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Exploring panarchy and social-ecological resilience: Towards understanding water history in precolonial southern Africa

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Abstract

There is a growing corpus of social-ecological thinking in the field of resilience studies. One example is the pioneering work of Gunderson and Holling (2002) on panarchy. The work has had a significant impact on disciplinary collaboration between the natural and human sciences. It appears that the discipline of History can benefit particularly from these interactions – particularly within the framework of panarchy theory. In the front loop of panarchy, Gunderson and Holling have safely ensconced a "memory" feeder, a progressive trend leading towards the conservation and responsible exploitation of natural resources. In the panarchy model this phase is especially evident before the onset of almost inevitable creative destruction/collapse that paves the way for renewal in the back loop. The understanding of "memory" in the panarchy cycle focuses on institutional memory, traditional knowledge and memorialised experience of resource management. Special attention is given to "memory" in that it creates opportunities for historical thinking. By introducing a discourse on historical consciousness, the concept of memory moves more in line with formal historical thinking. The meaning of "creative destruction"/collapse is therefore categorised in terms of Rüsen's (2013) conception of sense-making of the crisis phenomenon. Interpretive historical thought can then find space in panarchy theory. At the same time the use of memory, from an ecological and social perspective could create a better understanding of indigenous and/or local knowledge systems

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related to the past. In the final section there is a brief discussion on the Iron Age in southern Africa (from about 200 to 1850CE), focusing specifically on the proto-urban development of Mapungubwe and Great Zimbabwe. The exposition is consciously opaque. The objective is to encourage the reader to think about the interpretation of water history in precolonial southern Africa.

Keywords: Panarchy; creative destruction; social-ecological systems; historical consciousness; urban development; Iron Age, southern African precolonial history; Mapungubwe, Zimbabwe.

Opsomming

Tans is daar ‘n groeiende korpus van werk op die terrein sosiaal-ekologiese veerkragtigheidstudies. Een voorbeeld is die baanbrekerswerk van Gunderson en Holling (2002) oor panargie. Die werk het ’n betekenisvolle invloed op samewerking tussen die natuur- en geesteswetenskappe uitgeoefen. Dit wil voorkom asof die dissipline van geskiedenis by dié interaksies kan baat vind – veral binne die raamwerk van panargieteorie. In die voorstevoeder van die panargie-siklus het Gunderson en Holling die konsep van “herinnering” ingevoer wat ’n progressiewe en bewegende tendens voorwaarts inlei. Dan volg ’n fase of vlak van bewaring en die verantwoordelike eksploitering van die natuurlike hulpbronne. In die panargiemodel is die fase duidelik tot op ’n punt waar daar ’n onafwendbare proses van kreatiewe destruksie/ineenstorting plaasvind. Daarna word die weg voorberei vir hernuwing in die agterste kurwe van die panargieproses. Die verstaan van “herinnering” hou verband met institusionele herinnering, tradisionele kennis en prysenswaardige herinneringe aan hulpbronbewaring. In die artikel word o.m. aandag gegee aan herinnering wat die geleentheid skep vir die ontwikkeling van historiese denke. Deur ’n diskoers oor historiese bewussyn in te voer word herinnering deel van formele historiese denke. Die betekenis van “kreatiewe destruksie”/ineenstorting word derhalwe gekategoriseer in terme van Rüsen se voorstelling van singewing aan die krisisverskynsel. Interpretatiewe geskiedenisdenke kan derhalwe met gemak in panargieteorie staanplek kry. Terselfdertyd word die gebruik van herinnering, vanuit ’n sosiaal-ekologiese perspektief, gebruik om inheemse en/of plaaslike kennisstelsels, in verhouding tot die verlede, beter te verstaan. In die finale afdeling word kortliks aandag gegee aan die Ystertydperk in die geskiedenis van suider-Afrika (sowat 200-1850 jaar voor die hede) wat spesifiek op watergeskiedenis en proto-stedelike ontwikkeling in die nedersettings van Mapungubwe en Groot Zimbabwe fokus. Die uiteensetting is noodwendig vaag en slegs in breë lyne aangestip. Die doelwit is om die leser se denke te stimuleer in die interpretasie van watergeskiedenis in pre-koloniale suider-Afrika.

Sleutelwoorde: Panargie; kreatiewe destruksie; sosiaal-ekologiese sisteme; historiese bewussyn; stedelike ontwikkeling; Ystertydperk; suider-Afrikaanse pre-koloniale geskiedenis; Mapungubwe; Zimbabwe.

Introduction

Since its emergence towards the end of the twentieth century multi-, inter- and transdisciplinary (MIT) research has made significant headway in a number of fields.[1] Marcovich and Shinn speak of a "new disciplinarity" that is a by-product of ever-increasing complexity in thinking over concepts, instrumentation and materials that are constitutive of science. This complexity is the result of the increasing production and variations in scientific learning since the seventeenth century.[2] The recent tendency to seek collaboration came from the quarters of natural scientists who developed an interest in the social sciences. There was also the need to reconsider the nature/science dichotomy in a global environment where concerns about the future have attracted the attention of both the social science/humanities and natural sciences.[3] For social scientists it has in turn, become necessary to explore the natural sciences. Jörg explains that in order to make the shift to address the current crisis in science, one should have a realisation and understanding of its complexity. Only then will it be possible to find out what is lacking, what is innovative and what can be considered novel.[4]

In the field of environmental science Gunderson and Holling's study on panarchy has had a marked impact on social-ecological thinking.[5] The origin of their

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1 . C. Pohl, "From Transdisciplinarity to Transdisciplinary Research", *Transdisciplinary Journal of Engineering & Science,* 1, 1 (December 2010), p 75.

2. A. Marcovich and T. Shinn, "Where is Disciplinarity Going? Meeting on the Borderlands", *Social Science Information,* 50, 3/4 (September-December 2011), p 584.

3. I. Scoones, "New Ecology and the Social Sciences: What Prospects for a Fruitful Engagement?", *Annual Review of Anthropology,* 28 (October 1999), pp 479-507; C. Calhoun and D Rhoten, "Integrating the Social Sciences: Theoretical Knowledge, Methodological Tools, and Practical Applications", in R. Frodeman, J.T. Thompson Klein, C. Mitcham and J.B. Holbrook (eds), *The Oxford Handbook of Transdisciplinarity* (OUP, Oxford and New York, 2010), pp 103-119; M. Ceruti, "Narrative Elements: A New Common Feature between the Sciences of Nature and the Sciences of Societies", *Review (Ferdinand Braudel Center),* 22, 1 (1999), pp 1-15.

4 . T. Jörg, New Thinking in Complexity for Social Sciences and Humanities: A Generative, Transdisciplinary Approach (Springer, London and New York, 2011), p 21.

5. L.H. Gunderson and C.S. Holling (eds), *Panarchy: Understanding Transformations in Human and Natural Systems* (Island Press, Washington, 2002); C.R. Allen, D.G. Angeler, A.S. Garmestani, L.H. Gunderson, and C.S. Holling, "Panarchy: Theory and Application", *Ecosystems,* 17, 4 (2014), pp 578-589.

concept is steeped in almost mythological content, pointing to a tendency to seek understanding in the softer sciences. For example, Gunderson explains that some of the influence for the development of the panarchy concept came from his brother, an artist, who drew illustrations of the indigenous South American deity, Kokopelli,[6] who is reputed to arrive in remote villages to cause confusion among the people in the community. Gunderson and Holling found the agency of unpredictability epitomised in the capricious actions of Kokopelli useful in the development of the panarchy theory to understand cross-scale dynamics. The term panarchy itself is derived from the name of the Greek god Pan, while "archy" has a bearing on laws. Hierarchy, Gunderson explains, is a "mirror that reflects sacred rules".[7] For the discipline of History there seem to be significant opportunities for exploration in the field of panarchy. Apart from offering a shift away from postmodernist thinking and a partial realignment with Annales-type thinking on the Braudelian long durée [8] and deep history,[9] the revival of constructive methodological analysis provides the opportunity for deeper discovery of hermeneutics in a phenomenological mode.[10] Of particular importance is the realisation that the past, as is the case with the present, is complex and far removed from regularity. Adams, working from an archaeological and anthropological perspective comes to the conclusion that in the human and natural worlds, complexity emerges as an overarching characterisation of irregularity, discontinuities and processes of accumulation.[11] Panarchy may perhaps be useful for thinking about the natural world from a humanities perspective.

Historians are often wary of excessive theorisation leading to universalist and reductionist thinking. Yet, the attraction of open-ended and constant self-replicating infinite panarchical cycles as a way of looking at the past, provides an opportunity, especially for environmental historians, to see iterative processes at work in the past. These are useful pointers for the understanding of historical processes where, for example, written source materials are not readily available. When panarchy offers the

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6 . A fertility deity in native American culture, said to be a hump-backed flute player. See Anon., "Kokopelli", Wikipedia at http://goo.gl/ECkHo (Accessed 11 March 2015).

7. L.H. Gunderson, "Dr Gunderson Tells the Story of Panarchy", *You Tube* at http://goo.gl/fue18p (Accessed 2 December 2012).

8. D. Armitage, "What's the Big Idea? Intellectual History and the Long Duréé", *History of European Ideas,* 38, 4 (2012), pp 493-507.

9. D. Leibman, Deep History: A Study in Social Evolution and Human Potential (SUNY Press, New York, 2007).

10. See P. Ricoeur, "Phenomenology and Hermeneutics", *Noûs,* 9, 1, Symposium papers read at the Western Division of the American Philosophical Association in Chicago, 24-26 April 1975, pp 85-102; S.M. Laverty, Hermeneutic Phenomenology and Phenomenology: A Comparison of Historical and Methodological Considerations", *International Journal of Qualitative Methods,* 2, 3 (2003), pp 21-35.

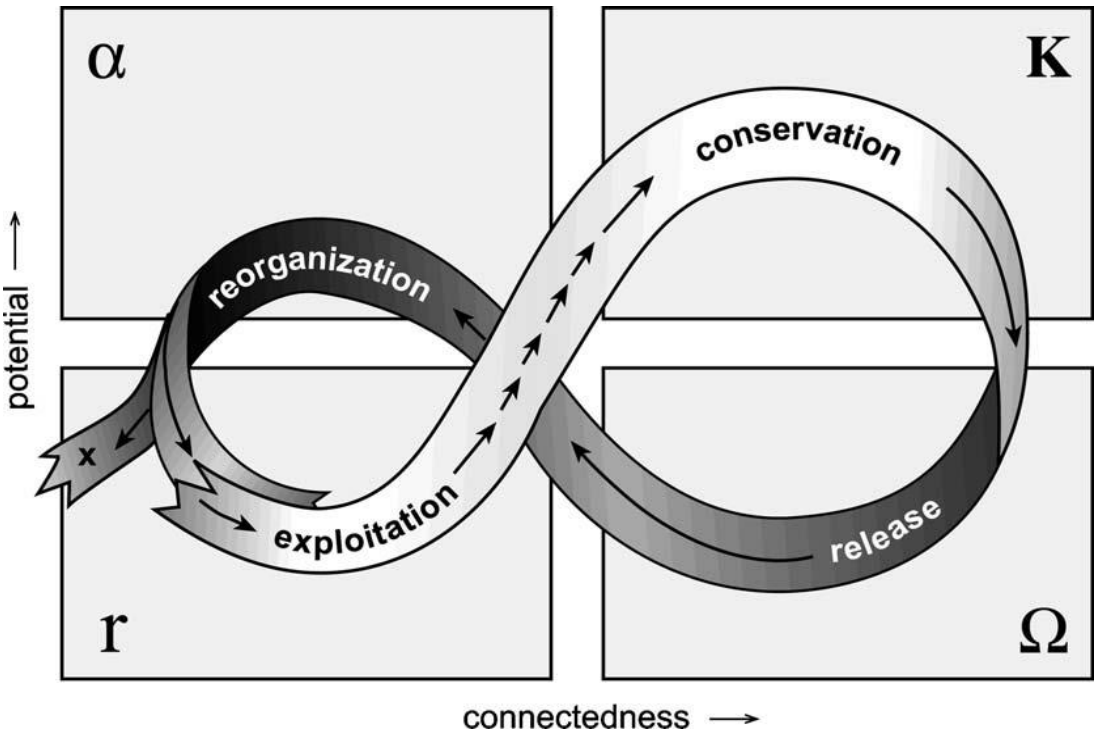
11. R. McC. Adams, "Complexity in Archaic States", *Journal of Anthropological Archaeology,* 20, 3 (September 2001), pp 345-360.

opportunity for non-linear thought and encourages one to think beyond states of equilibrium, there is a creative space for historical thinking to flourish.[12]

In outline, the focus of this discussion is initially on the theory of panarchy before turning to panarchy and cyclical theory; sigmoid curves and panarchy; front and back loop thinking; and adaptive management. Then follows a discussion on memory studies and historical consciousness before considering the emergence and process of change. The theoretical exploration of panarchy, social-ecological systems and resilience was a platform for the author's project of exploring southern African water history. The final section is a cursory reflection on a strategy for a better empirical understanding of the pre-colonial water history of the subcontinent.

Panarchy

Panarchy is defined in a variety of ways. According to Holling it is intended to "capture the way living systems persist and yet innovate".[13] It is a concept that by working in various scales of size, shows how ecosystems, through evolution, can change. At the same time it shows how events and processes can "transform humans and their societies through learning of the chance of learning".[14]



12. E.J. Carruthers, "Tracking in Game Trails: Looking Afresh at the Politics of Environmental History in South Africa", *Environmental History*, 11, 4 (October 2006), p 818.
13. C.S. Holling, "From Complex Regions to Complex Worlds", *Minnesota Journal of Law, Science and Technology,* 7, 1 (2005/6), p 1.
14. Holling, "From Complex Regions to Complex Worlds", p 1.

Figure 1: The basic infinite set of phases in the panarchy cycle[15]

The roots of panarchy can be traced back to the nineteenth century at a time in Europe when the concept of anarchy was fashionable. However, it may have an even longer history. Franciscus Patricius (1529-1597), a Dalmatian cosmopolitan philosopher, is said to have used the concept in a treatise on universal philosophy.[16] In the nineteenth century Emille de Puydt (1810-1891), a Belgian botanist and philosopher on occasion published an article in *Revue Trimestille* in which he applied panarchy theory to social and political relationships. It was for him a descriptor of space for economic competition. It is a space with choices and decisions that would typically determine how people function in society.[17] The biological thinking that informed panarchy has resonated well in seeking ways for understanding human society. There is acceptance for the diversity of ecological systems and multiple systems of order and disorder that can exist literally side-by-side in nature and also in society. Moreover, it becomes evident that panarchy is not exclusively a result of the workings of humankind. There is also a dynamic ecology within which humans form part of a rich cultural biodiversity.

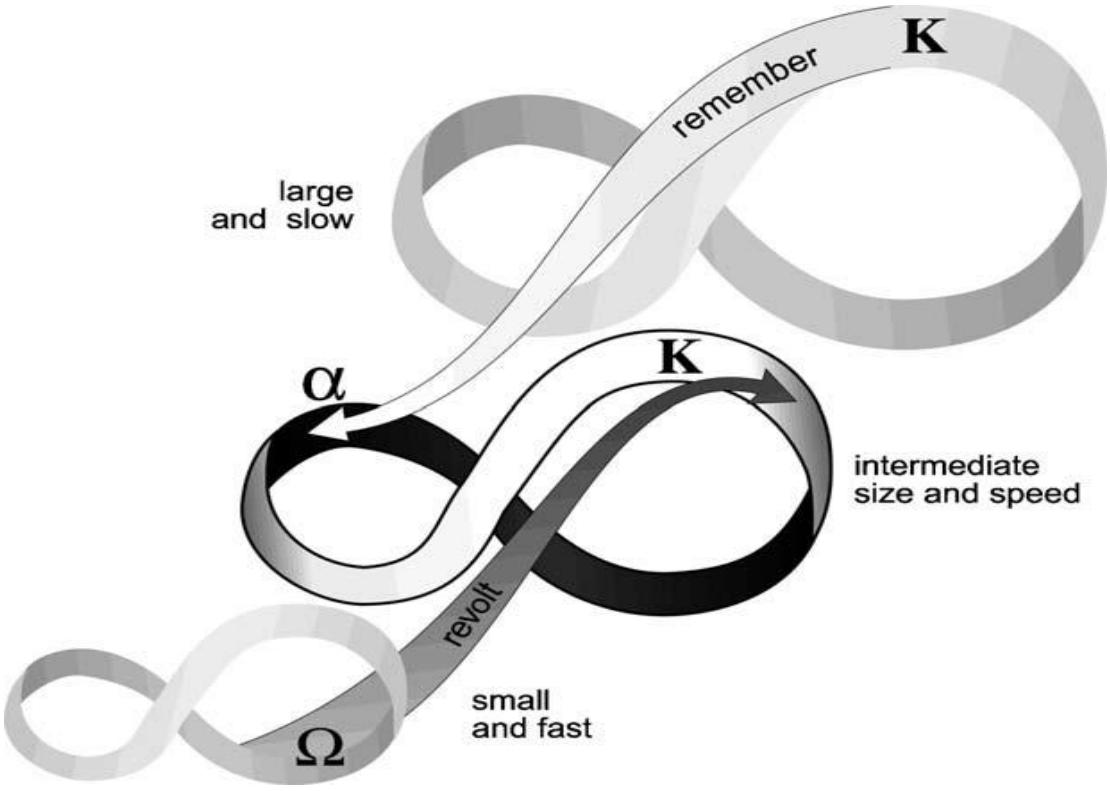
Panarchy brings into play the infinite nature of constant change that is evident in nature. There is little equilibrium and frequent change takes place over short or extended periods of time. A "flip" in the natural cycle can restore a former ecological state, or it may abruptly change it, leading to a state of collapse. Ultimately the objective of environmental scientists is to comprehend the complex processes contributing to states of increased activity, productivity, conservation, collapse, and re-start, followed by an upward trend in the consumption of the available resources in an ecological system.

An appealing feature of panarchy is that it becomes possible for historians to take into account the dynamics of fast, slow and cross-scale interactions as well as the interdependency of social ecological systems.[18] In short, there is space for innovative idiographic thinking that can potentially override nomothetic thinking in processes of interpretation and analysis.[19] Interdisciplinary theorists single out the strength of panarchy as a tool for studying social and ecological systems and understanding a

15. Illustration, Gunderson and Holling (eds), *Panarchy*. See J.E. Gary, "Towards a New Macrohistory: Extension of Sardar's 'Postnormal' Times'", *Futures,* 43, 1 (2011), p 49.
16. G.P. de Bellis, "On Panarchy", at http://goo.gl/xTvPsU (Accessed 11 March 2015).
17. P.E. de Pruydt, "Panarchy", *Revue Trimestrielle* (July 1860). Translated as "Panarchy", Gateway to selected documents at http://goo.gl/uwa8Sw (Accessed 11 March 2015).
18. C. Folke, "Resilience: The Emergence of a Perspective for Social-ecological Systems Analyses", *Global Environmental Change,* 16 (2006), p 258.
19. W. Krohn, "Interdisciplinary Cases and Disciplinary Knowledge", in Frodeman et al (eds), *Oxford Handbook of Interdisciplinarity,* pp 33-34.

historical event "more organically'.[20] From the outset it is accepted that cycles take place in different scales and at different times. Furthermore, there is no distinct or predictable outcome at all times. Too many external and internal dynamics have a profound influence on the way change takes place.

Figure 2: Holling's panarchical connections[21]



Panarchical and cyclical theory

In a panarchy cycle there are essentially four phases: 1) exploitation (Γ); 2) conservation (K); 3) release/creative destruction (Ω); and 4) reorganisation (α). The cycle is key to understanding the process of adaptation. In panarchy ecological and

20. B. Weeks, M.A. Rodriguez, J.H. Blakeslee, "Panarchy: Complexity and Regime Change in Human Societies", in Proceedings: Santa Fe Institute, 2004.

21 . From Gunderson and Holling (eds), *Panarchy,* Reproduced with permission of Island Press, Washington DC.

social-ecological systems tend to form nested sets of adaptive cycles. The larger cycles are slower and constrain the faster ones. They also tend to maintain integrity, whereas the faster cycles become unpredictable and trigger off responses that may give rise to revolt.[22]

For historians, at face value panarchy reminds one of modern cyclical historical theories which have relied on ancient myths and mythology discourses,[23] and since the seventeenth century on comprehensive systems outlined in the works of Giambettista Vico,[24] Benedetto Croce,[25] Oswald Spengler,[26] Pitirim Sorokin[27] and Arnold Toynbee.[28]

The historian Niall Ferguson recently outlined the concept, but from a collapse perspective, based on the works of the American artist Thomas Cole, founder of the Hudson River School. Cole depicted the course of empire from the process of rise to its fall and literal collapse in five paintings.[29] The selected works of art, dating back to the 1830s offer an interesting insight into Cole's visualisation of a sense of idealistic frontier consciousness with impressive natural landscapes transformed into a pastoral tranquillity – typical romanticised North American landscapes. The sense of empire and its collapse is represented in classical European urbanscapes in times of peace and prosperity, but also in states of war. Cyclical theory that ends in discourses of collapse has featured prominently in recent times especially in the field of end-time thinking of environmental thought and why states fail.[30] However, there has been a significant critique of conceptions of ecological collapse thinking in deterministic historical discourses. Jarred Diamond's *Collapse: How Societies Choose to Fail or*

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22. N.M. Gotts, "Resilience, Panarchy and World-systems Analysis", *Ecology and Society,* 12, 1 (2007), p 24 at URL: http://goo.gl/vKeX5x (Accessed 11 March 2015).
23. D.R. Kelley, "Intellectual History: From Ideas to Meaning", N. Partner and S. Foot (eds), *The Sage Handbook of Historical Theory* (Sage, Los Angeles, 2013), pp 82-83.
24. P. Hutton, "The New Science of Giambettista Vico: Historicism and its Relation to Poetics", *Journal of Aesthetics and Art Criticism,* 30, 3 (Spring 1972), pp. 359-367.
25. See comments by author on Croce in S. Kracauer, "Time and History", *History & Theory,* 6 (1966), pp 75-76.
26. O. Spengler, Der Untergang des Abendlandes: Umriss einer Morphologie der Weltgeschichte (Beck, München, 1922/3).
27. P.A. Sorokin, "A Survey of the Cyclical Conceptions of Social and Historical Process", *Social Forces,* 6, 1 (September 1927), pp 28-40.
28. A. Toynbee, "My View of History", in P. Gardiner (ed.), *Theories of History* (The Free Press, New York, 1959), pp 205-210.
29. N. Ferguson, "Empires on the Edge of Chaos", *Foreign Affairs,* 89, 2 (March/April 2010), pp 18-32.
30. E.H. Cline, *1177 B.C.: The Year Civilization Collapsed* (Princeton University Press, Princeton, 2014); D. Acemoglu and J. Robinson, *Why Nations Fail: The Origins of Power, Prosperity, and Poverty* (Crown Publishers of Random House, New York, 2012).

Succeed (2005) is perhaps one of the most popular environmental historical interpretations of collapse.[31] It also attracted considerable criticism.

In contrast, taken at face value, panarchy [32] tends to shift from a survivalist discourse of collapse[33] to resilience, which is far more useful. Previously the historian would have made a concerted effort to steer clear of zero-sum game theory in the history of events – especially over the long term. In resilience thinking it makes sense to understand continuity. Panarchy, integrated with resilience, has the potential to open up areas of exploration for long-term thinking.[34] On the whole, panarchy is a forward thinking theory.[35] Yet, there is nothing preventing the absorption of historical thinking in the process of responding to the need for adaptation in the present time. Perhaps the important redeeming element of panarchy is the fact that it is by no means prescriptive. It merely provides a framework for comprehending singular events in given contexts.

Until the 1990s, environmental managers, as a rule, worked on the deterministic theoretical foundations of resource management. Many used sigmoid curve theory.[36] This approach strengthened the focus on an outcome of "collapse". In panarchy the linkage between cycles featured in the front and back loops become what futurists call the "two-stroke model of' punctuated equilibrium"/equilibria,[37] the latter being a theory of evolutionary biology that takes note of stasis in genetic evolution over geological time spans.[38] In many respects determinism and the compulsion to seek equilibrium becomes more pragmatic and sensitive to unique processes of change that never quite repeat themselves in the same way.

Front and back loop thinking

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31. J. Diamond, *Collapse: How Societies Choose to Fail or Succeed* (Viking Press, New York, 2005).
32. For a good outline, see Gunderson and Holling (eds), *Panarchy* (Synopsis by B Wuetrich, Kindle edition, Island Press, Washington, 2002), Chapter 3.
33. K.W. Butzer, "Collapse, Environment, and Society", *Proceedings of the National Academy of Science of America,* 109, 10 (6 March 2012), pp 3632-3639.
34. S. Brand, K Kelly, A Rose and P Saffo, *The SALT Summaries: October 2003–June 2012* (Kindle version: The Long Now Foundation, San Francisco, 2013); R.A. Slaughter, "Long-term Thinking and the Politics of Reconceptualisation", *Futures,* 28, 1 (February 1996), pp 75-86.
35. Holling, "From Complex Regions to Complex Worlds", p 4.
36. F. Berkes and C. Folke, "Back to the Future: Ecosystems, Dynamics and Local Knowledge", in Gunderson and Holling (eds), *Panarchy,* location 2654.
37. Gary, "Towards a New Macrohistory", p 49.
38. N. Eldredge and S.J. Gould, "Punctuated Equilibria: An Alternative to Phyletic Gradualism", in T.J.M. Schopf (ed.) *Models in Paleobiology* (Freeman Cooper, San Francisco, 1972), pp 82-115.

Front and back loop transitions offer attractive thinking paradigms for historians, especially when the driving forces suggest "memory" and "revolt". It is here where change in time and space is manifest and there are distinct trends that contribute towards a better understanding of the way nature and culture interact. In the analysis of front loops it is possible to make predictions.[39]

The constant forward-moving trend tends to capture stability in the process of exploitation.[40] If there is prudence in resource harvesting the K-phase can last over an extended period of time, providing there are no events on the fringes causing debilitating disturbances. If there are endogenous agents of change, the way in which influential agents in the dominant social ecology adapt and remain absorbed in the downward phase, determines whether it becomes a process of "creative destruction". Creative destruction, a term coined from Marx[41] and outlined by the economist, Joseph Schumpeter (1883-1950), suggests that change, in for example a social-ecological system, is never static. Economic life, for example, merely goes on in a social and natural environment, but in the process there are changes in the shape of the economic actions taking place. The changes are often the result, for example, of wars or revolutions – and also natural phenomena, such as droughts, floods and earthquakes, but they are not prime movers. The real game changers are, more than often, the new consumers of goods, new methods of production, transportation/ communication, new markets, new forms of industrial production and the type of organisation created by economic enterprise.[42]

It then stands to reason that institutions of knowledge are created where there are appropriate management strategies. In the context of this article, these are management strategies, for example, for the use of the water supply. As will become evident in the final section, the example of southern African water history in the Iron Age (200–1850CE) implies that ecological factors, such as the functional availability of water resources, shaped governance and management strategies in the social sphere of pre-colonial societies. Polities, states and empires were shaped by emergent urban formations that were also directly informed by governance strategies in a variety of social ecological settings.

Back loop transition

39. Holling, "From Complex Regions to Complex Worlds", pp 6-7.
40. Gary, "Towards a New Macrohistory", p 49.
41. J.E. Elliott, "Marx's 'Grundrisse': Vision of Capitalisms' Creative Destruction", *Journal of Post Keynesian Economics,* 1, 2 (Winter 1978/9), pp 148-169.
42. J.A. Schumpeter, *Capitalism, Socialism and Democracy* [1942] (Harper Row, New York, 1975), p 82.

Panarchy cycle theory posits that the transition in the back loop is more unpredictable. This is where changes take place in a most marked manner.[43] When growth is literally halted, deep uncertainty explodes. At this juncture, several alternative futures come to the fore. The variety of circumstances in the back loop represent conditions of crisis. At the same time, they hold potential opportunity. Holling explains: "During a back loop, unexpected interactions can occur among previously separate properties that can then nucleate an inherently novel and unexpected focus for future good or ill in the next cycle".[44]

Unpredictability becomes master of the process. There is always the potential for small externalities to have major consequences. At the same time major events can have a minimal influence on change. Futurist thinkers on the environment suggest that the back loop creates fertile ground for radical social innovation.[45] For the discipline of History, back loop thinking can broaden perspectives on deep historical trends. Historians primarily think in the past, but are increasingly becoming sensitive to the need for understanding the present and the future. For example, a focused and orderly approach to conserving the environment in terms of governance is a fairly recent innovation. It is said to have been as a consequence of the eighteenth-century industrial revolution that by the twentieth century created concerns about the state of the natural environment. This led to the realisation that environmental degradation might jeopardise sustainability.[46] Currently there is an acknowledgement that globally, human societies have been instrumental in the process of a new geological epoch – the Anthropocene.[47] In more recent time there is a tendency to accept resilience thinking, instead of conventional value-laden sustainability. The change in accent could lead to greater spontaneous social ecological awareness.[48] A focus on panarchy's back loop from a resilience perspective

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43. Holling, "From Complex Regions to Complex Worlds", pp 6-7.
44. Holling, "From Complex Regions to Complex Worlds", p 10.
45. R. Biggs, F.R. Westley, and S.R. Carpenter, "Navigating the Back Loop: Fostering Social Innovation and Transformation in Ecosystem Management", *Ecology and Society,* 15, 2, (2010); and Article 9 at URL: http://goo.gl/AEYS43 (Accessed 11 March 2015).
46. G. Haq and A. Paul, *Environmentalism since 1945* (Routledge, Abingdon, 2012), Chapters 2 and 4.
47. C.N. Waters, J. Zalasiewicz, C. Summerhayes, A.D. Barnosky, C. Poirier, A. Gałuszka, A. Cearreta, M. Edgeworth, E.C. Ellis, M. Ellis, C. Jeandel, R. Leinfelder, J.R. McNeill, D. de B. Richter, W. Steffen, J. Syvitski, D. Vidas, M. Wagreich, M. Williams, A. Zhisheng, J. Grinevald, E. Odada, N. Oreskes and A.P. Wolfe, "The Anthropocene is Functionally and Stratigraphically Distinct from the Holocene", *Science,* 351(6269), 8 January 2016, available at DOI:10.1126/science.aad2622 (Accessed 10 January 2016).
48. T Elmqvist, "What is the Difference between Sustainability and Resilience and How Does it Matter for Cities? Lecture at the School of Environmental Sciences, North-West University, Potchefstroom, 18 November 2015.

provides valuable opportunities for understanding how uncertainty shapes social ecological systems under circumstances of radical change.

Adaptive management

Adaptive management is the responsibility of institutions that have codified rules, laws and legitimacy within a social-ecological system. They prescribe how society should function and what decisions should be taken.[49] At the same time adaptive management is notable for its inherent flexibility in method and conceptualisation. It begins with a simple "learning by doing" and then progresses to rigorous systems with sound planning and experimental design with a systematic evaluation process that makes it possible to monitor management. Adaptive management strategies are by no means "new" approaches. In fact, in the 1990s pioneers of social ecological resilience research, many of whom helped in the formulation and development of panarchy theory, worked from strategies of local indigenous knowledge and the way customs shaped human thinking. At the heart of the system was an understanding of how to take care of ecological systems. For the panarchy researchers it was evident that there were:

1. practices in conventional resource management, similar to those in traditional societies;
2. practices that had been abandoned in conventional resource management that still formed part of traditional societies' thinking; and
3. those that were both in conventional and traditional societies, but no longer being observed in conventional management strategies.[50]

Naturally, then, when ecologists refer to management and governance institutions, social-ecological terms feature prominently. These in turn are steeped in laws, traditions, customs and codes of behaviour. In short, we have history and mnemonic consciousness. In fact, as social-ecological systems thinking began to gain momentum in the early 1990s it was evident to Scoones that there was an increasing accent on people and places in analyses. There was acknowledgement of the role that history had to play in understanding change in time and space. Dynamic processes were seen at work in nonlinear interactions across hierarchies in systems analysis.[51] At the same time greater significance was attached to temporal dynamics, on current

49. Resilience Alliance, Assessing Resilience in Socio-ecological Systems: Workbook for Practitioners (Resilience Alliance, Version 2.0, 2010), p 8.
50. F. Berkes, J. Colding and C. Folke, "Rediscovery of Traditional Knowledge as Adaptive Management", *Ecological Applications,* 10, 5 (October 2000), p 1253.
51. Scoones, "New Ecology and the Social Sciences", p 483.

patterns and processes that provided better insight into paleoecology, evolutionary ecology and environmental history.[52]

Social mechanisms in traditional practices take care of local resources. They depend on local mechanisms that function in hierarchical patterns where knowledge flows from social institutions to mechanisms for cultural internalisation. In the process these interactions contribute to the development of worldviews.[53] These are clearly the result of historically evolved institutions where memory is directed towards management of the resources in the K phase. They are also informed by the knowledge acquired in the process of phases of creative destruction. Reorganisation in the back loop then provides new and novel approaches to finding solutions and optimising governance of the social-ecological system.[54] The responsibility for nurturing the appropriate resources for effective use is then understandably the domain of the traditional leaders who have acquired a historical consciousness of the way resources can be used effectively.[55] It is within this space that panarchical theorists conceive the seat of "memory".

Berkes and Folke see institutional memory in relation to resource use, essentially as the memory of experience that provides a sense of context for the modification of the way resources are used.[56] Institutional knowledge also incorporates local or traditional knowledge. In addition they suggest that "ecological knowledge" is a prerequisite "for the management and sustainable use of resources, biological diversity and ecosystems".[57] By implication, ecological knowledge seems to be seated in some type of memory. Thus, in view of the fact that they point to aspects of management, it implies that there has to be a sense of humanness about comprehending precisely what ecological knowledge is.[58] They go on to explain that institutional memory (also related to resource use), has a bearing on the "memory of experience" that provides strategies for the potential modification of resource-use rules and regimes.[59]

Memory studies and historical consciousness

Memory studies made significant headway in the post-World War 2 era when, in an attempt to understand the trauma created by the Holocaust, basic human memory

52. Scoones, "New Ecology and the Social Sciences", p 483.
53. Berkes, Colding and Folke, "Rediscovery of Traditional Knowledge", p 1256.
54. Berkes, Colding and Folke, "Rediscovery of Traditional Knowledge", p 1256.
55. Berkes, Colding and Folke, "Rediscovery of Traditional Knowledge", p 1258.
56. Berkes and Folke, "Back to the Future", location 2610.
57. Berkes and Folke, "Back to the Future", location 2613.
58. Berkes and Folke, "Back to the Future", location 2613.
59. Berkes and Folke, "Back to the Future", location 2611.

was explored extensively in an attempt to create a sense of comprehension from individuals in a larger collective of what had happened. The work of Pierre Nora on spaces of memory, as well as that of Maurice Halbwachs, asserted significant influence in much of the work emanating subsequently.[60] Memory also became an alternative, in the discipline of History, to replace the concept of historical consciousness. Historical consciousness had become suspect because this way of looking at the past created path dependencies for developing ideologies of nationalism, subservience to the state and the identification of heroes, villains, victors and the vanquished, in wars. In short, historical consciousness is the anathema for views of the past that make provision for diversified interpretations of the past.

Yet historical consciousness, contemplated from a methodological perspective offers in hermeneutics a pathway for comprehending how a collective of individuals would typically account for their past. For Dilthey, consciousness constitutes something that we are unable to experience. Instead, it is continuity between the past and the present (what we remember about the past and the present). It is the continuity of a qualitatively calculated reality and the continued efficiency of the past as a factor in the present. These are all literally traits of what we deem as "being present", or being conscious.[61] Luhmann, working on locating meaning, seeks a system of ontological metaphysics for coming to an understanding of consciousness, which he sees as a combination of being and thinking. The one cannot exist without the other. And yet, thinking becomes aware of itself as consciousness and characterises itself as negative and/or a mistake when it deviates from being.[62] It is this conundrum that contributes to a broader spectrum of states of historical consciousness that are seldom comprehendible.

Rüsen, an exponent of the method of Historik[63] as conceived by J.G. Droysen (1808-1884), suggests that in historical thinking the objective is to make sense (sinn). If the past makes sense it implies that the meaning attached to an event becomes a fact, there is a sense of knowing and comprehending how and why things are understood in a specific way. He speaks of three types of crises present in historical consciousness.[64] The first is an ordinary crisis, i.e. a past event that creates a problem and that can be resolved at short notice and little effort as part of the normal actions

60. For a philosophical and historiographical exposition, see M-C Lefebre, Historiography and Memory", in A. Tucker (ed.), *A Companion to the Philosophy of History and Historiography* (John Wiley, Malden, 2009), pp 362-370.
61. W. Dilthey, Pattern and Meaning in History: Thoughts on History and Society (Harper Torch Books, New York, 1962), p 99.
62. N. Luhmann, *Social Systems* (Stanford University Press, Stanford, 1995), pp 99-100.
63. J.G. Droysen, *Grundriß der Historik* (1857); also J.G. Droysen, *Outlines of the Principles of History,* trans. E.J. Andres (Athenaeum Press, Boston, 1893).
64. J. Rüsen, *Historik: Theorie der Geschichtswissenschaft* (BöhlauVerlag, Köln, Weimar, Wien, 2013), pp 50-51.

of the day. Then there are critical crises. In historical consciousness a critical crisis has a bearing on long term transitions, such as for example the historical period between 1740 and the late nineteenth century that predicated the era of industrialisation and the growth of capitalism after the Industrial Revolution that started in Britain. Koselleck called the phase in history the Sattelzeit, suggesting that immense changes were introduced in an ongoing manner and over an extended period of time.[65] Some of the changes appeared small; others were on the immediate horizon. Humans experiencing the present were consistently aware of how the new way of doing things, differed from former times. Thirdly, in historical consciousness there may be traumatic crisis conditions when there is an inability of connecting past and present because of the immense and far-reaching changes in the human condition. It is at such times of crisis that there is no way in which the present can be understood. It has no past examples; neither is it possible to see a way out in the future. The prospect of understanding what, why and how it all happened is simply incomprehensible.

Conceptualising the memory extension of panarchy from the slow and long process of time moving forward, to a mid-range level of resource exploitation heading towards the K-level in terms of historical consciousness, makes sense especially, as we will point out below. Adaptive management is then understood in terms of indigenous/local knowledge and in its rootedness in the experience of former times. As will be suggested below, the advent of human migration and settlement in southern Africa in the era of the Iron Age can be seen as sequences of successive and inter-related crises of a human presence that constantly re-defined the landscape and the endemic local resources – such as water.

Emergence and change

Key to understanding history is the comprehension of what constitutes change. History can be defined as the process of change and the way it manifests in time-spatial contexts. The way change crystallises out in the present is considerably different to a long-term view of slow change, or distant events in which change is only apparent over an extended period of time. In complexity thinking, as well as in resilience studies of social-ecological systems, the term emergence features prominently. Emergence has strong ties with scientific thinking and is usually associated with self-organisation and systems theory with deep historical roots.[66] It also suggests that under circumstances of emergence, novel properties of

65. R. Koselleck, "Über die Theorie Bedurftigkeit der Geschichtswissenschaft", in W. Conze (ed.), *Theorie der Geschichtswissenschaft und Praxis des Geschichtsunterrichts* (Klett Cotta, Stuttgart, 1972), pp 10-28.

66. A.T. Wood, "Fire, Water, Earth, and Sky: Global Systems History and the Human Prospect", *Journal of the Historical Society,* 10, 3 (2010), pp 292-294.

organisational structure come to the fore. As a rule those unique qualities are seldom evident in the parts or components that were responsible for the novelty presenting itself.[67] What is for the conventional historian the semblance of a history of the present, inspired by the work of Foucault, acquires a distinctly different content in complex thinking.[68] Emergence has a bearing on the evolving of novel and coherent structures, patterns and properties if and when complex systems begin to organise themselves.[69] Emergence as a concept entered the arena of philosophical discourse when G.H. Lewes, working on J.S. Mills' understanding of causality in the nineteenth century, contemplated chemical compounds as either resultant or emergent in the face of a chemical reaction that was taking place.[70] Darwinian evolutionary thinking formed part of thinking in the field. By the 1920s emergence featured prominently in philosophical and scientific discussions on "emergent evolutionism".[71]

Although the term emergence tended to fade in the 1930s, its continued use found a balance between vitalism on the one hand and reductive mechanistic thinking on the other. It was only in the 1960s, when emergence was still associated with "natural piety", that the advent of high-speed computers began opening up pathways for the development of mathematical constructs and new research methods in which emergence acquired a useful foundation for scientific explanation.[72] The direct linkage between emergence and complexity is the tendency for a higher emergent order that can become less complex than systems of a lower order because they seem to function independently of their material substratum. This implies that complexity need not be pre-determined materially. Instead, a new level of system formation can emerge with regard to the relevant environment. Emergence then, according to Luhmann, is not merely an accumulation of complexity, but instead an interruption and new beginning in the constitution of complexity. Neither is the action a decomposition of consciousness in ever-smaller entities that cannot be dissolved further. Instead, it becomes the result of social attribution.[73]

Whereas there seems to be a natural inclination and potential for the acceptance of emergence in the natural sciences as a pronounced way of thinking about transformations in time and space, there is also the business-like conception of change (a dynamic process that metaphysically shapes the way reality presents itself) in which it is historically acknowledged that no two moments are precisely the same

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67. F. Capra and P.L. Luisi, *The Systems View of Life: A Unifying Vision* (Cambridge University Press, Cambridge, 2014), p 145.
68. D. Byrne and G. Gallaghan, *Compexity Theory and the Social Sciences* (Routledge, London, 2014), pp 1, 20-24.
69. J. Goldstein, "Emergence as a Construct: History and Issues", *Emergence,* 1, 1 (1999), p 49.
70. Goldstein, "Emergence as a Construct", p 53.
71. Goldstein, "Emergence as a Construct", p. 53.
72. Goldstein, "Emergence as a Construct", p. 54.
73. Luhmann, *Social Systems*, pp 22-23.

in time and space. Neither would the understanding of a specific sense of reality necessarily be the domain of societal understanding. Awareness has its origins with the individual self who perceives, reflects and conceives that which constitutes society. In historical terms the way an individual perceives society is shaped by the self and a consciousness of a commonality that links the self with the social. From there a potential awareness of a certain type of phenomenon of reality could emerge, one that is still subject to diverse cognitive processes of interpretation and absorption into a sense of reality.[74] It is here where the historian takes note of change; negotiates how time and space interact; and where the dominant strains of contingent agency are situated.

In the process of accepting the fact that landscapes have been shaped by human action and that environmental features are legacies of past actions that were not always intended, it became evident by the 1990s that the emphasis was on diversity and complexity in patterns of spatial and temporal change. These resonated strongly with themes of non-linear dynamics, varying limits and the need for social-ecological interaction in the new ecology.[75] It is specifically in respect of comprehending the location of humankind in the space of time that the process of change is pronounced and needs to be viewed in panarchical contexts. When Gunderson and Holling explain that the essential focus of panarchy is to rationalise the interplay between change and persistence, between the predictable and the unpredictable,[76] there is a need to historicise our understanding of the transformations taking place.

Water history and Iron Age southern Africa

The author is currently busy with a project on the water history of South Africa since precolonial times. Understanding long stretches of time of which we have little direct human historical knowledge, requires conjecture. Consequently, whilst using the methodology of hermeneutic interpretation, it has also become imperative to take note of different contexts for understanding the past. Being aware of natural history implies being aware of the fluid course of a stream of water seeking out gravity at all times, before being absorbed into the larger hydrological cycle. A peculiar blend of understanding has been necessary for comprehending the history of the subcontinent. For the purpose of contextualising aspects of panarchy, outlined above, I shall give a brief overview of the history of water in Iron Age southern Africa. It is a complex discourse and is subject to diverse interpretations. What is evident is that "survivalist" theories somehow do not speak adequately to the process of constant

74. See L. Hunt, *Writing History in the Global Era* (W.W. Norton & Co, New York, 2014), location 1006-1556.
75. Scoones, "New Ecology and the Social Sciences", p 492.
76. Gunderson and Holling (eds), *Panarchy*, location 265.

change and transformation in social ecological systems. This is particularly so if we think about water on an arid to semi-arid subcontinent. Apart from geography there is a need to engage with archaeology and anthropology. Since the nineteenth century a significant tradition of historiography on the archaeology of the Iron Age has emerged in southern Africa. Initially Great Zimbabwe caught the attention with remarkable narrative discourses on the way the legendary Monomotapa made contact with the outside world by means of the eastern seaport opening up to the Indian Ocean world.[77] By the mid-twentieth century the discourse turned Africanist. There was a search for what was considered indigenous and belonged to those who had been subjected to colonial suppression.[78] In South Africa, since the first decade of the twenty-first century there has also been a concerted effort with the "five hundred years initiative" (FYI), pursued by scholars in a variety of historically-related disciplines to work towards a more comprehensive and integrated history of precolonial southern Africa.[79] This approach to the history of the subcontinent holds much promise.

Archaeologists are also increasingly seeking strategies for collaboration with historians on gaining a better understanding of the history of southern Africa.[80] The existing literature suggests that water is not a prime focus in much of the work. Yet, water has been crucial in the process of human settlement in southern Africa and most sources make some cursory reference to water. They provide the water historian with valuable insights into comprehending how archaeologists and anthropologists have explored the field and noticed the importance of water. The author has worked through numerous archaeological texts to form an impression of the Iron Age, primarily in what is currently South Africa.[81] Of particular importance is the Middle and Later Iron Age when, at the confluence of the Limpopo and Shashe rivers, a sequence of Iron Age settlements, now collectively known as Mapungubwe,

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77. R.N. Hall, Pre-historic Rhodesia: An Examination of the Historical, Ethnological and Archaeological Evidence as to the Origin and Age of the Rock Mines and Stone Buildings, with a Gazetteer of Medieval South-East Africa, 915 A.D. to 1760 A.D. and the Countries of Monomotapa, Manica, Sabia, Quiteve, Sofala and Mozambique (T. Fisher Unwin, London and Leipzig, 1909).
78. R. Summers, *Inyanga: Prehistoric Settlements in Southern Rhodesia* (Cambridge University Press, for the Inyanga Research Fund, Cambridge, 1958); R. Summers, *Ancient Ruins and Vanished Civilizations of Southern Africa* (T.V. Bulpin Publications, Cape Town, 1971).
79. N. Swanepoel, A. Esterhuysen, and P. Bonner (eds), *Five Hundred Years Rediscovered: Southern African Precedents and Prospects* (Wits University Press, Johannesburg, 2008).
80. J.C.A. Booyens, "The Entangled Past: Integrating Archaeology, Oral Tradition and History in the South African Interior", Inaugural lecture, Department of Anthropology and Archaeology, University of South Africa, Pretoria, 10 November 2011, pp 1-28.
81 . Chapter currently in press.

laid the groundwork for the future Great Zimbabwe civilisation, of which we have a good record of settlement history in South Africa's contemporary neighbouring state. The question for the water historian is: What role did water play in precolonial history?

Given the fact that we are dealing with Iron Age communities, issues of pastoralism and agricultural activity are foregrounded. At the same time there are traces of early industrial history and mineral resources, particularly copper, gold, and iron mining. Trade also flourished and the increasing importance of the Indian Ocean world tells the story of sea routes and the presence of Asia and the Middle East along the eastern coastline of southern Africa and their influence in the interior. In the complex discourse on the evolution of precolonial international trade, there is hardly space to acknowledge water. Typically, travellers moved in close proximity to rivers to supplement their water supplies in dry regions. However, we know little of water-based diseases and the mortality rates that shaped the presence of nuclear communities along the waterways of the Limpopo River catchment.

We do know that the people at Mapungubwe used water from the Limpopo River for planting crops on the flood plains and collecting water for domestic use. We also know of significant rainmaking ceremonies in the region – similar to many Iron Age cultures in southern Africa. Furthermore, we know how the Zimbabwean tradition of making rain usurped the traditions of the local San, who were probably the original meteorologists of the early Mapungubwe society.[82] In the case of Great Zimbabwe there is a far more comprehensive perspective on the role of water, but the direct functional aspects of water as infrastructure is unclear, except perhaps in the case of Nyanga on the Eastern Highlands where terracing and traces of what could have constituted an irrigation system has been under archaeological investigation since the 1950s.[83] In areas where large communities flourish there have to be substantial water resources. They do however become vulnerable in times of drought, climate change and over-grazing. Did Great Zimbabwe perhaps go into decline as a result of climate change and reduced water supplies?

In recent times there has been substantial interest in an African precolonial urban culture. Urbanisation is in fact a global trend that is increasingly shaping our cultural understanding of early human societies in all parts of the world, literally

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82 . M.H. Schoeman, "Clouding Power? Rain-control, Landscapes and Ideology in Shashe–Limpopo State Formation", PhD thesis, University of the Witwatersrand, 2006; and M.H. Schoeman, "Imagining Rain-places: Rain Control and Changing Ritual Landscapes in the Shashe–Limpopo Confluence Areas, South Africa", *South African Archaeological Bulletin,* 61, 184 (December, 2006), pp 152-165.

83. R. Soper, *The Terrace Builders of Nyanga* (Weaver Press, Harare, 2006).

since the onset of the Holocene (about 12 600 BP).[84] There appears to be a need for interfacing local, regional national and continental history with the global. At the heart of these histories was the urban phenomenon. Sinclair's *The Urban Mind: Cultural and Environmental Dynamics* (2010) is interesting in that it brings Africa (specifically southern Africa) into the ambit of our generic understanding of the phenomenon of urban society and how it functions.[85] More recently the bigger picture has become evident in the work done by Elmqvist.[86] Could it be that Mapungubwe was a typical African city before the relocation in the fourteenth century of its elite to Great Zimbabwe? Was the decline of Mapungubwe the result of a process of creative destruction? Diminishing local supplies of gold and other metals (from the Mapungubwe hinterland) might well have been responsible for resource exploitation at yet another locality. It is also possible that as a result of climate change local water supplies decreased to the extent that this was responsible for human mobility.

In the case of Zimbabwean archaeology there has been work done on resilience and urban development. Manyanga's study sheds light on the potential of using resilience for understanding landscapes. The focus of his research is the Shashe-Limpopo river basin from about 800 CE to the present day.[87] The growing diversity of scientific knowledge at our disposal, along with the new willingness for collaboration between the natural and social sciences, means that there is ample room for development which could guide us towards a new focus on the southern African Iron Age. We need to find out if water, for example, on the floodplains of the Shashe-Limpopo confluence, asserted an influence on local residents to resort to livestock farming, or even to move away. Are there perhaps indications of a back loop panarchy cycle?

Sinclair's assessment of the Zimbabwe Plateau is notable for the long-term views emerging and the blending of past, present and future social ecological systems. These are contemplated from a three-phased consideration of energy

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84. See for example, A. Zimmermann, "Cultural Cycles in Central Europe during the ~Holocene", in *Quaternay International,* 274 (October 2012), pp 251-258. For a later period, see Cline, *1177 B.C.: The Year Civilization Collapsed*.
85. See P.J.J. Sinclair, G. Nordquist, F. Herschend and C. Idendhal (eds), *The Urban Mind: Cultural and Environmental Dynamics* (Uppsala University Press, Uppsala, 2010).
86. T. Elmqvist, M. Fragkias, J. Goodness, B. Grüneralp, P.J. Marcotullio, R.I. McDonald, S. Parnell, M. Schewenius, M. Sendstad, K.C. Seto, and C. Wilkinson (eds), *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities* (Springer, Dordrecht, 2013).
87. M. Munyandzi, "Resilient Landscapes: Socio-environmental Dynamics in the Shashe–Limpopo Basin, Southern Zimbabwe c. AD 800 to the Present", PhD thesis, Uppsala University, 2006).

resources, humans and the natural environment.[88] Manyanga, Pikirayi and Chirikure, focusing on Mapungubwe and Great Zimbabwe from an urban perspective, lay the groundwork for the emergence of certain universals in the precolonial urban phenomenon.[89] Population mobility, migrations and the formation of settlements have their cultural and economic origins in centres of trade, commerce and industry – settlements that are functional for only as long as the available resources can carry a growing population. They do indeed collapse, but seemingly re-invent themselves elsewhere. Where there is decline there is a transformational process underlying the activities of humans on the landscape. When water resources become scarce there is bound to be change. In periods of climate change, colder temperatures and drought, communities are forced to give up a sedentary life and move to more favourable climes. Human migration movements are also, it appears, anything but uniform. People in the Iron Age moved north and south, even before 1300, when Mapungubwe went into a state of decline.

The archaeologist, Tom Huffman, is the most prolific and detailed in his research on the Mapungubwe–Zimbabwe culture and inter-linkages with the Middle and Late Iron Age in southern Africa.[90] His research and analysis of material culture is thorough, redolent with comprehensive investigations on a variety of relevant issues, such as climate change, political power and authority, the culture of ceramics and rainmaking traditions. However, what remains to be done, is to seek greater synthesis. There is a need to transfer and direct some of the valuable work that has been done into frameworks that correspond with, for example, panarchical cycles of social-ecological adaptation in both cultural spheres of Mapungubwe and Great

88. P.J.J. Sinclair, "Towards an Archaeology of the Future: the Urban Mind, Energy Regimes and Long-term Settlement System Dynamics on the Zimbabwe Plateau", in Sinclair et al (eds), *The Urban Mind*, pp 591-616.

89. M. Manyanga, I. Pikirayi and S. Chirikure, "Conceptualising the Urban Mind in Pre-European Southern Africa: Rethinking Mapungubwe and Great Zimbabwe", in Sinclair et al (eds), *The Urban Mind*, pp 573-590.

90. T.N. Huffman, "Archaeological Evidence and Conventional Explanations of Southern Bantu Settlement Patterns", *Africa,* 56, 3 (1986), pp 280-298; T.N. Huffman, "Archaeological Evidence for Climatic Change during the Last 2000 Years in Southern Africa", *Quaternary International,* 33 (1996), pp 55-60; T.N. Huffman, *Handbook to the Iron Age: The Archaeology of Pre-colonial Societies in Southern Africa* (University of KwaZulu-Natal Press, Pietermaritzburg, 2007); T.N. Huffman, "Climate Change during the Iron Age in the Shashe–Limpopo Basin, Southern Africa", *Journal of Archaeological Science,* 35 (2008), pp 2032-2047; T.N. Huffman, "Mapungubwe and the Origins of the Zimbabwe Culture", *Goodwin Series,* 8 (2008); T.N. Huffman, "African Renaissance: The Limpopo Valley 1 000 Years Ago, *Goodwin Series* (December 2009), pp 14-29; T.N. Huffman, "A Cultural Proxy for Drought: Ritual Burning in the Iron Age of Southern Africa", *Journal of Archaeological Science*, 36 (2009), pp 991-1005; T.N. Huffman, "Mapungubwe and Great Zimbabwe: The Origin and Spread of Social Complexity", *Journal of Archaeological Anthropology,* 28, 1 (2009), pp 37-54.

Zimbabwe.[91] Interestingly, there were attempts at creating constructive social-ecological discourses on contemporary political ecology, dating back as far as the 1990s,[92] but these, it seems, have been terminated as a result of the political changes in Zimbabwe in the late twentieth century.

Conclusion

The study of southern Africa's precolonial history, especially in as far as it has a bearing on the history of water, holds considerable promise. If it were possible to develop a theoretical outline, perhaps more closely interlinked with the African cultural worldview, in association with what thinkers in the Resilience Alliance[93] are contemplating, there could be a dynamic opening for our understanding of the social-ecological dynamics at work, influencing the adaptation of human societies in the subcontinent. Importantly, the discourse need not be deterministic in orientation. The historical understanding of contingency and the phenomenon of agency is far too strong to leave room for crude determinism. Instead, we should realise that if there are panarchical cycles, not one would ever be the same as another. Each is unique in itself. Yet, there may be some similarities, and that is what can stimulate creative historical thinking on water in southern Africa.

Panarchy could well be one way of coming to a better understanding of and searching for synchronisation with trends in water history in other parts of the world. Panarchy contributes to historical thinking beyond collapse. However, embracing the concept of panarchy implies that there must be cross-disciplinary collaboration. Historians as social scientists should be in a position to work with and embrace the tools and methods used by natural scientists. At the same time there needs to be a sense of transcendence and acceptance that disciplinary inter-dependence also means absorption. The more comprehensive the integration of knowledge to understand the history of water, the better will be our understanding of the dynamics of water in social-ecological systems in southern Africa.

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91. Hufmann has explored the field to a certain extent in 2009, but there still remains much to be done. See Huffman, "Mapungubwe and Great Zimbabwe" pp 37-54.
92. D.S. Moore, "Contesting Terrain in Zimbabwe's Eastern Highlands: Political Ecology, Ethnography, and Peasant Resource Struggles", *Economic Geography,* 69, 4 (October 1993), pp 380-401.
93 . See the website of the Resilience Alliance at http://www.resalliance.org/ (Accessed 8 March 2016).