

**Editor Decision: Reconsider after major revisions** (07 Oct 2014) by Prof. Dr. Murugesu Sivapalan

Comments to the Author:

Dear Authors: I managed to obtain comments on your revised manuscript from three reviewers, two of whom reviewed your previous discussion paper. The reviewers do say that (1) the paper is potentially interesting, including for the special issue, and (2) it is considerably improved from your previous version. However, they are still not happy with the paper, and would like substantial improvements, especially to the coherence of the message and the presentation. I cannot in good conscience accept the paper with these comments. At the same I would like to close the special issue: I will give you one more opportunity to revise the paper considering these comments, provided you turn around the paper in less than a month, at which time I myself will take the final decision on the basis of how you have addressed these comments and made substantial improvements to the paper. It seems from the reviewers perspectives, your main focus should be on the presentation. I hope this is OK with you - the alternative is to reject the paper, which I do not want to do. All the hard work you put in will be wasted, and the special issue will miss an important contribution. If you have any comments or suggestions, please come back to me. I do look forward to a revised manuscript that I can accept in a few weeks. Thanks, Siva

***Response:*** *Thank you for the opportunity to revise the paper and resubmit. We have significantly revised the presentation as requested. We cleaned up a lot of inconsistent overlapping content that should remove the “paper by committee” problem. We have even gone beyond presentation revision and provided one entirely new figure with new data. All of the revisions are described in detail below in response to the reviewer comments. We hope you will see that we made substantive changes that significantly improved the paper.*

Report #1

Submitted on 23 Sep 2014

Anonymous Referee #2

**Anonymous during peer-review:** Yes No

**Anonymous in acknowledgements of published article:** Yes No

### Recommendation to the Editor

#### 1) Scientific Significance

Does the manuscript represent a substantial contribution to scientific progress within the scope of this journal (substantial new concepts, ideas, methods, or data)?

Excellent Good Fair Poor

#### 2) Scientific Quality

Are the scientific approach and applied methods valid? Are the results discussed in an appropriate and balanced way (consideration of related work, including appropriate references)?

Excellent Good Fair Poor

#### 3) Presentation Quality

Are the scientific results and conclusions presented in a clear, concise, and well structured way (number and quality of figures/tables, appropriate use of English language)?

Excellent Good Fair Poor

For final publication, the manuscript should be

**accepted as is**

accepted subject to **technical corrections**

accepted subject to **minor revisions**

reconsidered after **major revisions**

I would like to review the revised paper

I would NOT be willing to review the revised paper

**rejected**

Please note that this rating only refers to this version of the manuscript!

### **Suggestions for revision or reasons for rejection (will be published if the paper is accepted for final publication)**

The paper gives an interesting overview of issues of land and water use in New Mexico irrigation communities. Based on extensive data gathering of different kinds, several aspects are discussed. Within the general umbrella of "resilience", however, the links between the different aspects remain unclear. For a special issue on sociohydrology, the link between hydrology and resilience would deserve to be a major focus, and that is not the case. The paper offers a list of issues and data sets, not really an integration of the same.

**Response:** *We added a special section to drive home integration themes and revised throughout (as described in the responses to reviewers 2 and 3 below) with substantial attention to the issue of hydrology and resilience.*

Report #2

Submitted on 24 Sep 2014

Referee #4: Christopher Scott, cascott@email.arizona.edu

**Anonymous during peer-review:** Yes No

**Anonymous in acknowledgements of published article:** Yes No

### **Recommendation to the Editor**

#### **1) Scientific Significance**

Does the manuscript represent a substantial contribution to scientific progress within the scope of this journal (substantial new concepts, ideas, methods, or data)?

Excellent Good Fair Poor

#### **2) Scientific Quality**

Are the scientific approach and applied methods valid? Are the results discussed in an appropriate and balanced way (consideration of related work, including appropriate references)?

Excellent Good Fair Poor

#### **3) Presentation Quality**

Are the scientific results and conclusions presented in a clear, concise, and well structured way (number and quality of figures/tables, appropriate use of English language)?

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See report.

Referee Report: [hess-2013-508-referee-report.pdf](#) :

Review of Fernald et al. “Linked hydrologic and social systems that support resilience of traditional irrigation communities” (**hess-2013-508-manuscript-version3.pdf**) in light of prior review comments and authors’ responses (**hess-2013-508-author\_response-version1.pdf**).

This is an extremely interesting and rich paper, which addresses a topic of direct relevance to socio-hydrology and the HESS special issues. There is enough material here for numerous papers; the challenge is to synthesize it into concise and compelling analysis and future projections. I do recommend that it be published, but offer suggestions and comments here that may improve it.

***Response:*** *We greatly appreciate the thoughtful review and we paid special attention to the challenge as described in our revisions.*

The abstract is overly descriptive of the research conducted and should be reformulated to synthesize results.

***Response:*** *Abstract has been rewritten, de-emphasizing methods by discipline, and highlighting connections that influence resilience.*

In light of the strong linkages between hydrologic and social systems, I suggest including short descriptions of acequia communities and management systems from current sections 3.2 and 4 up into the Introduction. This sets the stage for subsequent detailed descriptions of hydrologic processes and social-economic dynamics.

***Response:*** *Content from section 4 moved to introduction.*

A better “roadmap” paragraph (instead of simply “Our approach in this paper is to briefly outline the key component issues” on p. 3) would guide the reader through the subsequent sections. Which are the most salient components to address resilience over the longer term?

***Response:*** *We rewrote this paragraph at the end of the Introduction. We feel that “salient components” are what we are looking to uncover during the research process and so fit better in later sections.*

Irrigation seepage is posed as an adaptive strategy. Is seepage intentionally preserved as a feature of head-tail dynamics along the acequia ditches? Is it a product of local materials, the result of relative abundance of water (within confines of land irrigable by gravity), or some combination of these? Comment on the scarcity-adaptation, and water spreading outcomes of seepage. The comment on “use of hybrid drip irrigation” in section 3.2 seems incongruent. See other papers in the HESS socio-hydrology series related to irrigation efficiency.

**Response:** *Irrigation seepage is not an intentional byproduct of gravity-flow acequias or flood irrigation, although there is at least one site where acequias are allowed to run longer than normal in the fall to provide more groundwater recharge. There appears to be more seepage in some irrigated floodplains than others based on size of stream and amount of irrigated land (something we are trying to understand by expanding research into more locations). The water-spreading outcomes of seepage are discussed in sections 2 and 2.1, and other points in the paper. “Hybrid” in “hybrid drip irrigation” has been removed.*

What does the paleo-climate record indicate were the hydrological extremes over the past 400 years of acequia resilience?

**Response:** *Interesting question to look at hydrologic extremes – we do not have the hydrologic data for our study area to directly correlate with historical records, which are also not organized in a way that we can readily compare for droughts of the last 400 years. This would require a separate study to do a careful and rigorous analysis, which we would like to do, but do not have ready for this publication.*

Fig. 4 plotted over five runoff seasons doesn't convey the time shift as effectively as Fig. 5; a simple statement would suffice to say that by the end of the 21<sup>st</sup> Century the shift is expected to be on the order of approx. 15 days.

**Response:** *Great suggestion. Deleted figure 4 and accompanying text and inserted text as suggested.*

The ICLUS and SWReGAP model descriptions are only loosely connected to the other sections; following the comments of an earlier reviewer that this often reads as a paper-by-committee, the entire section 2.3 could be removed (I realize this may be one author's work, and I regret to suggest this if the team effort would suffer).

**Response:** *We condensed into two paragraphs with no figure, put into more self-explanatory terminology making connections between acequias, riparian vegetation and habitat. Avoided climate-model specific terminology, removing ICLUS and SWReGAP model references. Much of section removed.*

Figs. 9 and 10 could be combined.

**Response:** *Thank you for the great suggestion. We combined figures 9*

*and 10 and revised the text accordingly.*

The changes in livestock numbers and type (Fig. 11, 13 – why separated by Fig. 12 on tracts?), plus the agricultural tracts (Fig. 12, Table 1) are only loosely connected to the other sections, and could be removed (my same regrets comment as above).

***Response:*** *We now provide USFS data that show state-wide grazing permits (a proxy for livestock numbers) on public lands administered by this federal agency. We include an entirely new figure. We believe that this new data set shows a trend that is consistent with what is described in Section 3.1. for Rio Arriba county. (This comment is duplicated in response to Reviewer 3 comment #4)*

Section 3.3 (Figs. 14, 15, 16) are rich in detail, though a single ‘take-home’ message doesn’t clearly emerge, or isn’t artfully brought out.

***Response:*** *This is discussed in summary form in the new integrative section 5.3.*

Was the 2008 New Mexico Acequia Association assessment survey conducted in isolation of (before) the rest of the research reported on here?

***Response:*** *Yes. Added text “(before the current research project reported here)”*

How do the views on parcientes’ participation or conflict translate into management decisions that in turn translate into modified (socio-) hydrological regimes and, further, into high or low resilience?

***Response:*** *We do not have clear data on this issue. There is a lot of local discussion about the lack of participation, but usually if the community does not participate, the complaint is that fewer people need to do the work of more and people need to be paid to do the work of the community. Our conjecture is that it does therefore impact resilience but more in terms of community cohesiveness and not so much in terms of hydrologic regimes (the acequias keep flowing). We are trying to get a sense of the impact with our system dynamics scenarios, but have not yet completed the modeling effort. For completeness, we added the conjecture to integrative section 5.3.*

Modeling based on the causal loop diagrams (Figs. 17 and 18) is an important step in this direction. It would be helpful to know the specific steps you envision when making

the statement at the bottom of p. 26, “In order to identify resilience, sustainability, thresholds, tipping points, and future directions for hydrologic and community health, our ongoing work is developing a model that brings together all scenarios to help identify higher levels of interaction than are obtainable with disciplinary approaches.”

**Response:** *Removed figure 17 in response to Reviewer 3 and cited the previous paper, which discusses these modeling steps. An overview of modeling steps remains in sections 5.1 and 5.2.*

Finally, in relation to the authors’ responses (to earlier review comments), “we don’t claim that 100% of all acequias have survived, but that the institution of the acequia still operates and functions,” it is important to distill the essential characteristics of this endurance. In view of changing hydrological regimes and external (urbanization) pressures – the two drivers posed as presenting the greatest threats – what are the hydro-hydraulic characteristics of the systems (leakage, upstream-downstream, main-stem or side-tributary, surface-groundwater conjunctive availability...) and the social-institutional (crop and livelihood diversification, local knowledge, mayordomos’ expertise...) that strengthen resilience?

**Response:** *We have highlighted some essential characteristics of adaptation and resilience in section 5.3 Integrating elements.*

Report #3

Submitted on 03 Oct 2014

Anonymous Referee #5

**Anonymous during peer-review:** Yes No

**Anonymous in acknowledgements of published article:** Yes No

### **Recommendation to the Editor**

#### **1) Scientific Significance**

Does the manuscript represent a substantial contribution to scientific progress within the scope of this journal (substantial new concepts, ideas, methods, or data)?

Excellent Good Fair Poor

#### **2) Scientific Quality**

Are the scientific approach and applied methods valid? Are the results discussed in an appropriate and balanced way (consideration of related work, including appropriate references)?

Excellent Good Fair Poor

#### **3) Presentation Quality**

Are the scientific results and conclusions presented in a clear, concise, and well structured way (number and quality of

Excellent Good Fair Poor

figures/tables, appropriate use of English language)?

For final publication, the manuscript should be

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I would NOT be willing to review the revised paper

**rejected**

Please note that this rating only refers to this version of the manuscript!

**Suggestions for revision or reasons for rejection (will be published if the paper is accepted for final publication)**

Overall, I found the topic of the paper interesting and relevant to the theme of the special issue. The authors have obviously invested in a tremendous amount of primary data collection and historical archival work which is commendable.

With significant revisions it would provide a valuable addition to the debate on socio-hydrology, coevolution and resilience.

However, I think the presentation needs to be substantially improved.

There are problems with the structure of the whole paper (how the pieces add up to a coherent argument) and within the individual pieces themselves (inconsistencies). I found the logic and arguments very difficult to follow.

***Response:*** *As we responded to the editor, we made substantive changes to the paper. Among those were a significant effort to tie the paper together with improvement to the different sections and addition of the overall integrative section 5.3.*

1. The paper is not very clear on what its objectives are. For instance it says “the goals of this study are to connect human and natural systems using real data..”. Interdisciplinarity and linking models cannot be an end goal of a paper. The goal **MUST** be to answer either a real-world or academic puzzle which requires interdisciplinary thinking and coupling.

***Response:*** *The paragraph on goals at the end of the Introduction has been rewritten. We believe our goals, if accomplished, will answer a real-world question.*

The unarticulated goal of the paper appears to be to explore if acequia systems are more

resilient. This has real world implications are profound and I think this is a worth goal. Conventional wisdom over the last ten years has been to improve water-use efficiency in agriculture and allow transfer/sale water to cities. Acequia systems have been vilified for being inefficient and a major policy thrust has been to invest in water-use efficiency, though a few studies are beginning to question this. The paper is in fact suggesting there are real-trade offs between efficiency and resilience. It would be great if this could be articulated early on.

***Response:*** *We adapted the goals to address resilience, and in section 2.1 we expand irrigation efficiency discussion (e.g., rewritten text: "Irrigation efficiency at the farm scale can lead to increased crop yields and less seepage past the plant rooting zone. Flood irrigation is used because it is inexpensive and traditional. Seepage is an unintentional byproduct of the flood irrigation. The seepage, groundwater recharge, and delayed return flow back to the river support important economic and ecological functions.")*

2. The paper comes off as a bit schizophrenic in Section 2. Is the goal to look backward to argue that acequia systems have been resilient in the past? Or is it trying to predict the future fate of acequia systems under different change drivers? The Abstract and Introduction would lead the reader to understand that only the first goal is being addressed. Personally, I feel these are (or could be) two different papers. I was a little thrown off by the climate scenarios (Sections 2.2 and 2.3) early in the paper. I recommend eliminating the projections entirely and just explore the changes from 1935 to 2011. It's OK to motivate the paper by mentioning the threat of climate change and changing economy, but better to keep the story focused on either the past or the future - it is complex enough as it is.

***Response:*** *Our intention is to show the history leading to the current situation and also examine the features that could impact resilience in the future. We removed a lot of the climate change scenario projection content from sections 2.2 and 2.3.*

3. The paper also keeps going back and forth between background material and data analysis. I realize that this is challenging since this paper's contribution is to collate and analyze a huge amount of historical data to derive a causal loop diagram, so writing the paper is challenging. However, the author's must be upfront about it. State your goals, locate them in important questions in the wider literature, acknowledge that the system is a complex one, then present your approach in the paper.

***Response:*** *We moved about one page of content into the introduction to put the historical part first. We revised the goals, acknowledge the complexity, and describe our approach in more detail.*

I think the authors need to sit together and write down – what does this paper argue in 5 simple

sentences.

For instance, I do not think the paper actually establishes that acequia systems are more resilient. At best, it provides a systematic approach to begin to ask such questions.

My reading of the paper is that this consists of three or four different pieces.

- What do past data on different components tell us about trends in the economy, agriculture, water use, water flows and ecosystems? Here I would organize them a little more logically. First, talk about the long term changes to the economy – there seem to be three dominant trends – the move to non-farm jobs and economic activity, the shift from subsistence farms to large agribusinesses and change in livestock holdings. Would be good to link each of these to changes in the water cycle – decrease in seepage, reduced upland grazing etc.
- Which pieces do we include so our model reflects what the community actually cares about? How does this affect management goals?
- What linkages do communities perceive – traditional knowledge on the hydrosocial cycle? How can we use local knowledge to develop a model of resilience?
- How do we put these together to come up with a model to assess resilience of acequia communities?

***Response: These are great ideas. We respectfully ask the reviewer to consider our viewpoint that addressing all of these would create an entirely different paper.***

4. I am not 100% sure I understand the link between livestock and acequia irrigation describe in Section 3.1.2. There are several statements that seem inconsistent. In Section 3.1.1 you state, that in the 1930s the main livestock were sheep and chicken. Then the region slowly changed to a cattle-based economy. Then In section 3.1.2 you state that livestock raising itself is disappearing as a way of life and reducing resilience and stability. To provide evidence Figure 13 shows cattle inventory from 1975 (I don't like the use of deviations – why not just show cattle populations? And Why not trace cattle populations from 1935 instead of just 1975). It seems to me that cattle populations increased, peaked in the 1970s and declined after 1980. But if cattle themselves are a recent phenomenon, how can their decline contribute to economic instability in the community?

***Response: We now provide USFS data that show state-wide grazing permits (a proxy for livestock numbers) on public lands administered by this federal agency. We include an entirely new figure. We believe that this new data set shows a trend that is consistent with what is described in Section 3.1. for Rio Arriba county.***

5. Similarly, I found the paper plunges into the hydrology early on but then only explains what an acequia system is only later in Section 4. Isn't it better to explain this early on? It's a little awkward to understand the details of recharge, seepage, and future climate (!) first and wait till the end of the paper to find out that acequia systems include a system of irrigation ditches, a set of operational rules to manage them and a socio-cultural way of life.

***Response:*** Content from section 4 moved to introduction.

6. I find the presentation of two separate causal loop diagrams in the paper (figure 17 and 18) confusing. Having been through a few “community workshops” to develop soft systems models myself, I sympathize; community members have the tendency to throw everything and the kitchen sink in into these models. Maybe since Figure 17 has been discussed in a different paper, its OK to include only the simplified model in Figure 18 here.

***Response:*** Great recommendation. Fig. 17 removed and previous paper cited.

7. I found the idea that water doesn't end up mattering at all intriguing. As hydrologists we like to believe that water availability drives everything. But what does the lack of correlation between income and water availability tell us about system resilience? Should we stop worrying about the resilience of acequia systems since it doesn't matter in the big picture?

I think the authors have side-stepped the elephant in the room here.

Sure, when asked acequia farmers say they care about whether their community spirit and their connection to the land - but it doesn't show up in the hard numbers. Does this mean our measures of resilience itself are wrong (Agribusiness Income in \$) or that farmers don't really care, they just say they do?

You cannot present this data and not address it in the narrative.

***Response:*** Addressed this comment in section 5.3 that includes take home message requested by Reviewer 2.

Minor changes

1. Font sizes in Figure 12 unreadable.

***Response:*** Fixed font size

2. Suggest combining Figures 9 and 10. Not much difference between 2002 and 2007. The point is to highlight the decline in small farms – may as well just show 1935 and 2007.

***Response:*** Figures combined and only 1935 and 2007 included as suggested.

3. Legend missing in Figure 16.

***Response:*** Described in caption