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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Endogenous change: on cooperation and water in ancient history" *by* S. Pande and M. Ertsen

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Response to reviewer Varady

Maurits Ertsen and Saket Pande

We would like to thank Varady for his thorough and well-structured review. In our response, we will discuss 4 issues: - The issue of determinism - The issue of social realities - The archaeological data used in the analysis - The data used

Determinism

Vardy sees our linking of hydrology and societal organization as deterministic – as if society does not have a choice to make in a drought and the answer is already known.

The issue of determinism is a tricky one. How much room is there between the statement that environmental conditions matter, as they influence societal arrangements and the statement that environment determines society? Our approach is based on two linked concepts. First, we think that the environmental context of society is a major structuring element in how society emerges over time. Second, although society's actors obviously have many choices to make on the short term, we see more similarities in results on the longer term of how societies respond to environmental conditions than differences. Specific to water, many societies have been confronted with stress – either because of limited water availability or excessive demand. We argue that in response, societies will develop mechanism to distribute stress more rationally over different groups – in our case upstream and downstream groups in a basin. In other words, increasing water stress might enhance cooperation. However, there would be a limit in how much stress cooperation can compensate for and deal with. Concerning these elements – environmental context, similarity of response, stress and cooperation – we are not alone in linking them, as many scholars in evolutionary studies and modeling do the same. What makes our study special is that we focus on water. Water control has been vital in emergence, development and collapse of larger civilizations of our planet, and it is likely that amounts of water available in relation to how much is asked plays a role in societal development.

Social realities

So, having stressed the importance of cooperation and societal development, how can one study those without taking into account the real social arrangements? We argue we can link water, cooperation and societal development without focusing too much on the actual social arrangements. First of all, please allow us to remark that what we do is not different from scholars who study societal institutions and ignore the agencies of the human beings inside those institutions that do the actual work. Where institutional analysis usually lumps all human actions together, so do we lump social institutions. We do not deny their existence, nor do we deny that their shape matters in what a

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society does. We would be the last one denying the need to fully understand human agency in thinking about longer term changes, as human actors are finally the ones that act. Nevertheless, we argue that one can study the results of that agency – in the form of growth of societies, or movement – without exactly knowing how those features were arranged at finer scales. On the time scales that we look at – many decades and centuries – the importance of societal detail is relative. We are, however, capable of seeing certain patterns in a single society. What we test and think we can argue in the paper is that certain parallel developments in growth and hydrology create similar patterns in different societies.

Archaeological data

If we accept the validity of the two lines of arguments developed above, we may be less in need of archaeological data on the finest level of detail than the reviewer suggests. What we do need is a good dataset (or a proxy data set) of societal growth – population numbers, settlement patterns etcetera – and hydrological data. Starting with the archaeological record we employ in the paper, the reviewer seems to have two worries. The first one is that we only include a limited set of publications (a remark especially made for the Hohokam case, although the actual number of references to that civilization in the paper is higher); the second one would be that we are only aware of a limited number of publications. We however use a good mix of secondary literature and the original (paleo) datasets for our two cases. We can assure the reviewer that our knowledge of the Hohokam literature is wider than our list of references suggest, but that for this paper we have chosen to use the volume of Hohokam collapse, supported with specific other references, to discuss this case. We include some material on the Gila River to show how complex the issues are in terms of societal trajectories, but even then we can see similarities in our analysis. If needed, we can include a more general overview of Hohokam studies in a newer version of the paper.

Hydroclimatological (paleo) data

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We are aware that a newer reconstruction of hydrological conditions (again) in the Hohokam area is available. The results of the later dataset are not contradictory at all with the one we used in our paper, as the basic pattern of dry and wet is similar, including larger fluctuations in the Classic period. There is a very simple, but important reason for using the rainfall data we applied: their timespan is longer. The reconstructed rainfall data from 2001 we used runs from 1000 AD to the present, whereas the reconstructed river flow data are available from shortly after 1300 AD. Due to this limitation of the reconstructed river flow data, we used reconstructed rainfall and temperature data for the southern Colorado plateau too. We chose it for two reasons: 1) it has as larger (common) span going back to 570 AD and 2) it allows us to understand 'regional' hydroclimatology in a proximate manner. Please note that we also used regional hydroclimatic proxies for the Indus as is a standard practice in paleoclimatology, paleoecology or other related fields.

Final remarks

We are thankful to Varady as he confirms that what we do in the paper is relevant for the discussions on coupled human hydrological systems. Furthermore, we appreciate his detailed comments, as these clarify how we can improve the paper, where we should strengthen our arguments and how we should write them down, including avoiding typos and jargon. We will make beneficial use of the review and prepare the next version of our paper including our own comments on the reviews.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 4829, 2013.