

Article

# Navigating Multiple Tensions for Engaged Praxis in a Complex Social-Ecological System

Jessica Cockburn <sup>1,\*</sup>, Carolyn (Tally) G. Palmer <sup>2</sup>, Harry Biggs <sup>3</sup> and Eureta Rosenberg <sup>1</sup>

<sup>1</sup> Environmental Learning Research Centre, Department of Education, Rhodes University, P.O. Box 94, Makhanda (Grahamstown) 6140, South Africa; E.Rosenberg@ru.ac.za

<sup>2</sup> Institute for Water Research, Rhodes University, P.O. Box 94, Makhanda (Grahamstown) 6140, South Africa; tally.palmer@ru.ac.za

<sup>3</sup> Tsitsa Project, Department of Environmental Science, Rhodes University, P.O. Box 94, Makhanda (Grahamstown) 6140, South Africa; biggsharry@gmail.com

\* Correspondence: jessicacockburn@gmail.com; Tel.: +27-46-603-8389

Received: 18 September 2018; Accepted: 20 October 2018; Published: 6 November 2018



**Abstract:** Innovative, pragmatic approaches are needed to support sustainable livelihoods and landscape management in complex social-ecological systems (CSES) such as river catchments. In the Tsitsa River Catchment, South Africa, researchers and natural resource managers have come together to apply such innovative approaches. Since CSES are characterised by uncertainty and surprise, understanding and managing them requires a commitment to reflexive praxis and transdisciplinarity. Accordingly, we facilitated a collective reflection and learning process in the project team to deepen our understanding of praxis in CSES. Our findings indicate that CSES thinking created an enabling framing. However, building new linkages among diverse actors to put CSES thinking into practice is challenging, since it requires the development of novel working relationships. Existing institutional structures, power dynamics, and ways of working impose significant constraints. A deeper critical realist analysis of our findings revealed a metaphor which explains why this work is challenging. In this metaphor, the Tsitsa Project team is navigating a bumpy terrain of dialectic tensions. These are tensions for example between natural science and social science, and between science and indigenous knowledge. Based on this metaphor, we suggest an expanding role for scientists and managers, and recommend transformative social learning processes to support teams navigating such bumpy terrains.

**Keywords:** governance; strategic adaptive management; sustainable landscape management; sustainable rural livelihoods; transdisciplinarity

## 1. Introduction

How do we manage natural resources sustainably when we recognise that they are embedded in complex social ecological systems? This question has been posed by researchers, managers, and policy-makers worldwide since the notions of complexity and social-ecological systems began to influence research, management, and governance of natural resources [1,2]. Since then, new questions have emerged, such as: How do we manage natural resources sustainably in areas with eroded governance systems, a history of disempowered resource users, and high rates of poverty and degradation of natural resources? This question has been addressed in particular ways in South Africa [3–5], and also in other parts of the Global South [6]. In this article, we bring these two questions together. We investigate them through reflexive, engaged research praxis in an on-going landscape management initiative in the Tsitsa River Catchment in the Eastern Cape of South Africa. We consider the landscape of the Tsitsa catchment a place-based, complex social-ecological system (CSES).

By reflecting on the findings from a learning process convened approximately four years into the Tsitsa Project<sup>1</sup> [7], we provide grounded and, we hope, novel insights into these questions to deepen our understanding of praxis in CSES. Society's urgent sustainability issues require innovative and pragmatic approaches to researching and managing interconnected and interdependent CSES [6,8]. Such approaches recognise that addressing the challenges of sustainable natural resource management is no longer purely a question of more and better science [9] but that new constellations of stakeholders, which bring together diverse knowledge types and perspectives on natural resources and sustainability, are needed [10,11]. The Tsitsa Project is building such a new constellation of stakeholders including catchment residents and those involved in research, management, land use and governance across multiple scales and institutions to support sustainable management of the Tsitsa River Catchment. We have paused to reflect with each other on what we have learnt from implementation of this initiative. The aim of our article is to share the process and outcomes of this learning and reflection process, from within the broader research praxis of the Tsitsa Project. In particular, we focus on the principles for research and management in CSES that were applied in the project; the associated challenges experienced in implementation; and the insights gained into these challenges.

We begin by setting the scene for the article by outlining our understanding of reflexive research praxis and the importance of adaptive and learning-based approaches. We then introduce the Tsitsa Project as a case study of integrated management and governance for sustainability in a complex social-ecological system. We go on to outline the methodology which guided our learning and reflection process. We then discuss the findings (outcomes) of our reflection process, introducing the principles which were elicited to guide the process, highlighting key lessons which emerged from the collective reflections. In the discussion section, we develop an explanatory metaphor as a means of deepening our understanding of the lessons learnt on research and management praxis in CSES, proposing practical recommendations for the way forward. We then conclude the article by drawing out key insights emerging from this explanatory metaphor for research praxis in CSES.

### *Conceptual Framing: Reflexive Research Praxis in Complex Social-Ecological Systems*

We draw on the growing field of learning-based approaches to researching, managing and governing CSES (e.g., strategic adaptive management [12,13]) to frame our work in the Tsitsa Project and this article [14–17]. Since CSES are characterised by uncertainty, emergence, and surprise, understanding and managing them requires a commitment to systemic praxis [15] characterised by on-going reflection, learning-by-doing and the development of adaptive capacities [8,18]. Praxis is defined as purposeful practical action informed by theory and an intentional practice of reflexivity [15]. This kind of two-way praxis builds collective capacity among stakeholders to improve management of social-ecological systems and holds potential for transformative learning and change. We understand praxis to occur at the interface of management, research and governance of CSES. This means that praxis is inherently an activity which spans the boundaries of multiple organisations involved in collectively addressing complex problems in social-ecological systems [19], and it is a form of agency performed by actors in such systems [20].

The Tsitsa Project on which this article is based is a valuable case study for a number of reasons. Firstly, as Section 2 will show, it is a system with complex interacting social and biophysical dimensions, in a context where livelihoods and sustainability are daily considerations. Secondly, the project introduced by university and government partners in this context involves multiple stakeholders from diverse research and management domains. Thirdly, The Tsitsa Project brings together a bundle of concepts in the form of guiding principles. If realised in practice, this set of principles could amount to a different way of working towards landscape sustainability in CSES, responding to the significant

---

<sup>1</sup> The Tsitsa Project was previously known as the NLEIP: Ntabelanga and Lalini Ecological Infrastructure Project (2014–2018). The name change occurred in mid-2018.

questions we posed in the opening paragraph of this article. The systemic functional linkages between the principles emphasise necessity for their concurrent usage (see Cockburn et al. [21] for a diagram illustrating the interconnectedness of the principles). The Tsitsa Project is guided by the following vision: “to support sustainable livelihoods for local people through integrated landscape management that strives for resilient social-ecological systems and which fosters equity in access to ecosystem services” [7,22]. Finally, the project principles include a focus on learning linked to strategic adaptive management (SAM) [13,23], participatory monitoring, evaluation, reflection and learning (PMERL), and transdisciplinary research [18]. Within this framing, the reflexive learning process from which the data for the article was gathered, is the first of an envisaged series of reflections over the life of the project.

## 2. The Case of the Tsitsa Project

### 2.1. What Is the Tsitsa Project and How Did It Arise?

South Africa’s Department of Environmental Affairs: Chief Directorate Natural Resource Management (DEA: NRM) is responsible for 2 billion ZAR annually in employment benefits for poverty relief, all related to environmental rehabilitation, restoration<sup>2</sup> and careful use of natural resources. These various programmes (Working for Water, Working for Wetlands, Working for Ecosystems, Working on Fire, etc.) are considered a key mechanism for achieving sustainable development in South Africa [24,25]. Over the past 22 years, these “Working For” programmes have been extraordinarily successful in creating short term jobs for thousands of people but both the livelihood benefits and environmental outcomes are unlikely to be sustainable unless there are changes to the ways of work, including livelihood diversification [24,26].

The Mzimvubu Water Project (MWP) which includes a plan to build two large dams<sup>3</sup> (with the proposed names Ntabelanga and Lalini), was announced in the Tsitsa River catchment, one of the poorest areas in South Africa with high soil erosion rates [27] (Figure 1). The MWP and the proposed dams fall under the mandate of the Department of Water and Sanitation. Sedimentation was seen as a major threat to the dam investment, and it was considered desirable to lengthen the dams’ functional lifespans through controlling sediment [27,28].

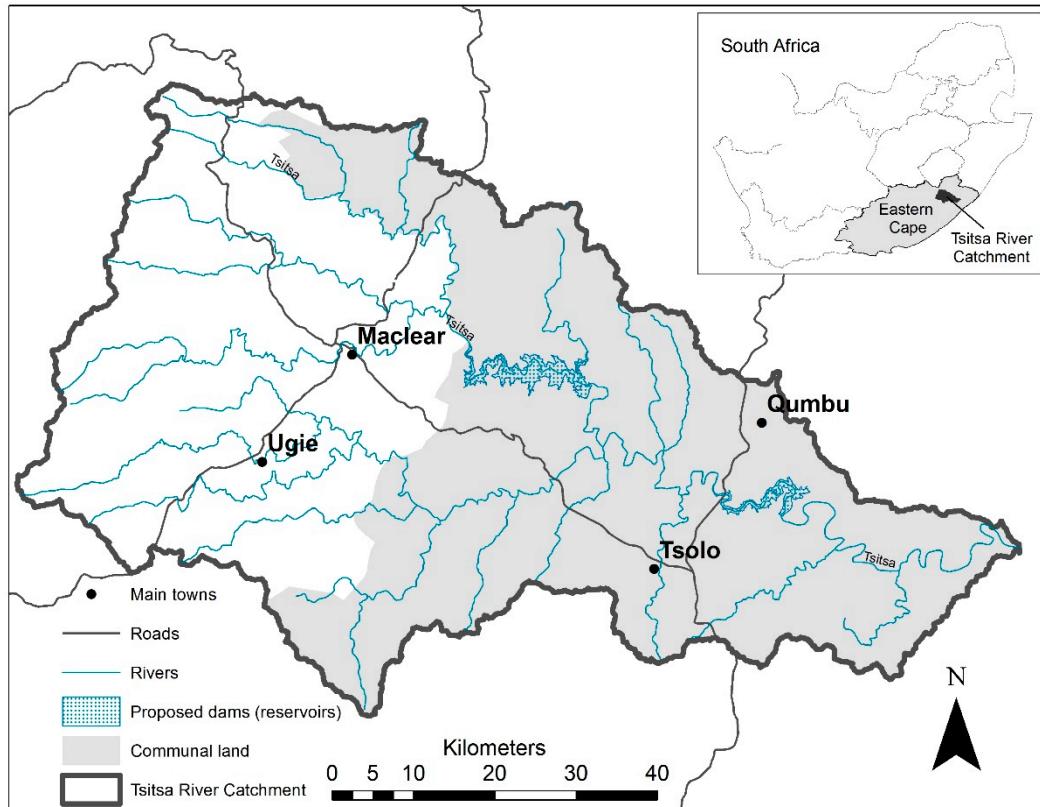
Recognizing the opportunity offered by the proposed development, DEA: NRM secured long-term funding to arrest sedimentation of the dams through practical landscape restoration initiatives and research to support and inform such activities in the Tsitsa catchment. From the outset DEA: NRM realized that if this was not effectively linked to livelihood benefits for local residents (beyond short-term jobs in “Working for” programmes and dam construction) that any benefits for people and the environment would be short-lived, and would likely be highly unequal, given current socio-economic inequalities in the catchment. Equally clear was the realisation that unless this initiative could increasingly be planned and done with meaningful local involvement, and with a clear focus on participatory and polycentric governance and capacity development, that ongoing adaptation and sustainability would be unlikely. The ambit of the initiative thus widened from a singular focus on sedimentation, to broader ecosystem services which could better support livelihood options, especially through stewardship and repair of landscape functionality, thus seeking not only ecological restoration but social-ecological landscape restoration and sustainable development [29]. This is the beginning of our story.

DEA: NRM initially (2014) partnered with the Department of Environmental Science and the Institute for Water Resources at Rhodes University. Later other departments (Geography and the Environmental Learning Research Centre) also joined what is now known as the Tsitsa Project. For the

<sup>2</sup> Although the initiative aims for ecological *restoration* of land, within the current scope of the project, the term *rehabilitation* may be more realistic.

<sup>3</sup> Note we use the word ‘dam’ as it is used in South African English to refer to the reservoir and the dam as a unit.

first four years the project was known as the NLEIP: Ntabelanga and Lalini Ecological Infrastructure Project. It was re-named the Tsitsa Project in 2018 in response to suggestions from catchment residents, and to reduce associations with the dam building initiative which has been considered contentious by some stakeholders.



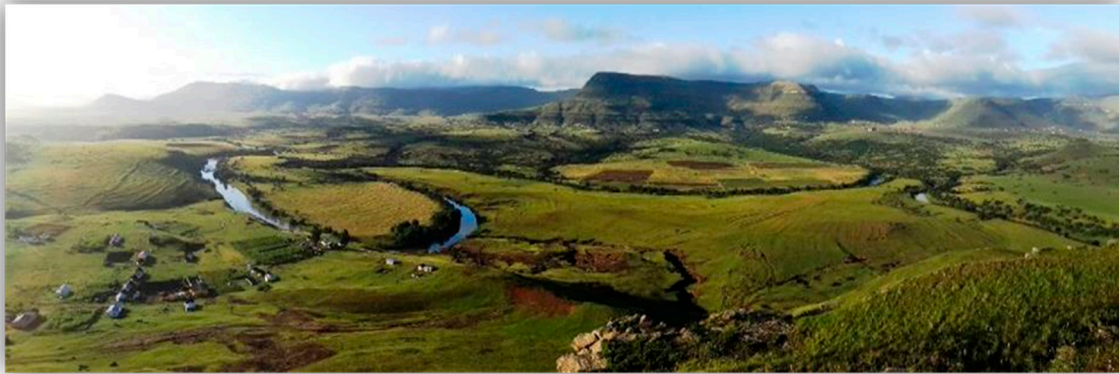
**Figure 1.** Location of the Tsitsa River Catchment in the Eastern Cape Province of South Africa (Map by Kyra Lunderstedt).

## 2.2. The Social-Ecological Context of the Tsitsa River Catchment

The Mzimvubu River flows through the Eastern Cape province into the Indian Ocean. The catchment covers almost 20 000 km<sup>2</sup>, the size of South Africa's Kruger National Park or the country of Wales (Figure 1, Figure 2). The landscape is characterised by large areas of highly erodible duplex soils, posing serious sedimentation, landscape and livelihood concerns [27,28]. The Mzimvubu's southern sub-catchment, the Tsitsa (the focus of the Tsitsa Project), occupies 5000 km<sup>2</sup> (Figure 1). The terrain is hilly, vegetation is mainly grassland (Figure 2), with riparian and other areas heavily infested with alien plants. There are approximately 80 villages in the easternmost part of the Tsitsa catchment, which were part of a so-called black homeland (the "Transkei") in pre-1994 Apartheid South Africa [30]. This communal land area is predominantly under the governance of traditional councils, comprising senior traditional leaders (*iiNkosi*, previously called "chiefs"), headmen and sub-headmen. Tensions between these traditional governance structures and the more recent democratic governance structures result in uncertainty and confusion, leading to concerns about eroding governance in the region. To the west lies a commercial farming area with freehold tenure. The freehold area is characterised by extensive plantation forestry and mixed agriculture including field crops and livestock. Plantation forestry is now also expanding into the communal area. De-agrarianisation (abandonment of crop lands) and an outflux of younger residents are key features of the communal area, as are increasingly violent forms of crime and political tensions. Resident communities depend on multiple livelihoods including at



least a partial dependence on natural products, home gardens and some cropping and livestock, as well as social grants and remittances [30].

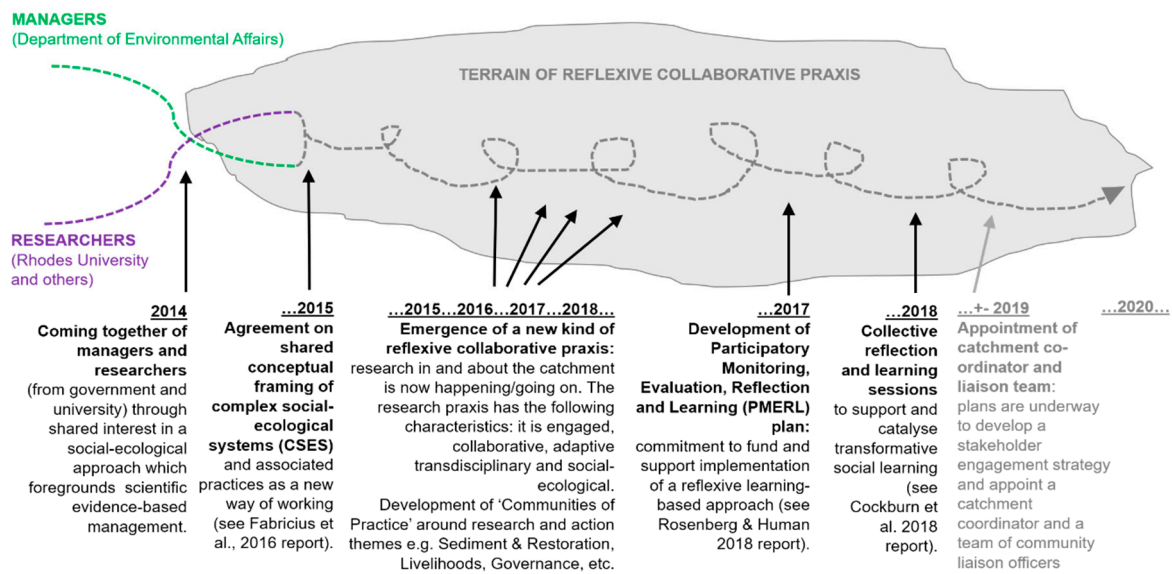


**Figure 2.** View over the Shukunxa village, one of the villages in the Tsitsa River Catchment (Photograph credit: Dylan Weyer).

The Tsitsa Project is situated in the space between the top-down approaches that characterised not only the proposed dam but also the “Working For” landscape restoration initiatives, and a commitment to meaningfully engaging local catchment residents and governance structures. Trust-building is jeopardized by uncertainty as to whether the dams will actually be built, and concerns have been raised about the way in which local communities were consulted and informed about the dam-building plans [31]. The concerns about eroding and confusing local governance arrangements, and inequitable forms of decision-making exacerbate concerns about community participation in landscape management decisions. The democratic government’s intention to introduce a participatory water management system through catchment forums and catchment management agencies (National Water Act, Act 36 of 1998) has not yet been fully implemented in the Tsitsa. This contentious socio-political and governance context poses a challenge to the ambitious vision of the Tsitsa Project.

### *2.3. How the Tsitsa Project Works*

The Tsitsa Project is a network of academic researchers from environmental, water and earth sciences, agriculture and education; as well as natural resource managers, decision-makers, practical implementers, and related stakeholders who started coming together in 2014 to manage the Tsitsa landscape collaboratively (Figure 3). While several universities are involved, the Tsitsa Project is currently co-ordinated by a core leadership group based at Rhodes University in Grahamstown (Eastern Cape, South Africa), situated some 400 km from the Tsitsa catchment. The participating natural resource managers include DEA: NRM staff based in the catchment, where they manage the various “Working For” restoration teams within government’s expanded public works programme, and senior managers based in nearby or distant urban centres, where DEA has regional and national offices respectively. Practical on-the-ground implementation is often coordinated by implementing agents contracted by DEA: NRM.



**Figure 3.** Key moments in the learning story of the Tsitsa Project [22,32].

A few key moments need to be highlighted in the unfolding story of the Tsitsa Project (Figure 3). Early on in the process (2015), project participants agreed on an explicit, intentional conceptual framework to guide the research process, which was documented in a strategic planning document [22]. Out of this, a certain kind of engaged research praxis was generated, illustrating the shared commitment of both researchers and managers to implement a social-ecological approach to landscape management. Based on this research praxis, research in and about the catchment is now underway. Distinct “Communities of Practice” (CoP) [33] have been established to loosen up the disciplinary boundaries whilst managing the budgets allocated to different research units within the university. The CoP typically consist of a group of more and less experienced researchers working on similar themes, and include natural resource managers as much as possible to link research to on-the-ground actions. The CoP work on themes such as sediment and restoration (e.g., see Bannatyne et al. [34]), participatory and polycentric governance, livelihoods and ecosystem services, and knowledge management.

A Participatory Monitoring, Evaluation, Reflection and Learning (PMERL) framework and plan was developed in 2017 to support ongoing learning and adaptive project management [32] and PMERL researchers were appointed. In 2016–2017 two stakeholder analyses were undertaken [35,36] and plans are underway to develop a stakeholder engagement strategy and appoint a catchment coordinator as well as a team of community liaison officers (DEA secured additional funding to support this expansion). These Tsitsa Project participants will be based in the catchment and will enable two-way communication and interactions between the network of researchers and managers on the one hand, with residents and other stakeholders in the catchment on the other hand (refer to the Tsitsa Project Learning Report for details on how the project is governed internally [21]). Tsitsa Project leaders have recognised the importance of history—in the form of antecedent conditions—in influencing project outcomes and trajectories (See Box 1, and the Tsitsa Project Learning Report for further details on these [21]).

**Box 1.** Where we have come from: reflections on antecedent conditions influencing the trajectory of the Tsitsa Project.

- Political and high-level administrative will to support and give the Tsitsa Project a fair chance: DEA: NRM has treated the Project from early on as a flagship initiative or “experiment” and given it the requisite partial freedom and space to attempt innovations in research, management, governance and practical interventions.
- Widening learning linked to parallel processes: Prior to the Tsitsa Project, and parallel to its development, DEA: NRM have conducted their own science and management planning meetings on a regular basis which have laid a foundation for leading officials transitioning from project managers to social and institutional entrepreneurs who mediate multi-party initiatives.
- Multi-scale and expanding nature of the initiative and its impact: multiple connected scales and levels of operation and governance influence Project activities; the ambitious nature of the scale makes this an imperative but also a challenge.
- Appreciation for systems features such as novelty and serendipity: There is a sense of novelty and serendipity arising from enabling leaders (including many experienced practitioners, scientists, administrators, and now wise community elders) to share ideas and co-construct potential ways forward.
- Openness to collective learning: Much of the evolution and progress in the Project is based on learning from inter-personal and especially inter-group interactions and shared experiences, rather than being ideologically rooted in some “external” idea or recipe. This requires pragmatism based on lively ongoing reflection and a commitment to adaptive practice.
- Enthusiasm for the complex and daunting task among participants: This upbeat attitude is an essential enabler and incentive for working in such a complex and challenging context.

### 3. Methodology

The collective reflection and learning process in early 2018 (Figure 3), which led to the development of this article, is described next. It too, has been a significant moment in the story of the Tsitsa Project as it was considered a significant step in beginning to implement the PMERL plan for the project (Figure 3). It was conceptualised as a collective process for researchers and managers to “pause and reflect” on what we are learning about and through our praxis. The methodological approach was informed by this commitment to collective reflexivity [15,37]. The data analysis process was conducted in a systematic, structured way, involving the broader Tsitsa Project team in an on-going, iterative manner.

#### 3.1. Critical Realism as an Underpinning Philosophy

For the research process reported here we draw on critical realism as a “philosophical underlabourer” [38] that is, an enabling philosophy which underpins the research. As Mingers [39] pointed out, a critical realist philosophy aligns well with a complex systems worldview [39], and thus with the CSES framing of the Tsitsa Project. Many key ideas in critical realism and complexity theory are consistent [39,40]. This includes the acceptance of an intransient dimension to our reality and a view of that reality as a multi-layered, open system, subject to emergence based on deeper underlying mechanisms, and the observer (researcher) being part of the system. Secondly, the concepts of emergence, hierarchies, and boundaries (framing) are important in both critical realism and complex systems thinking [40]. In both views, human understanding of reality is recognized as partial and fallible, requiring researchers and program managers to be reflexive, humble and learn in an on-going manner from observations and experience [8,41]. This is thus an enabling philosophy which supports our commitment to a collective, reflexive approach to the Tsitsa project and this article.

#### 3.2. Elucidating Principles to Guide Reflection and Analysis

As a starting point for the reflection and learning process, we elucidated a set of five guiding principles for the Tsitsa Project (see first section of the results). This was done by a small group of us coordinating the reflection process. We drew on project documentation (primarily on the Project’s

“Research Investment Strategy” by Fabricius et al. [22]) and on our own knowledge of the Tsitsa Project to elicit the five principles (through deliberations between JC, HB and another senior project researcher). These were then used as probes in the reflection sessions as a mirror to enable the emergence of learning and to guide the analysis of the findings.

### 3.3. Research Design and Methods

We generated data about the lessons learnt in the Tsitsa Project from two sources: project documentation and collective reflection sessions. Project documents included strategic planning documents, newsletters and internal reports. We facilitated reflective discussions with participants in the Tsitsa Project to “pause and reflect.” We selected participants for the discussions based on the length and intensity of their involvement in the Tsitsa Project. A list of 25 potentially suitable participants was drawn up and 22 of these participated in the reflections (three group reflection sessions, nine individual reflection sessions). Where possible, the reflective discussions were conducted collectively as focus group discussions to maximise opportunities for shared reflection and collective learning. Where participants were unable to join a collective reflection session, individual reflective interviews were held. We captured observation notes directly after reflection sessions and audio-recorded the discussions as a back-up and to allow partial transcription of relevant sections. Research ethics clearance was obtained from the Rhodes University Education Faculty Ethics Committee (Code: ED18030202).

We analysed data in an integrated manner across data sources [42], conducting manual coding and using NVivo software as a supporting tool for data management and analysis [43]. We coded the notes from reflection sessions, along with project documents, in two coding cycles [44]. In Coding Cycle 1, we open-coded the data to identify themes according to two questions: 1. What lessons have been learnt in the Tsitsa Project? (“general lessons learnt”). 2. What lessons have been learnt about implementing Principle X in the Tsitsa Project? (Where “X” stands for each of the five principles, see Figure 4). In Coding Cycle 1 we followed an inductive approach, whereby we moved from a number of particular instances of a lesson learnt (e.g., as identified in a specific project document or mentioned by participants) to induce a conclusion about a general lesson being learnt across the initiative as a whole. In this way, we moved from a larger number of coding themes to a smaller number of over-arching lessons learnt. Drawing on narrative research approaches, we developed common narrative threads [45] in order to re-create common verbatim statements from participants which convey the essence of key lessons identified during Coding Cycle 1 in a more personal way. We use these below to enrich presentation of the findings.

In Coding Cycle 2 we shifted to a more analytical mode, moving beyond the initial themes of lessons learnt [46]. Here we worked with the thematic codes identified in Cycle 1 by applying two strategies. Firstly, we applied the “describe-compare-relate” scheme [46] to work in an integrative way with the themes to develop rich descriptions of themes, identify relationships between the themes, and to compare them to one another. Secondly, we asked “realist questions” of the data to begin to identify explanatory mechanisms which may not be obvious in the empirical data. Realist questions are based on a mode of inference called abduction [39,47]. Abduction moves from a particular occurrence or observation (in our case the thematic “lessons learnt” identified in Coding Cycle 1) through an imaginative or creative leap by researchers, to think of an explanation which might account for that observation [39]. This process allowed us to probe more deeply into the underlying causal mechanisms of the observable lessons learnt about the Tsitsa Project.

A further step in this process was to present and share the collective reflections and preliminary findings within the Tsitsa Project team. We did this at team meetings, and we circulated the Tsitsa Project Learning Report (a more detailed version of this article) to project participants to catalyse discussion about lessons learnt and how these might inform praxis through future planning and project activities [21].



## 4. Findings

In this section, we present the findings of our reflexive learning process. We begin by outlining the principles which we developed to guide the process. Whilst these were implicit in the guiding approach of the Tsitsa Project from the early stages [22] they were only made explicit during this reflection process, and hence form part of our findings. After that, we report on lessons learnt through the process of reflecting on the principles in praxis, presenting the data that emerged from our “pause and reflect” process. We then shift into a more analytical process of sense-making, drawing out three foundational findings which helped us to make meaning out of this reflection data and capture our learning in an integrated way. We expand our discussion of these three insights alongside existing theory in the following section (Section 5), where we present an explanatory metaphor to deepen our understanding of engaged research praxis in CSES.

### 4.1. Findings Regarding the Guiding Principles of the Tsitsa Project

We developed a set of five inter-connected principles to guide our praxis for integrated sustainability research, management, and governance in a complex social-ecological system (Figure 4) [48].<sup>4</sup> These principles are considered key in supporting our work towards the Tsitsa Project Vision (central blue oval, Figure 4) as they are the “theory” guiding our intentional praxis. In the course of the “pause and reflect” process described here, we realised that these principles operate in a layered fashion, which helped us to understand how they interrelate and are mutually supportive, how they inform praxis, and how they interrelate with practice (Figure 4). The first layer of principles is about *framing*: how we bound, understand, think about, act in and communicate about the system [40,49] (Layer 1—orange ring). The second layer of principles relates to *what we are doing* (Layer 2—green ring): the Tsitsa Project is primarily concerned with conducting applied action-orientated *research* and supporting the development of effective *governance* for sustainable management of the Tsitsa River Catchment. The third layer is about *how we do what we do* and captures the Tsitsa project’s commitment to learning and stakeholder engagement ([16] (Layer 3—yellow ring)). We describe each of the principles in turn below, drawing on relevant literature to argue for their relevance.

#### Principle 1: Embed complex social-ecological systems and resilience thinking in praxis

Drawing on the literature and own experience [49], Tsitsa Project designers [22] identified CSES and resilience thinking as two key concepts for framing the project. The CSES perspective provides a shared mental model that encourages an integrated understanding of humans-in-nature [50], in which human systems are not only dependent on but embedded in the biosphere [51]. This perspective features in the Tsitsa Project’s intent to develop both biophysical and social development indicators, and to track them in integrated action initiatives focussed, for example, on livelihoods. Praxis in this context requires specific governance and management processes, to enhance the resilience of ecosystem services for human well-being [52]—which leads to the next principle.

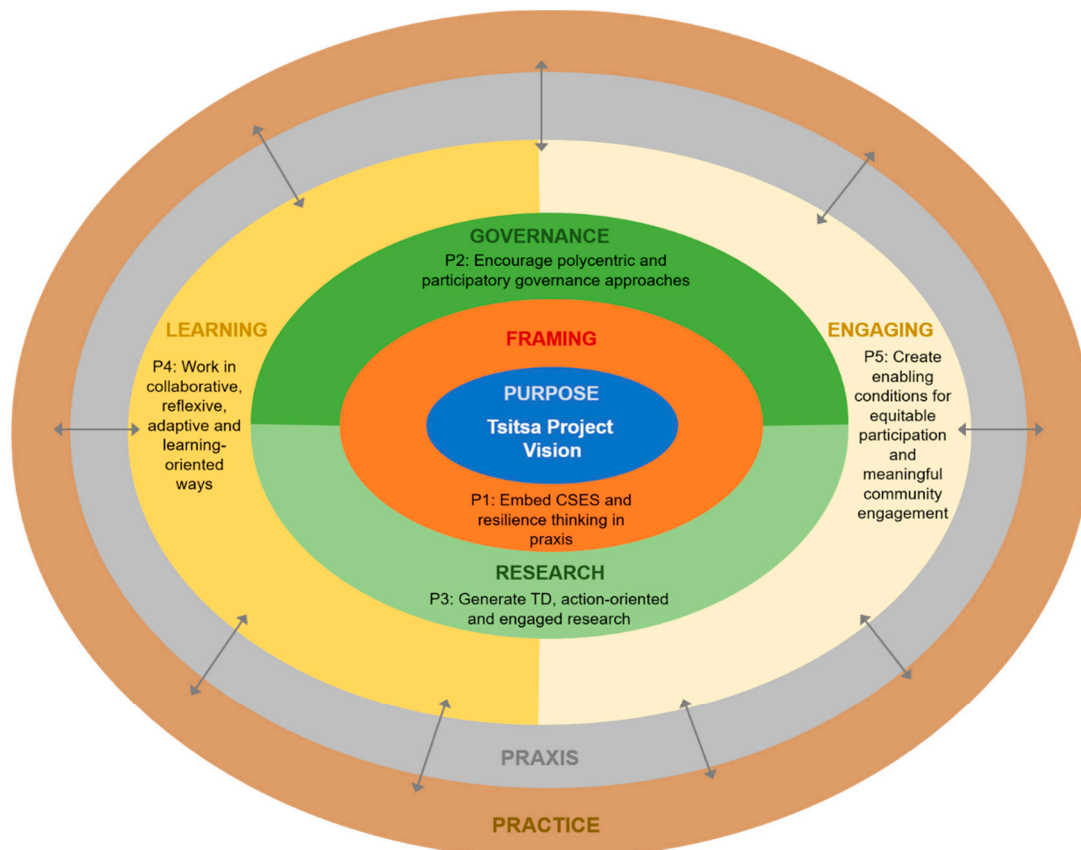
#### Principle 2: Encourage polycentric and participatory governance approaches

The Tsitsa Project designers argued that collaborative, multi-scale, polycentric governance approaches are needed to manage complex, place-based social-ecological systems such as landscapes [53], and these need to be underpinned by a social learning approach. This is supported by the literature [54,55] and by Tsitsa Project designers’ own research [8,56]. Polycentric governance systems that match the scale of the resource system and are characterised by multiple, nested authorities

---

<sup>4</sup> Upon further reflection after completion of our data collection and analysis, the Tsitsa Project team decided to adjust these principles for publication in its updated Research Investment Strategy (RIS Version 2), which is still in preparation. The main difference between the five principles presented here and those in the RIS Version 2 is the addition of a principle labelled “Scientific-technical foundation and evidence base,” which foregrounds the role of scientific knowledge in supporting management and governance of the catchment [48].

governing at different scales should be promoted to support resilient CSES [52,55]. These should be designed to enable and promote cross-scale collaborative governance and co-constructed action [56,57]. Yet these kinds of collaborative platforms face significant organisational and financial difficulties [58], and much can still be learnt about how to design, implement and facilitate these complex processes. We use “polycentric” to emphasise inter-governance connectivity across scales and “participatory” to denote the development of agency and voice among catchment residents like female farmers and villagers, who are the most marginalised stakeholders. An intention to introduce capacity development programmes with a focus on polycentric governance in the catchment, illustrates the application of this principle.



Vision: **PURPOSE** – What we are working towards: “to support sustainable livelihoods for local people through integrated landscape management that strives for resilient social-ecological systems and which fosters equity in access to ecosystem services”.

Layer 1: **FRAMING** – Principle 1: How we understand the system, how we think about the system, how we act in the system.

Layer 2: **RESEARCH and GOVERNANCE** – Principle 2 & Principle 3: What we are doing.

Layer 3: **LEARNING and ENGAGING** – Principle 4 & Principle 5: How we do what we do / how we work.

Layer 4: **PRAXIS** – Purposeful and reflexive two-way interface between theory and practice.

Layer 5: **PRACTICE** – Sustainable management and governance of land and livelihoods in practice.

**Figure 4.** Conceptual presentation of five layered principles (P1–P5) that guide the Tsitsa Project. The principles inform two-way praxis, at the interface of theory and practice. (CSES—complex social ecological system; TD—transdisciplinary).

### Principle 3: Generate transdisciplinary, action-oriented and engaged research

There is widespread support for transdisciplinary (TD) research in response to the complex social-ecological issues facing society [8,59–61]. Transdisciplinary research can help to bridge the research-practice gap in natural resource management [62], and is advocated as a means of improving working relationships between researchers and other relevant stakeholders for sustainable catchment management [63]. The CSES and multistakeholder nature of the Tsitsa Project—and its multifaceted vision—require transdisciplinary research. Engagement with relevant stakeholders is a key feature of

TD research, emphasising the co-construction of research questions, data collection (e.g., participatory monitoring of biophysical and social indicators) and sense-making [64]. Therefore, in the Tsitsa project TD research is more than multiple disciplines contributing to the knowledge base; non-scientific stakeholders are also engaged in the co-production of knowledge, with the aim to integrate knowledge into a whole bigger than the sum of individual parts.

Principle 4: Work in collaborative, reflexive, adaptive and learning-oriented ways

Dynamic, messy and difficult to navigate, CSES require researchers and managers to proceed through adaptive approaches that recognize and work with the complexity [57,65] and seek out collaboration and learning. Collaboration in management and governance is necessary because of the difficulty of problems, the wide range of stakeholders, the large landscape-scale of initiatives, and the collective sense-making and responses required [53,58,66]. Similar to the principle of polycentric governance, the new ties sought in such complex institutional settings are considered necessary to counter the fractured or “siloed” nature of many institutions [55]. Social learning is fundamental to guide and articulate, in iterative, reflexive cycles, CSES management and governance, enabling co-developed and systemic understanding and responses to uncertainty and non-linearity [10,54]. While systems and learning-based approaches are encouraged, researchers caution against simplistic understandings of how social learning processes unfold and how they can best be facilitated or supported [17].

Principle 5: Create enabling conditions for equitable participation by multiple stakeholders with a particular commitment to meaningful engagement with local communities

Putting a CSES framing into practice for the management and governance of natural resources requires on-going interactions among the multiple, diverse stakeholders in the system. This enables legitimacy, monitoring and compliance, a deeper understanding of system dynamics, and the capacity of managers to detect and interpret shocks and disturbances within the CSES [52,67]. However, the intensity of stakeholder participation in transdisciplinary research varies, and it is often not more than superficial engagement [67,68]. Politics and power are important mediating factors in how participative processes play out [69]. In order to overcome entrenched social injustice (often due to historical and geographical circumstances, such as the “black homeland” legacy which still shapes access to land, water and other resources in South Africa [30]), transdisciplinary research should pay attention to outcome and process, take ethical and political considerations into account, and be open to marginalised, diverse, and possibly conflicting viewpoints [8,61,70].

#### 4.2. Lessons Learnt about Principles through Praxis

Reflecting on the above principles with project participants led to the identification of a range of insights into research praxis in CSES (Table 1). Table 1 summarises participants’ perceptions of working with the principles and key “lessons learnt” about each principle. A key insight emerged about the concurrency of the five principles [21]. Participants noted that it is unusual to bring a bundle of principles together in this way but also that they profoundly work together (as illustrated in Figure 4 and the descriptions above) and produce synergy. There was also a shared agreement among participants that an ambitious initiative seeking to bring about change at a large and deep scale, requires such a set of guiding principles.

A related observation from the reflection sessions was that there was considerable enthusiasm towards the complex and daunting task, albeit with some qualifiers and concerns about constraints. This enthusiasm appears to be an important value-based incentive for participants to work beyond their usual incentive structures. These two narrative threads capture this enthusiastic attitude among some participants and illustrates the values-orientation which motivates many participants:

“This is an ambitious and ground-breaking project and I am excited about participating as it appeals to my personal commitment to doing meaningful work that can bring about change.”

“There is willingness in NLEIP and we are trying to implement the work according to the principles but it is difficult and, in many cases, constrained by external barriers.”

**Table 1.** Lessons learnt about putting the Tsitsa Project principles into practice.

Tsitsa Project Guiding Principles	Project Participants' Perceptions of the Principle in Praxis <sup>1</sup>	Key Lessons Learnt about the Principle
Principle 1: Embed complex social-ecological systems and resilience thinking in praxis	This is the principle which most participants seem to understand, identify with, and actively try to practice in their work. It sets the scene for the other principles.	<ul style="list-style-type: none"> <li>Using a CSES framing has created an enabling research environment. However, seeing this principle through in governance, management and community and stakeholder engagement has been more of a challenge.</li> <li>The term ‘social-ecological systems’ was mentioned more frequently by participants than the term resilience, potentially indicating challenges in operationalising resilience thinking in practice.</li> <li>The CSES framing creates an imperative for the other principles that is, there is concurrency among the principles.</li> </ul>
Principle 2: Encourage polycentric and participatory governance approaches	Some participants were unfamiliar with this concept. The leaders of the initiative, however, are passionate about it and believe it to be the biggest challenge but also potentially the biggest contribution of the Tsitsa Project.	<ul style="list-style-type: none"> <li>Current structures and processes of governance (in government and in academia) inhibit or constrain realization of polycentric governance in practice.</li> <li>In order for the other principles to be realized in practice, polycentric governance must be in place.</li> <li>Participatory governance is necessary to address power imbalances and to promote equity.</li> </ul>
Principle 3: Generate transdisciplinary, action-oriented and engaged research	Transdisciplinary research among scientists is considered to be on track, even if not yet entirely successful. However, the move from inter- to transdisciplinarity, and engaged and action-oriented aspects need further attention.	<ul style="list-style-type: none"> <li>Practice of TD is in the early exploratory stages—we are advocating for it but need to do more to practice it fully.</li> <li>This principle is about building two types of bridges: bridges between researchers from different disciplines (science-science or interdisciplinarity); and bridges between researchers from multiple disciplines and societal actors (science-society or transdisciplinarity).</li> <li>The Tsitsa Project is doing well building the first type of bridge but building of the second type of bridge (improving the links between science and society) is more challenging.</li> </ul>
Principle 4: Work in collaborative, reflexive, adaptive and learning-oriented ways	Collaboration, reflection and adaptation between scientists is going well, links between scientists and managers are slowly improving. But links to other catchment stakeholders and community members are still lacking.	<ul style="list-style-type: none"> <li>Putting Principle 4 into practice requires paying attention to conditions that enable good quality communication and the time it takes to reflect and adapt.</li> <li>Implementing this principle beyond the core Tsitsa Project group is a key challenge and requires additional capacity in the team.</li> </ul>
Principle 5: Create enabling conditions for equitable participation by multiple stakeholders with a particular commitment to meaningful engagement with local communities	Most participants feel we are not doing enough to implement this principle. Community engagement has been ad-hoc and only focused on traditional leaders, thereby marginalizing the less powerful. Lack of engagement with other government stakeholders is also a concern.	<ul style="list-style-type: none"> <li>Multiple factors constrain the Tsitsa Project’s efforts to act according to this principle. These include, bureaucracy and funding structure and demands; not enough of the right people with the right capacity and skills; the very large scale of the initiative; politics, and systemic barriers in the broader governance system.</li> <li>Without significant financial and capacity investments in community and stakeholder engagement, this principle will not be realized in practice.</li> </ul>

<sup>1</sup> Praxis is purposeful practical action informed by theory and an intentional practice of reflexivity (Ison, 2018).

Additionally, many participants commented on the value of the formalised and interactive reflection sessions facilitated for the purpose of this “pause and reflect” moment, and it was suggested that we conduct these at least on an annual basis. This further illustrates the commitment among participants to the principles (in particular for Principle 4), despite the fact that participating in the reflection session places additional demands on their time. We now go on to discuss key insights gained through our reflection sessions for each principle, drawing on some of the data in Table 1 and illustrating the insights with *narrative threads*.<sup>5</sup>

The lessons learnt about Principle 1 indicate that Tsitsa Project participants have adopted this framing and are committed to working according to CSES and resilience thinking, despite the challenges. The way in which participants spoke about this principle indicated an understanding that it is the overall framing principle but that all the principles are necessary and interconnected, and work with one another in a synergistic way. One of the main concerns which people shared was that working according to Principle 1, and therefore also the other principles, is time and resource intensive:

“It takes time ... and money ... and the right people ... to work according to CSES principles ... to build trust ... to build relationships ... to work reflexively and adaptively ... to build polycentric governance ... to put all these principles into practice.”

Principle 2 was one which some participants felt unsure about. It seems not to have been discussed as much as Principle 1 in project meetings, and people were not always clear on its meaning and relevance. However, most senior leaders in the initiative shared an enthusiasm about the importance of this principle, as shown in this narrative thread:

“The focus on polycentric governance is probably the most important work. It is the most challenging but it has the potential to bring about the most significant and sustainable change in the catchment.”

Most participants agreed that Principle 3, related to transdisciplinarity, was one of the more successful in implementation. However, it was clear in these reflections that participants thought that implementing transdisciplinarity was primarily the task of researchers rather than managers, and that researchers were making good progress in working across disciplines even if this is challenging. Bringing the voice of managers and catchment residents into TD research (i.e., meaningful stakeholder engagement and knowledge co-production), and moving towards actionable work on the ground, was however experienced as more of a challenge, particularly because of the dominant role of science in driving the initiative, as reflected in this narrative thread:

“There has recently been a shift in the Tsitsa Project: the dominance of “science” has somewhat decreased. For a long time, the science voices were loudest in the room but now there is a stronger sense of purpose and understanding of what we are doing, there is better cross-pollination and integration (e.g., among CoP and also between scientists and managers) and there is a clearer focus on tangible local actions.”

Most participants reflected that Principle 5, focussing on learning, working reflexively and collaboratively, is happening in the Tsitsa Project, even though it is currently mostly among scientists. Collaboration is slowly beginning to happen between scientists and managers but there is still very limited interaction between scientists/managers and catchment residents. This narrative thread suggests that channels of communication are important for enabling Principle 4, and that they have not always been clear in the Tsitsa Project:

---

<sup>5</sup> Narrative threads are composite quotes used to illustrate general discourse and themes among participants by combing a number of verbatim quotes into one statement.



“The links between research and management have been unclear and confusing, and the lines of command/responsibility/communication between researchers and managers/implementers has not always been clear, though this is getting better.”

Most participants consistently felt that Principle 5, loosely summarised as community engagement, was the hardest to put into practice. Many participants expressed a strong commitment to engaging meaningfully with catchment residents and a more diverse suite of stakeholders, yet they felt there were multiple external barriers constraining this, as these narrative threads illustrate:

“Community engagement and facilitation are a priority and concern. Some effort is being made in this regard but it seems that the current effort is insufficient or is not working.”

“Sufficient budget must be put aside to have a community engagement team in the catchment to build trust and long-term relationships with local communities. The social side of things cannot be an afterthought.”

#### 4.3. From Reflection Data to Meaning-Making and Learning

The above findings—based on empirical reflection data—give useful insights into the extent to which principles are being put into practice by Tsitsa Project participants and the challenges and partial successes experienced in the process. To these reflections we as authors added a further step to interpret these reported “lessons learnt” in the broader context of the initiative. We synthesised three foundational findings which helped us to make meaning from this reflection data and capture a meta-level of learning. We discuss them below, with examples of how we may be able to strengthen these principles in the Tsitsa Project praxis.

##### 4.3.1. Social-Ecological Systems and Resilience Thinking, and Recognition of Guiding Principles, Have Created an Enabling Framing

Using the integrated CSES framework and Tsitsa Project principles to recruit researchers and plan and guide research praxis has enabled the development of collaborative working relationships among an interdisciplinary team of scientists. The ambitious and novel approach taken in the initiative has attracted soil scientists, water resource scientists, educators, ecologists and agricultural researchers to work out together how the natural resources of the Tsitsa landscape could be monitored, managed and governed. The approach inspires people and generates a sense of hope for change. While one could somewhat cynically say that a CSES approach is currently popular with funders and that funding also attracts researchers, there is evidence that both funders (in this case the national government entity, DEA:NRM) and researchers are enthused by the possibilities of overcoming reductionist, linear or non-systems thinking in research and development initiatives [7,21,56] (Also see Box 1).

But how easy is it for the Tsitsa Project implementers to apply CSES and resilience thinking? Thus far, discipline or field-based teams of younger and more experienced scientists (CoP) have acknowledged the need for both social and biophysical research and interventions but have only just begun to co-construct these with each other. The Project design features a central core of PMERL in which catchment residents and researchers alike are collecting social and biophysical monitoring data [34]; while some also undertake more in-depth case studies in areas like livelihoods or governance [32]. While this design feature is in the early stages of implementation, the intention is to integrate across the data to identify trends and patterns including possible linkages, in quarterly gatherings of the multi-disciplinary CoP. This is an opportunity for synthesis across the sciences, to shift from a multi-disciplinary to a transdisciplinary approach and use the CSES framing to come up with new insights for the intractable problems of the catchment.

Participants in the Tsitsa Project reflected that it seems harder for the natural resource managers in the catchment to apply CSES thinking, given the siloed nature of the different government departments and that the “Working For” programmes report separately on their performance [21]. Involving them in the PMERL data gathering and sense-making process and quarterly “pause and reflect” meetings,

will be an opportunity to make their siloes a bit more permeable, even if just temporarily, to inform shared insights and possibly co-constructions of the way forward [71].

Participants also noted that some of the residents of the catchment may already be practising some form of CSES and resilience thinking (though not using this language), given that they are surviving under difficult circumstances. It would be important to be open to this possibility as we start engaging catchment residents more proactively in the next phase of the Tsitsa Project: what can we learn from those residents who already apply CSES and resilience thinking? What role can local and indigenous knowledge play in informing sustainable landscape and livelihood management?

#### 4.3.2. Building Novel Linkages among Diverse Actors in the CSES is a Challenge

Building new working relationships across deep-seated socio-cultural-political divides and in a complex political landscape is challenging. Applying the Tsitsa Project principles in praxis, requires enabling opportunities for exchange, and a deeper awareness of power differentials among the actors involved. Overcoming the tension between theory and practice, research and action, and science and management is particularly challenging in a science-led process. It requires productive engagements between actors operating in different knowledge systems, with different socio-cultural, political and economic histories and with conflicting incentives and success measures in these different systems [72]. For example, for scientists in academia success may be measured by publication outputs, while natural resource managers in government measure success by budget spend or number of structures built to control soil erosion.

What would enable more learning-full engagements between scientists and managers? We found evidence of three strategies or emergent practices that have shown some success thus far: Firstly, meeting in neutral venues helped to loosen boundaries between scientists and managers, with the latter more likely to participate on equal footing with the gathered scientists in the relatively informal setting of a village inn, than at the university. Roux et al. [18] describe these as generative “third spaces” and note that more is needed than a physical space. At the more recent science-management meetings a shift was observed in how questions are asked of each other during presentation sessions, which was perhaps evidence of a move towards greater collaboration and learning. Participants seemed to genuinely seek to understand the other party better, rather than to “prove wrong” (a default mode for many, based on a particular logic and knowledge system).

A second practice to encourage is the inclusion, in meetings, committees and forums, of those with divergent understandings and viewpoints. Whereas it is much easier to only choose like-minded scientists or managers for collaborative networks, proponents of social learning [73] note the importance of a certain level of disruption of existing maxims for transformative learning to occur. During a recent field trip to the catchment stimulating conversations were triggered by dissenting viewpoints among senior members of the “Strategic Advisory Panel,” showing the potential of diverging understandings.

Thirdly, beyond talking, a productive approach seems to be to collaborate on a practical and necessary task in which both groups have an interest. One example here is the co-development of annual management plans that include the identification of the “Working For” rehabilitation sites (by the Sediment and Restoration Community of Practice), another is the development of sustainable livelihood activities such as rainwater harvesting or nurseries for growing plants used in restoration activities (by the Livelihoods & Ecosystem Services Community of Practice). A third example was the co-development by residents and researchers of draft objectives on which to base a local Tsitsa Catchment Management Strategy (by the Governance CoP). Through these tangible, goal-oriented activities, participants are getting an opportunity to work across conventional boundaries (science-management, or natural science-social science) towards a particular product or outcome, building new inter-personal relationships. Thus, through purposeful collective action, collaborative capacity can be built [74].

#### 4.3.3. Existing Institutional Structures, Cultures and Ways of Working Impose Significant Constraints

Enhancing existing enabling conditions that intersect (serendipity) whilst working to create new ones (novelty) are important leverage points in this kind of change-oriented initiative in a CSES (See also Box 1). For example, existing working relationships between senior university researchers and DEA officials enabled some cohesion between academia and management early on. However, there are also significant structural and systemic barriers which act as disabling conditions, particularly for adaptive and collaborative ways of working (Principle 4), and for meaningful community participation (Principle 5). These enabling and constraining factors are particularly challenging to identify and to work with due to the large scale, complexity, and ambitious vision of the initiative. For example, natural resource managers work in a strictly bureaucratic system of reporting on measurable outputs, which reduces their time and motivation to communicate with scientists, to build relationships with local people, or to work responsively on local livelihood-related activities.

The importance of leaders working to create enabling conditions or “room to play” should not be underestimated (Box 1). This is particularly important considering existing bureaucratic and political constraints in a government-funded initiative. This signals political will and support for the initiative, which inspires participation. However, several participants reflected that as an ambitious and complex endeavour intended to have impact at such a large scale, it needs to be resourced accordingly. These resources are not only budgets but also time, and a suitable mix of open-minded people willing to do things differently. With budgets, it is not only large amounts of money that are important but also the flexibility to be able to respond nimbly to emergence, whether in the form of new opportunities or new insights. Van Breda and Swilling [65] make a somewhat similar point, about the need to find resources that give research and development teams the flexibility to respond to emergence as they work in complex systems.

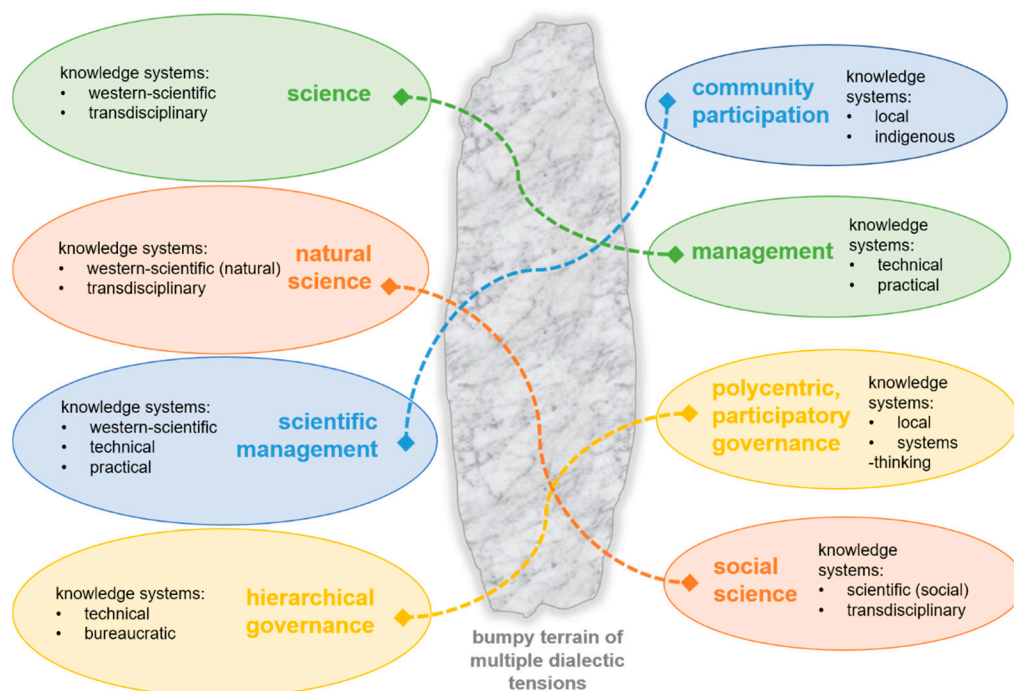
### 5. Discussion: An Explanatory Metaphor of Wider Relevance—Navigating a Bumpy Terrain of Dialectic Tensions

Thus far we have shared the reflections by Tsitsa Project participants on the extent to which they are able to apply a set of principles for engaged praxis in complex social-ecological systems, and our analysis of associated learnings. We have noted that the process is challenging and successes only partial. Nonetheless we found some evidence of movement in the right direction (see examples in Section 4.3) and we have shared these as recommendations for going forward in the Tsitsa Project. These include an integrative PMERL framework that includes natural resource managers and catchment residents, that also draws on local resilience-related knowledge; routine use of “third spaces” for engagements among diverse stakeholders; some requisite diversity and comfort with dissent in constituting project groups; and undertaking practical shared tasks. We believe that these recommendations may also apply to other programme contexts, beyond the Tsitsa catchment, taking similar approaches.

We consider our insights and lessons to be applicable wherever scientists, managers and local communities come together to collaborate across traditional boundaries for the first time [19], to manage multifaceted ecosystems. Moreover, we consider our lessons to be particularly relevant for initiatives working in complex social-ecological systems with high heterogeneity, including differences in cultures, knowledge, power and wealth, along with contestation around resources and insecure governance. Under these conditions, collaborative praxis among different stakeholders is particularly challenging, and this kind of context is usually more common in the Global South than in the Global North [75]. However, according to our philosophical framing of complex adaptive social-ecological systems, we caution against generalisability in terms of frameworks, rules or blueprints. Rather, we suggest our findings as “principles of practice” [8], and encourage others to test these out in their contexts as part of reflexive learning processes. In this final section of the article we take a third analytical step to find even more general insights that are likely to apply across landscape management

initiatives being implemented in other socio-cultural and geographic contexts. To do this we use the Critical Realist framing as an analytical tool.

The diagram in Figure 5 shows the diverse stakeholder groups (operating from different domains of practice) and knowledge forms that the Tsitsa Project's guiding principles suggest should be brought together. Our findings show that this is generally not yet happening, and the following tensions are evident: Natural Science wants to but struggles to, engage Social Science and vice versa; they are not sure they trust and fully value each other's particular contribution to knowledge and lack the concepts to engage across the disciplines. Science wants to but struggles to, engage Management and Government, and the groups may find that they do not understand or appreciate each other's practical realities and incentive systems. Science wants to but falls short of, engaging rural Communities; once research is set up, funded and underway, little time remains for the "whole new ball game" of engaging catchment residents in need of more development and livelihood options. Scientists find indigenous and local knowledge very interesting but are not sure of its place in the scientific-academic endeavour. Rural communities feel disconnected from both universities and government which they see as resource rich and often uncaring entities; in the Tsitsa, the traditional leaders have been asking scientists to mediate on their behalf with government around the proposed dam, for example. Academic theories about participatory and polycentric governance clash with existing hierarchical, technocratic and bureaucratic governance structures which favour those currently in power and tend to disregard local knowledge and interests.



**Figure 5.** A bumpy terrain of multiple, interconnected dialectic tensions to be navigated by participants in the Tsitsa Project (grey area in the centre). This terrain is characterized by intersecting linkages between actors operating from different domains of practice informed by different knowledge systems (ovals on the left and right-hand side of the diagram).

Clearly, it is difficult to engage each other across disciplinary and cultural-historical divides. Can we conceptualise the situation in such a way that we can move forward in implementing good intentions—project principles—more successfully?

We drew the diagram in Figure 5 to explain our findings, then noted that it represented a series of dialectics, that is, "opposites" that are held in tension in that one is the absence of the other. A picture emerged of the Tsitsa Project as an attempt to implement principles for working in complex

social-ecological systems, represented by a bumpy terrain of different intersecting domains of practice, that are not easy to reconcile. The domains in which scientists, managers and catchment residents operate, have “differing logics, time dimensions, communication styles, rigor and relevance, and interests and incentives” [72] (p. 1181); and, we would argue, different histories and levels of status or power (the ovals on the left are drawn as larger than those on the right, illustrating these as currently the more powerful domains of practice). They also favour different knowledge systems [76]. Therefore, this terrain of intersecting domains is uneven, not a “level playing field.”

If this is a situation that many initiatives aiming to implement CSES and resilience principles find themselves in, what can be done to advance the field? We propose in this concluding section the explanatory metaphor of a bumpy terrain of dialectic tensions, and in particular, multiple interacting dialectic tensions, as a conceptual tool that can inform practical programme design and management decisions.

The concept of a dialectic has long been influential in the work of philosophers like Hegel and Marx (discussed by Bhaskar [38]) in relation to learning and deep-seated, “revolutionary” change, and more recently, for understanding the ways in which institutions operate in society [77]. Bhaskar, the theorist most closely associated with critical realism, described dialectics as “the pulse of freedom” [78]; they are transformative because they enable social actors to recognize “absences” (such as a lack of justice, equality, development options or resource conservation) and then moving to “absent the absences” [78,79]. The notion of a dialectic means that the tension is never resolved but the movement between them, with the critical consciousness of what the one has that the other lacks, is “the pulse” that helps actors to address a particular issue. Similarly, in organizational studies, Seo and Creed [20] argued that a dialectic perspective of institutional change reveals that institutional tensions and contradictions (as illustrated in Figure 5 for the Tsitsa Project) can be sources of change, and are an opportunity for actors to exercise agency.

The Tsitsa programme theory is that by bringing diverse actors and understandings together, better ways to achieve social-ecological sustainability in the landscape can be found (Figure 4). The notion of a dialectic helps us understand that science does not have to collapse into or be replaced by local knowledge, just as the natural sciences need not collapse into social sciences; and there need not be a wholesale rejection of either indigenous or scientific knowledge, as one seeks to address the limitations of one by engaging the other through a generative tension or dialectic (Figure 5).

When one realizes that a complete merger of opposites is not required, the task becomes more realistic. The pulse in the dialectic, the constant movement between the opposites, is perhaps a more manageable task. But, it is more than token engagement, as the concept of “absenting absences” implies. It is a task accomplished through deep engagement and learning, which in turn may necessitate a carefully bounded choice of context, at least to start with, working with smaller but representative slices of the complexity of the CSES. In the Tsitsa Project, the aim will be to monitor change across the entire catchment but to work in generative, learning-oriented and transdisciplinary ways in particular social-ecological locations.

The explanatory metaphor of the “bumpy terrain of multiple, interconnected dialectic tensions” (Figure 5) helps to shed light on the findings we presented above (Section 4.3), revealing two additional insights for praxis in CSES, and leading us to suggest further practical recommendations for the Tsitsa Project and others working in similarly complex contexts (Box 2).

Firstly, the explanatory metaphor (Figure 5) illuminates an expanding role for scientists and managers. A science-led intervention seeking societal change requires an expansion in the role and competencies of scientists, a point also made by Wittmayer & Schapke [80], Cockburn [81], and Rosenberg et al. [82], in relation to sustainability practitioners more broadly. It might be useful for Tsitsa Project participants—and others working in similar CSES programmes—to explicitly re-imagine themselves as transformative change agents in the process, recognising the importance of not only technical but also of relational and transformational competencies [82]. In a context where external constraints are perceived by many as a perhaps insurmountable barrier, a reminder that participants



potentially have transformative agency [20,83], could help to inspire people engaged in this deeply challenging work (See Box 2 for practical recommendations).

One such role scientists and managers play is that of mediator across boundaries of expertise [19]. The aim would not be to mediate “the Other” into the sciences, or management, development, politics or indigenous knowledge (for example) but to establish a move and exchange between knowledge forms, which could be seen as critical dialectics [38] to help participants understand that the knowledge required may sit within the system as a whole, and emerges out of relational processes [18,19].

Secondly, transformative social learning processes seem critical. By this we mean learning which is transformative in nature that is, learning not as acquisition, or even as participation or induction into existing communities of practice [19,84] but a shared seeking of new knowledge geared towards the collective transformation of existing practices and frames [15,85]. In many cases in CSES the knowledge needed may not (yet) be in the system, which is why we need social learning of the transformative kind [16,17,84], and transdisciplinary and collaborative research practices which are alert and open to the emergence of new knowledge and practices [65] (See Box 2 for practical recommendations).

**Box 2.** Practical recommendations and examples to support initiatives navigating multiple tensions for engaged praxis in complex social-ecological systems.

**To support the expanding role of scientists and managers:**

1. **Develop context-specific communication, advocacy, community engagement and knowledge management strategies:** this may be outside the comfort zone or expertise of participants (e.g., scientists and managers with training in natural resource management), however projects should partner with others to get new expertise into the team. This may require re-allocation of funding away from research, or alternative sources of funding, for example, the Tsitsa Project is investigating partnering with NGOs with expertise in rural development and agricultural extension; funding has been allocated for development of communication, community engagement and knowledge management strategies; plans are underway to appoint a local catchment co-ordinator and team of liaison officers to improve communication and engagement in the catchment and to better embed the initiative in the catchment.
2. **Investigate potential adjustments to incentive structures both for managers and scientists:** for example, for scientists: university awards and promotion criteria which incentivise community-engaged and change-oriented research (this is already becoming more prevalent at Rhodes University); for managers: develop ‘Key Performance Indicators’ which recognise managers spending time in engaged, collaborative processes, not only those which count ‘hard’ outcomes such as number of hectares of invasive plants cleared, number of jobs created and so forth. The Tsitsa Project still needs to reflect further on the role of incentives in supporting the potentially transformative work of the project, especially since we envisage expanding roles for participants.

**To support development of transformative social learning processes:**

3. **Carefully design for and support reflexive praxis:** make time and space for reflection and embed Participatory Monitoring Evaluation Reflection and Learning (PMERL) throughout the activities of the project by aligning reflection with other activities and appointing staff to manage and implement PMERL for example, the Tsitsa Project has recently appointed a PMERL co-ordinator; informal and fun reflection sessions take place after meetings over a cup of coffee or a drink before everyone heads home; participants are encouraged to reflect together while travelling to and from the catchment.
4. **Pay attention to the development of new inter-personal relationships beyond formal work activities to enable boundary-spanning and learning:** relationships of trust often deepen, enabling deeper reflection and learning, when participants interact ‘after hours’ or in a less formal setting other than a meeting. Therefore, we suggest structured activities for people to work together on something non-trivial but also not too daunting, for example, in the Tsitsa Project we plan to conduct collective in-field restoration or monitoring activities; and host social activities like ‘braais’ (barbeques) where scientists, managers and catchment residents can get to know each other and explore their shared values.

## 6. Conclusions

There is an ongoing need for reflective praxis, something not normally well supported by the traditional view of natural resource management and development projects unfolding in a neat linear fashion: starting with research, followed by “technology transfer” and “capacity building” [86].

Conventionally, these types of processes are seen to unfold without (or with very limited) social learning, reflexivity and praxis. This is however not consistent with the dynamic natures of CSES [59]. Here, the challenge is to recognise the ongoing change, uncertainty, emergence and surprise which characterise CSES and to find ways to permanently couple research praxiologically with governance and management processes. If the evolving patterns and principles induced in the SES can turn out to be self-maintaining or self-replicating, then some measure of more genuine sustainability might be achieved.

In this article, we have shared the challenges of one attempt at intervening in CSES, applying associated principles of praxis. In recognition that these challenges may be widely-experienced, we have reflected here on emerging insights and made small practical recommendations towards a stronger application of the principles of CSES thinking; transdisciplinary praxis; participatory governance; social learning and community engagement.

Based on the shared reflections of the Tsitsa Project participants that resulted in this article, a consciously designed reflexive process holds much potential. This process was well-received and has advanced our understanding of working in CSES. We offer our “pause and reflect” approach as a possible methodology for supporting reflexive research praxis in CSES, to be tried out, revised, and embedded in ongoing adaptation as we navigate the challenges of working in large CSES.

A deeper analysis of our findings, through a critical realist analytical lens, suggested a metaphor which helps to explain the challenges of working in CSES, and gives guidance on how to navigate them. If initiatives such as the Tsitsa Project are navigating a bumpy terrain of dialectic tensions, then the multiple, interacting tensions between distinct domains of knowledge and practice such as “natural science–social science,” “scientific management–community participation” or “science–management” can be viewed as generative rather than undesirable, providing we constantly seek to gain what is absent from the current situation. Better understood and critically engaged dialectic tensions can be treated as a source of transformative social learning—an opportunity for novel knowledge and practices to emerge from the tensions in the system. This may imply an expanding role for scientists and managers, as well as catchment residents, re-imagining themselves as mediators of different kinds of expertise and agents of change. To succeed in these re-imagined roles, the work needs to be embedded in a suitably designed, resourced and supported learning process, to allow for on-going adaptation and evolution of the CSES.

**Author Contributions:** Conceptualization, J.C., C.P., H.B. and E.R.; Formal analysis, J.C., C.P., H.B. and E.R.; Methodology, J.C. and E.R.; Writing—original draft, J.C.; Writing—review & editing, J.C., C.P., H.B. and E.R.

**Funding:** This research was funded by The Department of Environmental Affairs: Chief Directorate Natural Resource Management (Government of South Africa).

**Acknowledgments:** The authors have played mostly a convening role in the reflection and learning process on which this article is based. We acknowledge all Tsitsa Project/NLEIP participants who hold the programme’s collective knowledge. We thank in particular the following participants for joining us in individual and collective reflection sessions, and for sharing their insights: Michael Braack, Japie Buckle, Rienette Colesky, Laura Conde, Alta De Vos, Michael Kawa, Kyra Lunderstedt, Karen Milne, Nosiseko Mtati, Justice Ngcengane, Sarah Polonsky, Nina Rivers, Kate Rowntree, Ayanda Sigwela, Bennie van der Waal, Margaret Wolff and four participants who wished to remain anonymous. Thank you to Mike Powell for guidance, support and oversight for the process, to Karen Milne and Kyra Lunderstedt for assisting with communications, meetings, project information and maps, and to Margaret Wolff for editorial support.

**Conflicts of Interest:** The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

## References

1. Berkes, F.; Colding, J.; Folke, C. *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*; Cambridge University Press: Cambridge, UK, 2008.
2. Folke, C. Resilience: The emergence of a perspective for social-ecological systems analyses. *Glob. Environ. Chang.* **2006**, *16*, 253–267. [[CrossRef](#)]

3. Shackleton, S.; Luckert, M. Changing Livelihoods and Landscapes in the Rural Eastern Cape, South Africa: Past Influences and Future Trajectories. *Land* **2015**, *2015*, 1060–1089. [[CrossRef](#)]
4. Vetter, S. Development and sustainable management of rangeland commons—Aligning policy with the realities of South Africa’s rural landscape. *Afr. J. Range Forage Sci.* **2013**, *30*, 1–9. [[CrossRef](#)]
5. Shackleton, C. Will the real custodian of natural resource management please stand up. *S. Afr. J. Sci.* **2009**, *105*, 91–93. [[CrossRef](#)]
6. Biggs, R.; Rhode, C.; Archibald, S.; Kunene, L.M.; Mutanga, S.S.; Nkuna, N.; Ocholla, P.O.; Phadima, L.J. Strategies for managing complex social-ecological systems in the face of uncertainty: Examples from South Africa and beyond. *Ecol. Soc.* **2015**, *20*, 52. [[CrossRef](#)]
7. Powell, M.; Biggs, H.; Braack, M.; Ntabelanga and Lalini Ecological Infrastructure Project team. Ntabelanga and Lalini ecological infrastructure project. In *A Better World Volume 3: Ensure Access to Water and Sanitation to All. Actions and Commitments to the Sustainable Development Goals*; Nicklin, S., Cornwell, B., Trowbridge, L., Eds.; Tudor Rose: Leicester, UK, 2018; pp. 83–87.
8. Palmer, C.G.; Biggs, R.; Cumming, G.S. Applied research for enhancing human well-being and environmental stewardship: Using complexity thinking in Southern Africa. *Ecol. Soc.* **2015**, *20*, 53. [[CrossRef](#)]
9. Berkes, F. Evolution of co-management: Role of knowledge generation, bridging organizations and social learning. *J. Environ. Manag.* **2009**, *90*, 1692–1702. [[CrossRef](#)] [[PubMed](#)]
10. Ison, R.; Collins, K.; Colvin, J.; Jiggins, J.; Roggero, P.P.; Seddaiu, G.; Steyaert, P.; Toderi, M.; Zanolli, C. Sustainable Catchment Managing in a Climate Changing World: New Integrative Modalities for Connecting Policy Makers, Scientists and Other Stakeholders. *Water Resour. Manag.* **2011**, *25*, 3977–3992. [[CrossRef](#)]
11. Margerum, R.D. A Typology of Collaboration Efforts in Environmental Management. *Environ. Manag.* **2008**, *41*, 487–500. [[CrossRef](#)] [[PubMed](#)]
12. Roux, D.J.; Foxcroft, L.C. The development and application of strategic adaptive management within South African National Parks. *Koedoe* **2011**, *53*, 1049. [[CrossRef](#)]
13. Kingsford, R.T.; Biggs, H.C.; Pollard, S.R. Strategic Adaptive Management in freshwater protected areas and their rivers. *Boil. Conserv.* **2011**, *144*, 1194–1203. [[CrossRef](#)]
14. Cundill, G.; Rodela, R. A review of assertions about the processes and outcomes of social learning in natural resource management. *J. Environ. Manag.* **2012**, *113*, 7–14. [[CrossRef](#)] [[PubMed](#)]
15. Ison, R. Governing the human-environment relationship: Systemic practice. *Curr. Opin. Environ. Sustain.* **2018**, *33*, 114–123. [[CrossRef](#)]
16. Wals, A.E.J. Learning in a changing world and changing in a learning world: Reflexively fumbling towards sustainability. *S. Afr. J. Environ. Educ.* **2007**, *24*, 35–45.
17. Lotz-Sisitka, H.; Mukute, M.; Belay, M. The ‘social’ and ‘learning’ in social learning research: Avoiding ontological collapse with antecedent literatures as starting points for research. In *(Re)views on Social Learning Literature: A Monograph for Social Learning Researchers in Natural Resources MANAGEMENT and Environmental Education*; Lotz-Sisitka, H., Ed.; Environmental Learning Research Centre, Rhodes University/EEASA/SADC REEP: Grahamstown/Howick, South Africa, 2012; pp. 56–88.
18. Roux, D.J.; Nel, J.L.; Cundill, G.; O’Farrell, P.; Fabricius, C. Transdisciplinary research for systemic change: Who to learn with, what to learn about and how to learn. *Sustain. Sci* **2017**, *12*, 711–726. [[CrossRef](#)]
19. Edwards, A.; Kinti, I. Working relationally at organisational boundaries: Negotiating expertise and identity. In *Activity Theory in Practice: Promoting Learning across Boundaries and Agencies*; Daniels, H., Edwards, A., Engeström, Y., Gallagher, T., Ludvigsen, S.R., Eds.; Routledge: Oxon, UK, 2010; pp. 126–139.
20. Seo, M.-G.; Creed, W.E.D. Institutional Contradictions, Praxis, and Institutional Change: A Dialectical Perspective. *Acad. Manag. Rev.* **2002**, *27*, 222–247. [[CrossRef](#)]
21. Cockburn, J.; Biggs, H.; Rosenberg, E.; Palmer, C.G. *Tsitsa Project Learning Report 2018. Learning through Reflective Praxis: Lessons from Integrated Sustainability Research with a Governance Focus in a Complex Social-Ecological System, Eastern Cape, South Africa*; Tsitsa Project Internal Report; Rhodes University: Grahamstown, South Africa, 2018.
22. Fabricius, C.; Biggs, H.C.; Powell, M. *Research Investment Strategy: Ntabelanga and Lalini Ecological Infrastructure Project (NLEIP)*; Department of Environmental Science, Rhodes University: Grahamstown, South Africa, 2016.
23. Biggs, H.C.; Breen, C.; Slotow, R.; Freitag, S.; Hockings, M. How assessment and reflection relate to more effective learning in adaptive management. *Koedoe* **2011**, *53*, 1001. [[CrossRef](#)]

24. Van Wilgen, B.W.; Wannenburg, A. Co-facilitating invasive species control, water conservation and poverty relief: Achievements and challenges in South Africa's Working for Water programme. *Curr. Opin. Environ. Sustain.* **2016**, *19*, 7–17. [[CrossRef](#)]
25. Cumming, T.L.; Shackleton, R.T.; Förster, J.; Dini, J.; Khan, A.; Gumula, M.; Kubiszewski, I. Achieving the national development agenda and the Sustainable Development Goals (SDGs) through investment in ecological infrastructure: A case study of South Africa. *Ecosyst. Serv.* **2017**, *27*, 253–260. [[CrossRef](#)]
26. Bek, D.; Nel, E.; Binns, T. Jobs, water or conservation? Deconstructing the Green Economy in South Africa's Working for Water Programme. *Environ. Dev.* **2017**, *24*, 136–145. [[CrossRef](#)]
27. Parwada, C.; Van Tol, J. The nature of soil erosion and possible conservation strategies in Ntabelanga area, Eastern Cape Province, South Africa. *Acta Agric. Scand. Sect. B Soil Plant Sci.* **2016**, *66*, 544–552. [[CrossRef](#)]
28. Le Roux, J.J. Sediment Yield Potential in South Africa's Only Large River Network without a Dam: Implications for Water Resource Management. *Land Degrad. Dev.* **2018**, *29*, 765–775. [[CrossRef](#)]
29. Fernández-Manjarrés, J.F.; Roturier, S.; Bilhaut, A.-G. The emergence of the social-ecological restoration concept. *Restor. Ecol.* **2018**, *26*, 404–410. [[CrossRef](#)]
30. Sigwela, A.; Elbakidze, M.; Powell, M.; Angelstam, P. Defining core areas of ecological infrastructure to secure rural livelihoods in South Africa. *Ecosyst. Serv.* **2017**, *27*, 272–280. [[CrossRef](#)]
31. van Tol, J.; Akpan, W.; Kanuka, G.; Ngesi, S.; Lange, D. Soil erosion and dam dividends: Science facts and rural 'fiction' around the Ntabelanga dam, Eastern Cape, South Africa. *S. Afr. Geogr. J.* **2016**, *98*, 169–181. [[CrossRef](#)]
32. Rosenberg, E.; Human, H. *Tsitsa Project Participatory Monitoring, Evaluation, Reflection and Learning Inception Document, April 2018*; Environmental Learning Research Centre, Rhodes University Grahamstown: Grahamstown, South Africa, 2018.
33. Cundill, G.; Roux, D.J.; Parker, J.N. Nurturing communities of practice for transdisciplinary research. *Ecol. Soc.* **2015**, *20*, 22. [[CrossRef](#)]
34. Bannatyne, L.; Rowntree, K.; van der Waal, B.; Nyamela, N. Design and implementation of a citizen technician-based suspended sediment monitoring network: Lessons from the Tsitsa River catchment, South Africa. *Water SA* **2017**, *43*, 365–377. [[CrossRef](#)]
35. Sisitka, L.; Ntshudu, M.; Hamer, N.; de Vos, A. *Ntabelanga (Laleni) Stakeholder Analysis Report for the DEA: NRM Branch—Ntabelanga Laleni Ecological Infrastructure Project*; Tsitsa Project Internal Report; Rhodes University: Grahamstown, South Africa, 2016.
36. Rivers, N.; Burt, J.; Ntshudu, M.; Mtati, N.; Lunderstedt, K. *Lalini Rapid Stakeholder Analysis Report*; Tsitsa Project Internal Report; Rhodes University: Grahamstown, South Africa, 2018.
37. Popa, F.; Guillermin, M.; Dedeurwaerdere, T. A pragmatist approach to transdisciplinarity in sustainability research: From complex systems theory to reflexive science. *Futures* **2015**, *65*, 45–56. [[CrossRef](#)]
38. Bhaskar, R. *Enlightened Common Sense: The Philosophy of Critical Realism*; Routledge: Oxon, UK, 2016.
39. Mingers, J. *Explanatory Mechanisms: The Contribution of Critical Realism and Systems Thinking/Cybernetics*; Working Paper No. 241; University of Kent: Canterbury, UK, 2011.
40. Audouin, M.; Preiser, R.; Nienaber, S.; Downsborough, L.; Lanz, J.; Mavengahama, S. Exploring the implications of critical complexity for the study of social-ecological systems. *Ecol. Soc.* **2013**, *18*, 12. [[CrossRef](#)]
41. Rogers, K.H.; Luton, R.; Biggs, H.; Biggs, R.; Blignaut, S.; Choles, A.G.; Palmer, C.; Tangwe, P. Fostering Complexity Thinking in Action Research for Change in Social-Ecological Systems. *Ecol. Soc.* **2013**, *18*, 31. [[CrossRef](#)]
42. Bazeley, P. Integrative Analysis Strategies for Mixed Data Sources. *Am. Behav. Sci.* **2011**, *56*, 814–828. [[CrossRef](#)]
43. QSR International. *NVivo 11 for Windows. Edition: Pro.*; QSR International, Pty Ltd.: Melbourne, Australia, 2017.
44. Saldaña, J. *The Coding Manual for Qualitative Researchers*; SAGE Publications Inc.: Thousand Oaks, CA, USA, 2013.
45. Brand, G.; Morrison, P.; Down, B.; Westbrook, B. Scaffolding young Australian women's journey to motherhood: A narrative understanding. *Health Soc. Care Community* **2014**, *22*, 497–505. [[CrossRef](#)] [[PubMed](#)]
46. Bazeley, P. Analysing qualitative data: More than 'identifying themes'. *Malays. J. Qual. Res.* **2009**, *2*, 6–22.



47. Danermark, B.; Ekström, M.; Jakobson, L.; Karlson, J.C. *Explaining Society: Critical Realism in the Social Sciences*; Routledge: London, UK, 2005.
48. Biggs, H.; Clifford-Holmes, J.K.; Conde-Aller, I.; Lunderstedt, K.; Mtati, N.; Palmer, C.G.; Powell, M.; Rosenberg, E.; Rowntree, K.; van der Waal, B.; et al. *The Tsitsa Project (Previously NLEIP\*) Research & Praxis Strategy: Resource Library (Version 2) Informing Plans for 2018–2021*; Department of Environmental Science, Rhodes University: Grahamstown, South Africa, in preparation.
49. Biggs, D.; Abel, N.; Knight, A.T.; Leitch, A.; Langston, A.; Ban, N.C. The implementation crisis in conservation planning: Could “mental models” help? *Conserv. Lett.* **2011**, *4*, 169–183. [[CrossRef](#)]
50. Berkes, F.; Folke, C. *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*; Cambridge University Press: Cambridge, UK, 1998.
51. Folke, C.; Biggs, R.; Norström, A.V.; Reyers, B.; Rockström, J. Social-ecological resilience and biosphere-based sustainability science. *Ecol. Soc.* **2016**, *21*, 41. [[CrossRef](#)]
52. Biggs, R.; Schlüter, M.; Biggs, D.; Bohensky, E.L.; Burnsiver, S.; Cundill, G.; Dakos, V.; Daw, T.M.; Evans, L.S.; Kotschy, K.; et al. Toward principles for enhancing the resilience of ecosystem services. *Annu. Rev. Environ. Resour.* **2012**, *37*, 421–448. [[CrossRef](#)]
53. Cockburn, J.; Cundill, G.; Shackleton, C.; Rouget, M. Towards Place-Based Research to Support Social-Ecological Stewardship. *Sustainability* **2018**, *10*, 14–34. [[CrossRef](#)]
54. Pahl-Wostl, C.; Mostert, E.; Täbara, D. The Growing Importance of Social Learning in Water Resources Management and Sustainability Science. *Ecol. Soc.* **2008**, *13*, 24. [[CrossRef](#)]
55. Newig, J.; Fritsch, O. Environmental governance: Participatory, multi-level—And effective? *Environ. Policy Gov.* **2009**, *19*, 197–214. [[CrossRef](#)]
56. Palmer, C.G.; Munnik, V. *Practising Adaptive IWRM (Integrated Water Resources Management) in South Africa: Report to the Water Research Commission*; WRC Report No. 2248/1/18; Water Research Commission: Gezina, South Africa, 2018; Available online: <http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/2248-1-18.pdf> (accessed on 28 August 2018).
57. Biggs, H.C.; Clifford-Holmes, J.K.; Freitag, S.; Venter, F.J.; Venter, J. Cross-scale governance and ecosystem service delivery: A case narrative from the Olifants River in north-eastern South Africa. *Ecosyst. Serv.* **2017**, *28*, 173–184. [[CrossRef](#)]
58. Head, B.W.; Ross, H.; Bellamy, J. Managing wicked natural resource problems: The collaborative challenge at regional scales in Australia. *Landsc. Urban Plan.* **2016**, *154*, 81–92. [[CrossRef](#)]
59. van Kerkhoff, L. Developing integrative research for sustainability science through a complexity principles-based approach. *Sustain. Sci.* **2014**, *9*, 143–155. [[CrossRef](#)]
60. Roux, D.J.; Stirzaker, R.J.; Breen, C.M.; Lefroy, E.C.; Cresswell, H.P. Framework for participative reflection on the accomplishment of transdisciplinary research programs. *Environ. Sci. Policy* **2010**, *13*, 733–741. [[CrossRef](#)]
61. Hamer, N.G.; Lipile, L.; Lipile, M.; Molony, L.; Nzwana, X.; O’Keeffe, J.; Shackleton, S.E.; Weaver, M.; Palmer, C.G. Coping with water supply interruptions: Can citizen voice in transdisciplinary research make a difference. *Water Int.* **2018**, *43*, 603–619. [[CrossRef](#)]
62. Cockburn, J.; Rouget, M.; Slotow, R.; Roberts, D.; Boon, R.; Douwes, E.; O’Donoghue, S.; Downs, C.T.; Mukherjee, S.; Musakwa, W.; et al. How to build science-action partnerships for local land-use planning and management: Lessons from Durban, South Africa. *Ecol. Soc.* **2016**, *21*, 28. [[CrossRef](#)]
63. Ferguson, L.; Chan, S.; Santelmann, M.V.; Tilt, B. Transdisciplinary research in water sustainability: What’s in it for an engaged researcher-stakeholder community? *Water Altern.* **2018**, *11*, 1–18.
64. Lang, D.J.; Wiek, A.; Bergmann, M.; Stauffacher, M.; Martens, P.; Moll, P.; Swilling, M.; Thomas, C.J. Transdisciplinary research in sustainability science: Practice, principles, and challenges. *Sustain. Sci.* **2012**, *7*, 25–43. [[CrossRef](#)]
65. van Breda, J.; Swilling, M. The guiding logics and principles for designing emergent transdisciplinary research processes: Learning experiences and reflections from a transdisciplinary urban case study in Enkanini informal settlement, South Africa. *Sustain. Sci.* **2018**. [[CrossRef](#)]
66. Wondolleck, J.M.; Yaffee, S.L. *Making Collaboration Work: Lessons From Innovation In Natural Resource Management*; Island Press: Washington, DC, USA, 2000.
67. Stringer, L.C.; Dougill, A.J.; Fraser, E.; Hubacek, K.; Prell, C.; Reed, M.S. Unpacking “Participation” in the Adaptive Management of Social-ecological Systems: A Critical Review. *Ecol. Soc.* **2006**, *11*, 39. [[CrossRef](#)]



68. Brandt, P.; Ernst, A.; Gralla, F.; Luederitz, C.; Lang, D.J.; Newig, J.; Reinert, F.; Abson, D.J.; von Wehrden, H. A review of transdisciplinary research in sustainability science. *Ecol. Econ.* **2013**, *92*, 1–15. [[CrossRef](#)]
69. Krueger, T.; Maynard, C.; Carr, G.; Bruns, A.; Mueller, E.N.; Lane, S. A transdisciplinary account of water research. *Wiley Interdiscip. Rev. Water* **2016**, *3*, 369–389. [[CrossRef](#)] [[PubMed](#)]
70. Hillman, M. Justice in River Management: Community Perceptions from the Hunter Valley, New South Wales, Australia. *Geogr. Res.* **2005**, *43*, 152–161. [[CrossRef](#)]
71. Rosenberg, E.; Biggs, H. NLEIP Ecological Infrastructure Programme: The Learning Journey. Conference Presentation. In Proceedings of the Adaptation Futures Conference, Cape Town, South Africa, 19 June 2018.
72. Bartunek, J.M.; Rynes, S.L. Academics and Practitioners Are Alike and Unlike: The Paradoxes of Academic–Practitioner Relationships. *J. Manag.* **2014**, *40*, 1181–1201. [[CrossRef](#)]
73. *Social Learning towards a Sustainable World*; Wals, A.E.J.E. (Ed.) Wageningen Academic Publishers: Wageningen, The Netherlands, 2007.
74. Patterson, J. Purposeful collective action in ambiguous and contested situations: Exploring ‘enabling capacities’ and cross-level interplay. *Int. J. Commons* **2017**, *11*, 248–274. [[CrossRef](#)]
75. Ayala-Orozco, B.; Rosell, J.; Merçon, J.; Bueno, I.; Alatorre-Frenk, G.; Langle-Flores, A.; Lobato, A. Challenges and Strategies in Place-Based Multi-Stakeholder Collaboration for Sustainability: Learning from Experiences in the Global South. *Sustainability* **2018**, *10*, 3217. [[CrossRef](#)]
76. Tengö, M.; Brondizio, E.S.; Elmqvist, T.; Malmer, P.; Spierenburg, M. Connecting Diverse Knowledge Systems for Enhanced Ecosystem Governance: The Multiple Evidence Base Approach. *AMBIO* **2014**, *43*, 579–591.
77. Benson, J.K. Organizations: A dialectic view. *Adm. Sci. Q.* **1977**, *22*, 1–21. [[CrossRef](#)]
78. Bhaskar, R. *Dialectic: The Pulse of Freedom*; Routledge: London, UK, 2008.
79. Norrie, A. *Dialectic and Difference: Dialectical Critical Realism and the Grounds of Justice*; Routledge: London, UK, 2010.
80. Wittmayer, J.M.; Schöpke, N. Action, research and participation: Roles of researchers in sustainability transitions. *Sustain. Sci.* **2014**, *9*, 483–496. [[CrossRef](#)]
81. Cockburn, J.J. Stewardship and Collaboration in Multifunctional Landscapes: A Transdisciplinary Enquiry. Ph.D. Thesis, Department of Environmental Science, Rhodes University, Grahamstown, South Africa, 2018. Available online: <http://hdl.handle.net/10962/61267> (accessed on 23 October 2018).
82. Rosenberg, E.; Rosenberg, G.; Lotz-Sisitka, H.B.; Ramsarup, P. *Green Economy Learning Assessment South Africa. Critical Competence for Driving a Green Transition*; PAGE: Partnership for Action on Green Economy: Johannesburg, South Africa, 2016.
83. Westley, F.R.; Tjornbo, O.; Schultz, L.; Olsson, P.; Folke, C.; Crona, B.; Bodin, Ö. A Theory of Transformative Agency in Linked Social-Ecological Systems. *Ecol. Soc.* **2013**, *18*, 27. [[CrossRef](#)]
84. Engeström, Y.; Sannino, A. Studies of expansive learning: Foundations, findings and future challenges. *Educ. Res. Rev.* **2010**, *5*, 1–24. [[CrossRef](#)]
85. Ison, R.L.; Steyaert, P.; Roggero, P.P.; Hubert, B.; Jiggins, J. The SLIM (Social Learning for the Integrated Management and Sustainable Use of Water at Catchment Scale) Final Report. The SLIM Project. 2004. Available online: <http://slim.open.ac.uk> (accessed on 28 August 2018).
86. Leeuwis, C. *Communication for Rural Innovation: Rethinking Agricultural Extension*; Blackwell Science Ltd.: Oxford, UK, 2004.

