation to socio-ecological changes and the processes of change in the context of governance systems. A quality control system with controlling and monitoring instruments could also ensure sustainability. Engle and Lemos [8] describe seven institutional governance indicators of adaptivity:

1. Representation, established accountability, and the legitimacy of organizational decisions;
2. Participation processes and forms (the more participation, the more adaptive);
3. Knowledge and use of information;
4. Equality and knowledge availability, e.g., distribution of power between stakeholders, information and resource access, freedom of expression;
5. Flexibility and aptitude of an organization (also depends on representation and participation opportunities, e.g., equal decision-making processes);
6. Commitment of the stakeholders regarding the management model;
7. Networks: The different levels and interactions, and negotiations between organizations and other stakeholders (i.e., social capital at these levels).

The most important elements of adaptability are the mechanisms and organizations by which political actors take environmental action and control results [55]. A balance must be achieved between equality in decision-making, representation, level of participation, and the availability of knowledge. The sizes of the fairness and the adaptiveness gears refer to their long-term effects. These have, once they are set in motion, the power to drive the system ahead through good governance.

To ensure active implementation, legal frameworks related to planning should be conducive. Good governance can only be achieved through the participation of stakeholders from affected groups and sectors along with adaptive and strategic methods of implementation. Fairness, transparency and quality control are further aspects to ultimately achieve a standard of good governance in SLM. Since the governance attributes are interlocked (assuming that all attributes have to be addressed), our framework displays a set of four gears which work only in cooperation with one another. An order of rotation is secondary—the impulse can start from every attribute—but we consider the structure of the rules system, either formal or informal, and the format of the decision-making as crucial to enable democratic systems. This does not presuppose that the system must be designed top-down. Likewise, impulses can be guided from the bottom up. This conveys the strength of democracy. If one component has not been addressed sufficiently, then the rest cannot rotate efficiently (Figure 1). A fair and transparent process is not given when the framework (e.g., format, modes, rules) is missing. In democratic systems, the framework can archive a fair process. We are particularly interested in the decision-making processes in the field of SLM. For this reason, we scrutinize the relevant ecosystem services and the innovative practices to use and develop them sustainably: What resource and ecosystem is affected by the SLM practice and for what purpose? Which ecosystem functions and services are involved? What are the possible (side) effects?

3. Material and Methods

3.1. The Good Governance Template for Implementing Sustainable Land Management

For the implementation of SLM practice, we have operationalized the governance attributes by presenting indicator questions (Table S1, Supplementary Material, left column). We derived the questions from the literature as presented in the literature review. The indicator questions guide the user through the different dimensions of good governance. Answering all questions for a specific case or situation leads to a comprehensive overview of the case at hand. Knowledge gaps become apparent when the answers to the questions are incomplete. We tested the approach by using biological pest control as an example of a SLM innovative practice. The different sections of the template disclose (i) concrete and practical steps that need to be implemented; (ii) the comprehensiveness and fit of the legislation, handling, and operation, including the roles of actors; (iii) understanding which interest groups/interested parties are in favor or against the regulations in place; (iv) information about fairness and transparency, including who has the necessary information and what data are needed; and (v) regarding adaptation over time, what data should be collected and how should it be made available? How is success measured? Who will do the evaluation and how?

The latter were tested on a concrete example of the scenario of biological pest control in irrigated agriculture in our study region by experts of environmental planning and biology. An expert panel answered the questions according to the template (Table S1, Supplementary Material). It became clear when completing the table that there were knowledge gaps in issues such as the current implementation of the legal framework with respect to irrigated agriculture. Since a range of different stakeholders appeared to be relevant for inclusion, an interactive bridging method was selected to moderate the process. Therefore, a second round with local stakeholders was designed as a participatory approach; i.e., constellation analysis. The constellation process has been organized around the four thematic "gears" of good governance, with the guiding questions of the template as a basis for interaction.

3.2. Participatory Approach

We applied the good governance framework in the frame of a comprehensive, collaborative project in Brazil [56,57]. The scientific project aimed at analyzing functions, challenges and opportunities for the more sustainable management of land and water resources in the São Francisco River Basin in the aftermath of establishing the large Itaparica Reservoir. Several farmers had been relocated in public irrigation schemes as a compensation for flooding their former land. We collaborated with farmers and other stakeholders in the semi-arid municipalities north of the reservoir (Figure 2). Compare this with Rodorff et al. [58] for more details about the situation in terms of planning, implementation and follow-up of the reservoir.

For the purpose of this study, we invited stakeholders to constellation analysis [59] workshops (Table S2 of Supplementary Material). According to the results of administering our guiding questions to the expert panel, we selected participants from the public and private sector, from civil society, and from governmental agencies. The audience was mixed in terms of gender and educational background. In the qualitative constellation analysis [59], participants map relevant actors in relation to each other, along with particular elements of the natural environment, technical objects and the regulatory formal and informal framework. The group members jointly identify, discuss and arrange such elements visually according to their significance and interrelationships (see Figures 3 and 4 in Section 3).

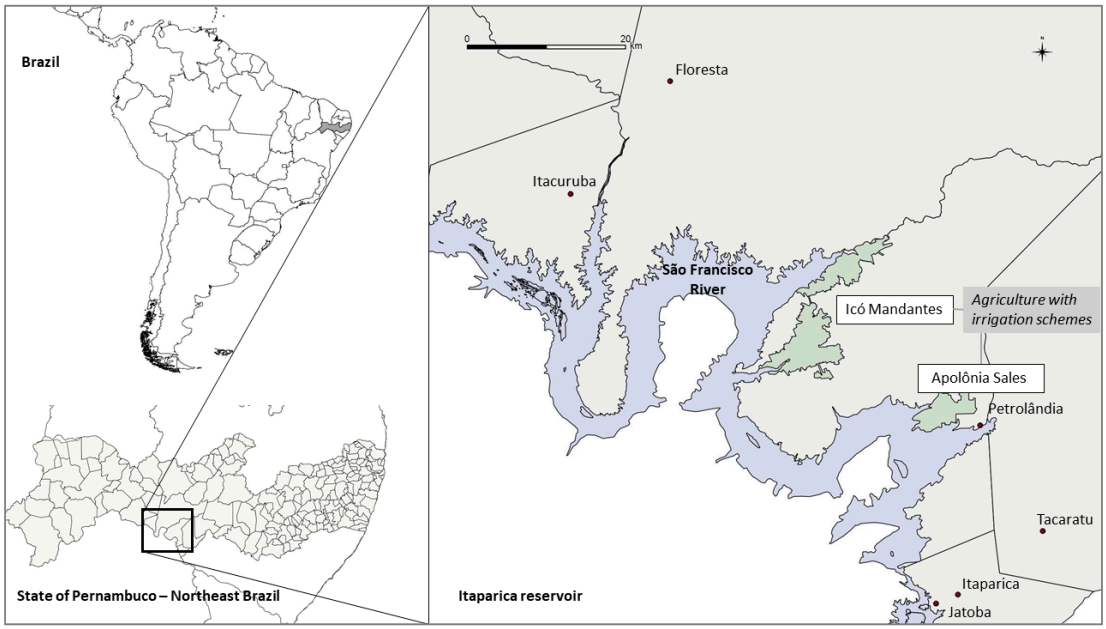


Figure 2. The study location: public irrigation schemes in three municipalities in Pernambuco state, north of the Itaparica Reservoir, which is part of the São Francisco River.

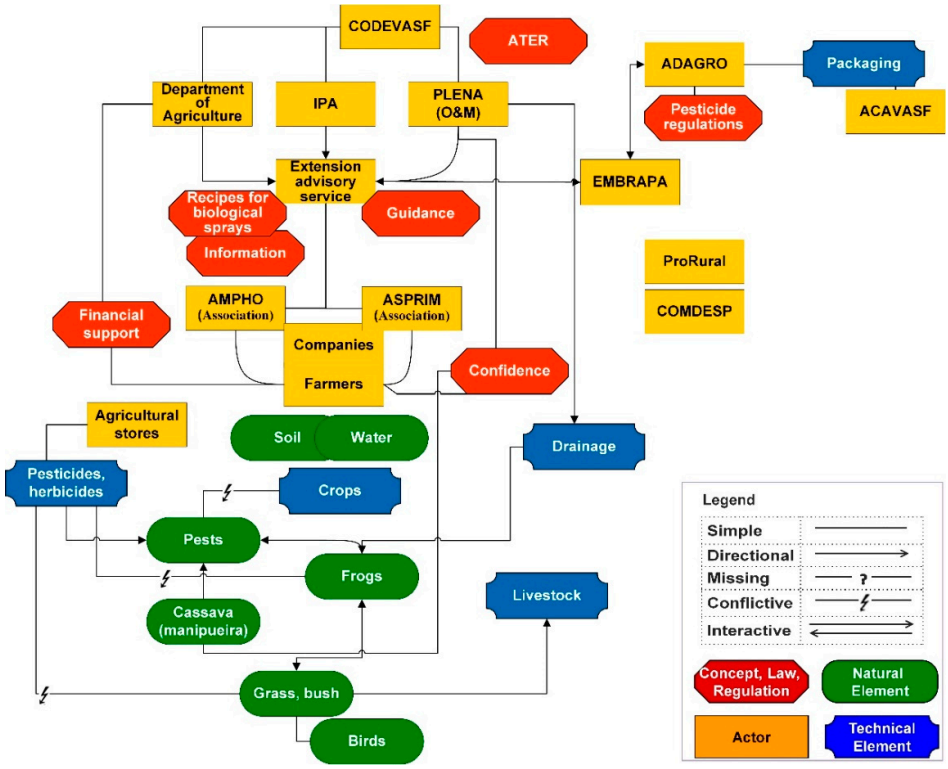


Figure 3. Inhibiting and supporting factors for implementing biological pest control. First constellation analysis workshop with farmers from the Icó-Mandantes irrigation project, 2016. Abbreviations: ACAVASF: association of agricultural trade of the São Francisco Valley; ADAGRO: livestock and crop health inspection agency, Pernambuco; AMPHO: association of women producers of organic vegetables; ASPRIM: farmer association of the Icó-Mandantes irrigated perimeter; ATER: farmer advisory program; CODEVASF: São Francisco and Parnaíba valley development company; COMDESP: municipal council of sustainable development, Petrolândia; IPA: agronomic institute of Pernambuco; EMBRAPA: Brazilian corporation for agricultural research; PLENA: company providing support for the use and maintenance of the irrigation infrastructure; ProRural: state program for sustaining small-scale farming.

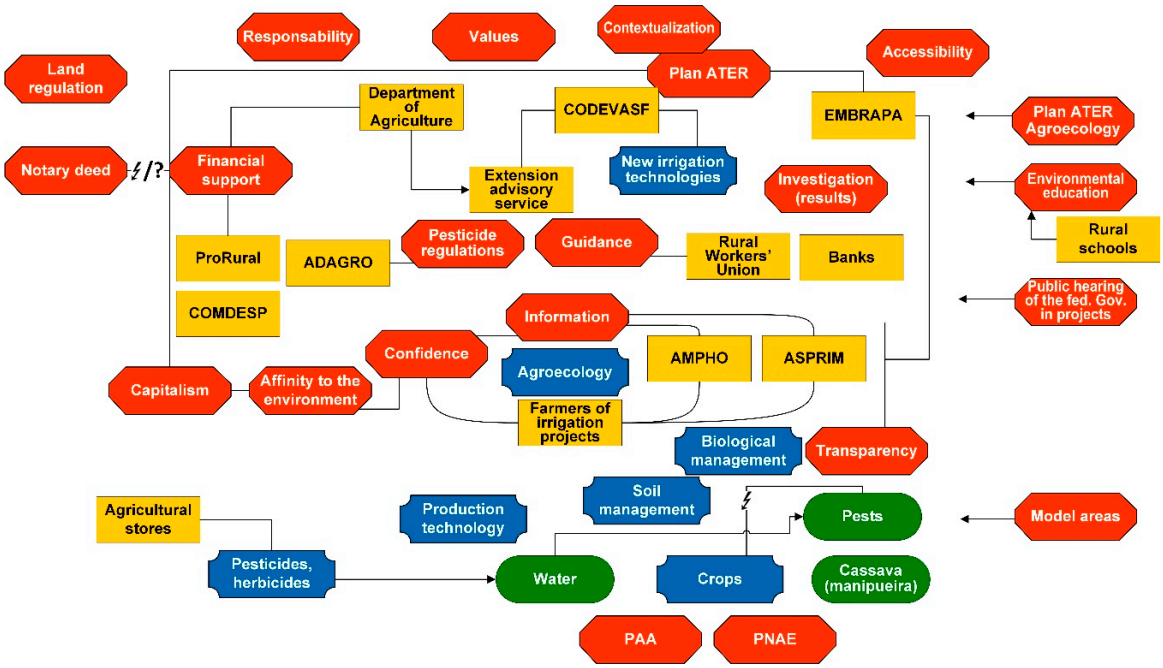


Figure 4. Essential factors for and against the promotion and establishment of biological pest control. Second constellation analysis workshop with stakeholders in the City of Petrolândia, 2016. Abbreviations: PAA: food acquisition program; PNAE: national school feeding program.

A first workshop was conducted in the municipality of Petrolândia, at the administrative center of the irrigation scheme Icó-Mandantes, and lasted about 2 h. The group of 8 people (2 women and 6 men) was made aware of the method and was introduced to the topic of innovative pest control in agriculture. The involved parties were mainly farmers (see Table S2). Three scientists guided the workshop as facilitators. A second workshop was conducted in the city of Petrolândia. The foregoing constellation was introduced and redefined on a whiteboard film on the wall and together developed into a new image. The group of participants included 12 people, among which were 3 women and 9 men. Farmers, representatives of NGOs, development organizations, and members from the ASPRIM, AMPHO, and ARBIO associations attended the workshop (Table S2), along with the additional team of three scientists. The workshop lasted for 2.5 h. Holding two workshops was conducive to better give voice to farmers, in particular to women and young farmers (workshop 1), and then to involve further experts, practitioners and representatives of organizations (workshop 2). A closer connection was achieved by inviting farmers from the first workshop to the second workshop.

In the course of the constellation analysis workshops, our template of guiding questions served to integrate good governance attributes. The participants primarily emphasized accountability and values. This included quality, access to data and information, mode of transmission, general conditions, trust, and transparency. Subsequently, the constellation was digitized with the Microsoft Visio program 2013 and finally transcribed. Notes, observations, and comments provided by the participants and additional research served to inform the transcription. The constellation was extended during the second workshop with additional administrative content and clear responsibilities and recommendations for successful implementation.

4. Results

4.1. The Template for the Implementation of SLM Practices Framed by Good Governance

Our template for the implementation of SLM practices translates the scheme of Figure 1 into a list of indicator questions (Supplementary Material 1, Table S1). In the first section, we scrutinized the SLM practice that as meant to be implemented (compare Figure 1, best practices, top right). The

resource and ecosystem of our example are the anurans in irrigated farming, targeting the ecosystem service biological pest control, which requires adequate habitats for the biocontrol agents. While many positive external effects are to be expected, there might be pests that cannot be controlled with natural predators and there might be predation on the anurans by other animals.

The following section of the template is dedicated to the "enabling framework" and "accountability & legitimacy" gears (compare Figure 1). Although there is a legal framework on different levels, the use of agrochemicals often takes place without the necessary precautions. Apparently, safety conditions are not sufficiently understood, and empty containers are left on site instead of being returned to the shops. There are rumors about illegally sold unauthorized chemical products. While the agricultural extension service has been suspended in the irrigation schemes (by law, small farmers are entitled to receive advice), the agricultural shops have widely filled that gap with their own interests. Some farmers raised health concerns regarding the application of agrochemicals. The system foresees a national strategy for advisory content, whereas the strategy development appears to still be in the planning phase. There are several organized agents besides the actors of the public and private sector and of the civil society; nevertheless, few farmers are actively organized in associations or cooperatives. The question is finally not only whether the rules are appropriate, but whether there is enough enforcement of the rules and commitment at all levels. There are clear gaps in capacity, responsibility and legitimacy.

The next section of the template deals with fairness and transparency. It was shown that farmers have complained about advisors from other regions of Brazil who were not knowledgeable about the local condition. Some years ago, there were attempts by an association to discuss and introduce agroecological practices. However, that process was not successful, and its procedural justice could not be evaluated. Information and knowledge are shared amongst farmers mostly by word of mouth. Local bloggers have gained visibility in the last years and can be considered major points for information exchange in the region. Some agricultural research organizations and universities study plant-based pesticides and other management alternatives to agrochemicals, although their results hardly reach the farmers. It is unclear to what extent other levels of governance are aware of such information. Finally, there are a few local owners of recipes for plant-based pesticides with local ingredients. A major input for the preparation of such mixtures is labor, which can be a limiting factor.

The last section of the template is devoted to adaptiveness and quality control. The answers here are hypothetical since biological pest control is currently not being implemented. It would be important to implement comprehensive monitoring and reporting of the existence of amphibians, while farmers need to learn to closely observe their crop stands, parallel habitats and the existence of pests and predators. Students of the local institutions of higher education could be instrumental in learning and applying their knowledge in cooperation with farmers. Access to material for constructing simple insect traps for observation must be assured; for instance, through local supermarkets. Severe droughts remain a major threat, and maintaining at least a few artificial water puddles is necessary to safeguard the survival of the predators.

4.2. Participatory Evaluation of Good Governance Attributes towards Sustainable Land Management

4.2.1. Farmers' Views on the Implementation of Biological Pest Control

The main driver of the first constellation (Figure 3) is the practice of alternative pest control using a combination of promoting habitats for amphibians as biocontrol agents while combating remaining pests using alternative products to replace harmful pesticides. Farmers contributed with their knowledge of organic self-made pesticides based on the extract of manioc roots or chili pepper. This was complemented with research results on frogs and toads (anurans) serving as predators of arthropod pest species in agriculture once they adapt to the habitat. Relevant habitats include drainage areas, border plants, and small ponds or puddles next to vegetation.

An important result of this workshop is defining the role of actors. Farmers are in the center of the constellation; they depend on companies and traders as well as soil and water. To some extent,

associations also represent the economic and environmental interests of farmers (here, AMPHO and ASPRIM). Important elements for implementation include confidence, information and orientation, along with financial support. Major players were named in this regard during the workshop; for example, the Department of Agriculture and Environment provides financial and technical support. The agronomic institute of Pernambuco (IPA) and PLENA, with the latter financed by the development company CODEVASF, also contribute to providing technical support. Programs such as the agricultural advisory system (ATER) act as drivers. The latter was stipulated for family farming within the National Rural Policy for Agricultural Advice (PNATER) in 2003 and obligates certain organizations to provide technical advice [60]. The national research corporation EMBRAPA was also identified in this workshop as a relevant actor due to their contribution of technical support and advice. ProRural is a government program of Pernambuco State, which focuses on improving the quality of life and income generation in rural communities. They can mobilize financial resources from the World Bank and other international organizations. Such agencies participate in joint actions with NGOs, municipalities, religious organizations, cooperatives and governmental organizations such as the livestock and crop health inspection agency (ADAGRO) and the IPA. COMDESP is the municipal council of sustainable development of Petrolândia, which was established around 2001 from ProRural. Its effectiveness remained unclear at the time of the study as this council had no further planned activities.

Best practices (in the following, compare with Table S1, Supplementary Material) are depicted as a combination of single practices. Negative aspects were not additionally queried within the timeframe of the workshop. Regarding accountability, actors and roles are shown in relation to one another. Capacity and capacity building were only indirectly mentioned by this stakeholder group, namely via information needs. Companies, associations, agricultural advisory services and agricultural stores influence farmers' decisions. Values and responsibilities arise from their own actions and experience, as well as advisory bodies and associations of farmers. The constellation has been developed with a focus on actors, which represent drivers of the establishment and of the acceptance of the studied SLM practice. An important criterion of governance is transparency and access to both information and resources. Access to information and work practices can be given through technical advice and support. Technical support serves not only to inform farmers, but also to give practical help in the form of workshops and on-site visits with detailed instructions and opportunities for controversial debate. Furthermore, financial support is a precondition for access to different innovative practices, management strategies, and technologies.

A guarantee for the quality of information and practices can be provided through the research corporation EMBRAPA. A mutually beneficial relationship is demonstrated here with the technical advice service and ADAGRO. In contrast, the delivery of advisory services is undertaken by several actors: The Department of Agriculture and Environment, Agronomic Institute of Pernambuco (IPA), PLENA (although they only have a mandate for irrigation infrastructure), and EMBRAPA. CODEVASF is closely linked to these actors in a different way, as the regional development agency. A clear deficit can be identified in the region regarding the continuity of the actors' activities, due to changes in staff and the exchange of whole contracted advisory companies [61]; people who were identified as key drivers by the participants. This can make it difficult to build a relationship of trust. ADAGRO was viewed by participants as acting in line with EMBRAPA and the legal promotion of herbicides and pesticides.

The relational positions of natural and technical elements summarize the cycle of sustainable land management practices in terms of environmental advantages. The beneficial frogs, toads, insects and birds are negatively affected by the toxic agents, along with their habitats. Important measures to conserve the habitats of pest-controlling fauna include the preservation and promotion of drainage ditches, habitats formed by different layers of vegetation, and irrigation puddles. Additional organic compounds can be part of the alternative in combination with frogs and toads as pest control agents, but harmful pesticides should be avoided. As an example, organic self-made pesticides based on the extract of manioc roots may be the most accessible for those in the region as manioc cultivation

is very common. Furthermore, one participating farmer already had several years of experience with this mixture. Compared to common insecticides, this organic, self-made product works as a repellent and seems to have no negative effect on frogs and toads according to personal communication with farmers. Moderate livestock grazing instead of herbicide application avoids the introduction of generally harmful chemicals and is also frog-friendly.

4.2.2. A Multi-Stakeholder Perspective on the Implementation of Biological Pest Control

The second constellation workshop brought agroecology practitioners together with other stakeholders at the municipal level (Figure 4, Table S2). Information and trust were crucial for stakeholders, especially in building affinity with the environment and its ecosystems. Practical guidance and information were depicted here at the center of the constellation. As responsible actors, the rural workers' union and banks were named as well as organizations providing technical assistance (through CODEVASF and the Department of Agriculture).

In Figure 4, ADAGRO stands between ProRural and COMDESP and controls the compliance with regulations for herbicide and pesticide application. These are relevant to the technical assistance and support providers as practical guidance. Capitalism was mentioned here by the participants as the driver for production techniques seeking short-term benefits, often indiscriminately supported by the agricultural advisory program, with a low level of concern for the environment and the values of many farmers and actors. The agricultural advisory plan is also connected to the EMBRAPA research corporation, which is tasked with transparently communicating research results pertaining to biological and soil management. Financial support comes from the Department of Agriculture and development-promoting institutions such as ProRural. There are difficulties encountered—e.g., due to the lack of land titles that inhibit many farmers from accessing funds—which could sustain new practices.

Within the constellation process, various actions have been proposed and are illustrated at the edge of the constellation by the incorporation of the following elements: the inclusion of agroecology in the agricultural advisory plan, environmental education (particularly in rural schools and public hearings held by the federal government in the project areas). So far, farmers have gained experience with applying chemical pesticide products but less so with alternative methods from organic farming.

Within the process of creating the constellation, aspects of governance such as access to data, information, financing, and technologies were identified and integrated. Furthermore, transparency, accountability, values, confidence, and trust were parts of the constellation and respective discussion. The identified best practices are the engine of the constellation but are not explored in depth, being considered in their environmental state. The group discussed how the SLM practices and access to them could be assured, and what conditions must be created in the process of good governance. Ultimately, these include actors, their values, relationships, and regulatory components such as concepts, rules and ideals.

The focus of discussions with participants was the lack of guidance and advice given to farmers to identify their responsibility towards their products and agricultural production. Technical assistance is an important component for all participants, but it is important to answer whether it is currently fair and communicates the right information. Is there any quality control of information? According to participants, the information provided is neither enough nor adequate and there are no provisions for adaptability. Justifications for the non-disclosed evidence in the annual reports and problems over the years at the decision-making level were questioned. Agricultural assistance has either been discontinued in recent years or has not been regularly maintained. The capacity to deliver such assistance was insufficient and there was little consultation, while subsidies were rare.

Additionally, the agricultural advisory program was perceived as not making a substantial distinction between irrigated and non-irrigated areas. A clearer proposal of the program's content is required of the Ministry of Agricultural Development (today transferred to the Special Secretariat for Family Agriculture and Agrarian Development) [62]. Agro-ecological practices are rarely pursued by

the regional development agency, which was contracting companies for agricultural advice to farmers in public irrigation projects.

Maintenance of drainage installations was discontinued in the last 5 years preceding the workshops, which made irrigation practices less efficient. Salinization of agricultural land occurred, resulting from poor drainage systems and the mishandling of irrigation. Comments of participants were as follows: "The health of the family is not considered; it's all about production and consumption." This raises the question of whether farmers are at least partially to blame for this situation. Participants commented: "They have their own future accepted and signed in contracts. However, many are not able even to read or write. That's why they depend on [accessible] information and support".

The situational context seen by the participants is mainly related to the agricultural advisory plan of the national government, which has been referred to by some participants as the "Bible of agriculture" in Brazil. To our knowledge, a concrete plan does not even exist, and therefore standard practices of industrial agriculture are being promoted (i.e., the application of costly inputs such as mineral fertilizer, pesticides and herbicides) without assessing alternatives. Existing research by EMBRAPA on environmentally-friendly and low-cost practices could be highly relevant but so far has hardly entered the advisory content. The contracted advisory service providers should consider the different regional realities before implementing services. Unfortunately, the lowest bidder gets the contract; companies may originate from a completely different social and environmental background. Moreover, input from the local research organizations is missing, and the technical advisory service is not updated with the newest local research results. EMBRAPA and IPA are two such organizations responsible for conducting studies and managing dialogs.

Public hearings concerning the irrigation projects and further agricultural development in the region, held by the public sector, should take place in areas where the irrigation projects are located as well, facilitating the exchange of information in these places. Social movements are also identified as an essential driver of change. As far as financial resources are concerned, banks are not free to lend money to invest in new forms of agriculture when the farmer has failed to obtain a land deed. This is often still the case in the region. We summarize the main barriers to adopting sustainable practices as follows:

- Lack of awareness of the farmers, with restricted ability to get information and put it into practice;
- Absence of technical advice that supports locally adapted farming practices;
- Missing dialog and transfer of information and results between research, the advisory program and practice.

5. Discussion

The conceptual framing of governance attributes and the selection of guiding questions furthers the implementation process. In our case study, answering the questions allows for a breakdown of existing good governance attributes and reveals which aspects are lacking (see template in Table S1 of Supplementary Material). We used a two-step procedure. The first step consisted of communication with experts, and the second contained transdisciplinary and participatory workshops. Lamarque et al. [63] confirm the importance of stakeholders' perceptions and environmental attitudes for the effective implementation of practices securing ecosystem services. Moreover, complex transitions, such as the large-scale implementation of biological pest control, require coordination to address and resolve farmers' hindrances [64].

For practical reasons, we condensed the many good governance attributes into four interacting "gear-wheels": the arena (an enabling framework as the basis within informal and formal rules); the responsible actor (accountability and legitimacy of actors), the process quality (fairness and transparency within processes as well as the access to resources and information), and the follow-up (adaptiveness and quality control of innovative practice, processes, actors and frameworks). A best practice example showed the advantages of our novel approach for implementing sustainable land management, namely revealing interactions with ecosystem functions and services and pointing to

effects, feasibility and externalities. The depicted governance attributes should not be considered separately from each other but together, as shown in the figure of the gear train (Figure 1). Likewise, they are not to be regarded as definitive, but are related to the example and topic specified here, a particular example of sustainable land management. It became clear that not every question could be answered, and, in some cases, there was not yet enough background information on the subject. This is because experience of biological pest control in the local smallholder farming systems is scant [45].

However, the queried experts and stakeholders provided highly relevant answers to address specific local requirements. Similarly, Hattingh et al. [65] emphasize the relevance of research using a balanced set of research questions on the different dimensions of ecosystem and water resource governance. Siyambalapitiya et al. [66] conclude in their study into green growth in Asia that poorly implemented governance has a detrimental effect on the economy in the end. In this sense, an operationalizing scheme is a necessary first step to reveal and negotiate actors and tasks and to identify gaps.

5.1. Enabling Framework and Accountability

There is a current lack of action from the government on conservation and sustainable land management policy, and engaging governance frameworks such as communities, stakeholders, and institutions is a major challenge. Agricultural advice regarding irrigation should focus more on agroecology and provide information on approaches addressing regional differences. Methodological approaches from the applied research of eco-agricultural production systems (e.g., [67]) and the sustainability of products should be integrated as adaptive measures. It is recommended to adapt the formal system to enable the framework of good governance to ensure accountability [68]. The Department of Agriculture is seen as accountable to farmers and more strongly than previously considered.

Associations and farmers need to take more responsibility in acting, informing, debating, and making decisions. Accordingly, Prager [69] confirms collaborations among and between farmers and other rural stakeholders in successful agro-environmental management. For this to be possible, public hearings with officials from the public sector were mentioned by participants. They need to be held at the local level when decisions regarding water and land and their development are to be made, and this is especially true for projects involving irrigation. The current situation regarding missing land titles still represents a significant barrier to farmers having the ability to invest in new approaches and technologies. The system must change in this regard to give actors agency as well as access to emerging practices, techniques, and resources.

5.2. Adaptiveness and Quality Control

Basic environmental education needs more attention. There is a lack of rural schools with an emphasis on agricultural education. New generations do not have access to information about agriculture and horticulture through the standard educational system. Initiative should be taken on the part of local governments in conjunction with the departments of agriculture, environment, and education to work together with teachers on curricula and public outreach (e.g., environmental days). This is part of adaptiveness and quality control as well fairness because it enables access to education and best practices. Demographic changes and the growth of family size have not been considered so far and should be part of development planning and the adaptiveness of current planning [61].

A model farm could help to create awareness and trust by being transparent and showcasing different agricultural techniques such as those used in biological pest control. This must be accompanied by meetings, field visits, and supported by associations in cooperation with the relevant institutions (here, CODEVASF, EMBRAPA, IPA, agricultural advisors and the municipality). This would also help with capacity building and funding. At the same time, a model site can support quality control and foster the capacity to adapt to future external drivers such as climate change.

Often, there is a lack of communication of international scientific knowledge that could be shared through communities, partnerships, networks and exchange to foster capacities and quality control; for example, comparative studies, such as the effect of agricultural landscapes on biodiversity-based ecosystem services [70], the negative effects of pesticides on biodiversity, and the use of biological control on European farmland [71], or the comparison of conventional to organic crops [72], should be instigated.

5.3. Fairness and Transparency

Daily et al. [73] make a case for the integration of innovation, sustainable land management, and ecosystem services in decision-making. The involved actors need to take responsibility and lend their support towards enabling a framework for activities such as fair decision-making.

Also, commercialization is very important for the farmers. National programs were mentioned as significant for support. PNAE is a public policy aimed at guaranteeing and improving the nutrition of pupils in public schools and for strengthening rural production by purchasing products from local family farms. In addition, PAA is a food acquisition program and is especially important for small farmers in the context of commercialization [74].

Guidance for sustainable farming is still missing, and information is rare. Both must be improved through an enabling framework (adequate advisory plan, communication politics), the accountability of research institutes and government to farmers and associations, as well as through environmental education and media outreach. As far as our research activities are concerned, in addition to direct interaction with stakeholders, we have published a book with stakeholder-relevant research results [75] and videos (https://vimeo.com/208127666, https://vimeo.com/210405943, https://vimeo.com/208126454, https://vimeo.com/210406131), for example. The following driving and inhibiting factors were demonstrated by our workshops and give clear proposals for action:

- Agro-ecology and the values of SLM must be given more space in the agricultural advisory program;
- Clarifying the responsibilities and tasks in the agricultural advisory program is required in terms of the best practices of SLM;
- Environmental education and the understanding of sustainability issues require more emphasis as the key drivers for action;
- Environmental education must be part of school curricula, especially in rural schools;
- Accountable representatives from the public sector should participate in public hearings on irrigation projects when they are about development planning, land use planning and decisions regarding land and water;
- A pilot project or agricultural demonstration field is essential for quality control, monitoring and for building confidence in a successful implementation of a new practice, which needs to be proven ecologically and economically viable;
- Public and private research organizations need to disseminate research results adequately on local levels in a transparent and comprehensible way;
- The lack of land titles is still a conflict for the independent financing of new forms of management as well as the self-confidence of farmers and their responsibility for land use.

In order to analyze the governance attributes, they first must be expressed, understood and discussed. This can succeed via participatory processes. With the guiding questions from the template, we were able to collect knowledge gaps and identify the relevant actors involved. The pictorial and discussion-based interactive workshops with various stakeholders support the identification of challenges for a good governance-based implementation of sustainable land management practices.

The governance attributes can be differentiated into those that still have to be deployed (in our case, quality control and capacity building) and those that already play a role in the process of participation; e.g., transparency, technical input, fair treatment. Participatory processes are the key to inclusive governance. However, good governance requires a comprehensive concept for long-term

and reflective processes for the enabling framework, accountability, adaptiveness and, in particular, quality control. Finally, using the governance attributes as a framework and transparently reflecting, answering, and solving them with the help of our questionnaire template can structure and facilitate innovative practices. We are not proposing this as a blueprint for entire processes to achieve fair and just resource use and conservation; additional instruments are needed to promote cooperation and resolve ongoing conflicts, among other things. We recommend further use of the framework to test and improve its applicability and usefulness.

6. Conclusions

Good governance, and environmental governance in particular, is multi-faceted. Our focus was on the implementation process of SLM practices. We developed an approach to guide the assessment of such a governance process regarding its attributes. Our template (Supplementary Material, Table S2) is a checklist that first scrutinizes the SLM practice to be implemented and then dives into the governance attributes of its (i) enabling framework, (ii) accountability and legitimacy, (iii) fairness and transparency, and (iv) adaptiveness and quality control. Figure 1 illustrates the core template. Each attribute is sustained by guiding questions, which we derived from the literature. Answering the questions pointed us to specific gaps in the implementation of biological pest control as a test case. Trying to be rather holistic, the list of questions is quite long and requires insight and knowledge of different aspects of the SLM practice. This task could best be solved through cooperation within participatory workshops between actors from different disciplines, sectors and levels. However, this ideal is rarely found in real-world applications. This brings us back, in the case of Brazilian governance, to the inherent problem of having issued comprehensive regulations but falling short of implementing and enforcing them. Thus, our template of guiding questions can likewise be used (and further developed) by interested parties to better grasp the complex situation of implementing SLM practices and to detect bottlenecks to be solved. While the template breaks down challenges into individual questions, Figure 1 shows that the governance attributes are interconnected. The four gears work together, and there is no prioritization of attributes. This is finally also a normative question. We postulate that both the process and the outcomes count in implementing SLM practices, at least in democratic systems. The universality of this assertion should be further investigated.

Supplementary Materials: The following is available online at http://www.mdpi.com/2071-1050/11/16/4303/s1, Table S1: Template for the implementation of sustainable land management practices framed by good governance (in democratic systems); exemplarily applied to biological pest control; Table S2: Participants of the two workshops.

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