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### Not long before the end? SF and the economics of resource scarcity

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*Abstract:* The commodity price booms of the early 1970s and of 2006–2014 were both associated with predictions of devastating scarcity of key natural resources, in popular media as well as in science fiction. However, both price booms ended within a few years for largely similar reasons, linked to the economic incentives that high commodity prices create. Given the economic forces that ensure that spells of resource scarcity usually do not last, writers of science fiction set in scarcity futures, especially fiction of the “if this goes on...” type, need to provide plausible reasons why those forces might stop working. This paper examines how authors describing resource-scarce future Earths have attempted to offer such reasons, and how those reasons have evolved over time.

*Keywords:* natural resource scarcity, economics, science fiction.

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The commodity boom in the early 1970s and the boom in 2006–2014 both led to high prices for many raw materials. Both price spikes were associated with predictions among natural scientists and in the popular press that the world was running out of key natural resources (see e.g. Meadows et al. for the first price spike, and Kjell Aleklett, Robert A. Lovett, or Robert Silverberg for the second). In both periods, SF writers picked up on these predictions, and “scarcity stories” – SF set in resource-scarce futures – increased in popularity. Despite the obvious similarities between the two periods, there were key differences between the scarcity stories written during those periods. One important difference was that the second generation of scarcity stories was written for readers who were at least to some extent aware that the pessimistic predictions of the 1970s had not, in fact, come true. SF writers needed to account for this in their authorial world-building, and provide plausible explanations for why the economic drivers that had resolved the temporary resource scarcity problems of the 1970s would not again do so.

The economic forces that tend to end spells of resource scarcity and high resource prices are well understood (see e.g. Jon M. Conrad or Barry C. Field for standard treatments of this topic in natural resource economics). Increased absolute or per-capita scarcity of a natural resource will in most cases tend to make production (or, in the case of non-renewable resources, extraction) of the resource more costly, driving up the price of the resource for its users. This will in turn tend to

reduce demand for the resource in the short run, as well as encourage users to switch to other, usually worse, alternatives. In the slightly longer term, the higher price of the resource will make it more profitable to (i) develop means of using existing sources of the resource more effectively, (ii) identify new sources of the resource, (iii) improve existing alternatives to the resource, and (iv) develop new alternatives to the resource. This will create incentives for innovation and development of technologies that permit one or several of these four options to be put into effect more cheaply, gradually driving down the price of the resource in question either because more of the resource becomes available or because users are able to shift to improved alternatives. Notably, while all four sources of innovation will tend to matter in practice, in principle any one of them would be enough to resolve the problem on its own – at least in the longer term. Thus, an SF author who accepts this mainstream analysis of resource scarcity, and who wishes to set a story in a future world where some key resource has become permanently scarce, will need world-building where it is plausible either that the potential for profits has stopped having an impact on these four forms of innovation or, alternatively, that innovation itself has become infeasible.

There could be several reasons for the author of a scarcity story to disregard the standard economic analysis of why increased natural resource scarcity is normally a temporary phenomenon. Some of the natural scientists in both generations of price-spike literature (Aleklett can again serve as a useful example from the more recent spike) explicitly rejected economists' analysis of the problem, including the premise that innovation could help resolve the resource problems that they discussed. Thus, an SF writer could similarly choose to reject the standard analysis and write a story where, for physical reasons, innovation has become more difficult than in the past.

Another reason to disregard the standard economic analysis could be that the SF author simply wants to tell an entertaining story and does not wish to give too much thought to background detail. However, scarcity stories are frequently in the “if this goes on...” tradition of SF, aiming to warn readers of what might happen in future with increased scarcity of one or several important resources. Thus, the need for plausibility is harder to brush off than in SF written for other purposes. Indeed, if a key purpose of a story is to warn the reader of what might happen if some trends continue unabated, the author needs to convince the reader that the story actually provides a reasonable picture of the future to which those trends might lead.

Of course, rather than an SF author's rejecting the standard economic analysis, s/he may simply be unaware of it. Many authors continue to feel that, rather than referring to the disciplines in question, they can handle social science aspects of their stories through reliance on “common sense” reasoning that may not align very closely with what those disciplines actually have to say about the topics in question (thus, for instance, Brian Stableford notes (1129) in the *Encyclopedia of Science Fiction* that “the influence of academic sociology [on SF] is clearly negligible” – this when writing about ostensibly sociological SF). There is an increased expectation among readers that writers should strive to get key aspects of the natural and social sciences right in their stories; nonetheless, there is no question that some disciplines remain more equal than others in this respect. Authors disregard mathematics or physics at their peril, but while there is a growing expectation that authors should also attempt to make, for example, the biology, sociology and economics in their stories plausible, the bar remains substantially lower for these disciplines.

Thus, studying how authors of scarcity stories explain – if they do – the continued resource scarcity in their stories provides an interesting test case for how SF deals with the social sciences in general. This paper studies some widely discussed scarcity stories from the two commodity boom periods to see how they deal with the role of economics, and also looks at a few other stories that can be used to illustrate specific aspects of this. Economics is rarely discussed at length in SF works, but scarcity stories form a strand of SF where this general rule might be broken. An author of scarcity SF who rejects the standard economic analysis of scarcity issues and believes that innovation is less feasible than such an analysis predicts (and, thus, also less feasible than it has

been in the past) can be expected to make this important premise clear in the story. An author who accepts the standard analysis, but nonetheless believes (at least within the scope of the story) that innovation is unlikely to solve the problem in practice, can be expected to explain why this is so. On the other hand, an author who ignores the standard economic analysis because of a lack of awareness of it can be expected not to discuss innovation at all – or, at any rate, not to do it in a way that contrasts the lack of innovation in the story with what one would expect from the mainstream economic analysis of scarcity issues.

Very few SF authors have set scarcity stories in futures where innovation has ceased for intrinsic reasons. Cyril M. Kornbluth (“The Marching Morons”) and Paolo Bacigalupi (“Pump Six”) both set stories in futures where the average intelligence has declined precipitously; Kornbluth explains this as being due to cumulative genetic deficiencies, while Bacigalupi blames environmental toxins for causing irreparable brain damage. A scarcity story set in such a background could, in principle, be used to explain a lack of innovation, but so far no writer has taken this approach. Notably, both Kornbluth’s and Bacigalupi’s stories focus on characters who are of above-average intelligence, presumably because it is difficult to write engaging stories about futures where everyone is of low intelligence. Scarcity stories set in such a future would similarly suffer from the problem that it is difficult to write engagingly about problems that only remain unresolved because the protagonists, and everyone around them, are markedly less intelligent than the reader is.

Another option for explaining a lack of innovation is to set stories sufficiently far into the future and in societies with sufficiently advanced technologies that physical laws preclude additional innovation. However, a detractor for such stories would be that the future societies described would have technologies sufficiently advanced to make them near indistinguishable from magic (Clarke), in turn making it difficult to write engagingly about the problem that these technologies cannot be further improved. Thus, for instance, Michael Moorcock, in his *Dancers at the End of Time* series (*An Alien Heat*, *The Hollow Lands*, *The End of All Songs*), describes a future where the universe is literally ending and where everything the characters do with their advanced technologies further depletes the universe’s limited remaining resources, thus making its demise increasingly imminent. However, most of the characters come across as decadent in the extreme, and although these stories are interesting for other reasons, the scarcity aspect has probably not engaged many readers.

Instead, most authors writing scarcity stories have described futures where technological innovation would be possible in principle, but nonetheless does not take place in practice. One way of making this more plausible is to reduce the importance of the profit motive, for instance by setting stories in future societies where the economic system has changed such that prices and profits become less important as drivers of behaviour than they are in our society. However, even in societies where profitability is of limited importance, it seems likely (see e.g. Jared Diamond or Rosenberg and Birdzell) that competition with surrounding societies would – at least over the longer term – encourage development of technologies that permit more efficient use of scarce natural resources. Thus, for plausibility, such stories either need to be set in futures where the new, stagnant status quo has not been in place for long – for instance, post-apocalypse stories set shortly after the apocalypse in question<sup>1</sup> – or in future societies that are relatively isolated and do not need to fear competition from surrounding societies.

While the price boom of the 1970s saw a number of scarcity stories being written, there are also earlier examples of SF authors considering resource scarcity. However, these earlier authors

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<sup>1</sup> Mulligan (*Shattered States: Catastrophe, Collapse and Decline in American Science Fiction*) analyses post-apocalyptic literature at length and identifies social constraints such as access to knowledge and education, rather than resource constraints per se, as the key constraints to recovery in most post-apocalypse stories.

tended to assume that technological innovation would be unproblematic. William Hope Hodgson's 1912 novel *The Night Land*, for example, is set on a far-future Earth after the Sun has died – possibly the ultimate energy scarcity problem. The novel includes no discussion of economics per se or of economic incentives as a driving force for innovation. However, humanity has (and, it appears, so too have its enemies) developed technologies that allow it to draw on the “Earth-Current” rather than the Sun for energy, and this is not described as having posed any major difficulties – although the protagonist does anticipate, much further in the future, “the day when the Earth-Current shall become exhausted” (Hodgson 41), suggesting that even surviving the death of the Sun is not enough to put fears of future scarcity to rest.

In Lawrence Manning's *The Man Who Awoke* series of short stories from the 1930s, the protagonist sleeps for thousands of years at a time and wakes up into increasingly further-future societies. However, unlike most “when the sleeper wakes” stories of the time, social progress (as defined by the authors in question) is not linear, and none of these societies are utopian in any sense; rather, each new society has its own set of problems. The protagonist's first awakening, in the year 5000, brings him to a society that has run out of oil and coal, and which has switched to biomass-based energy and hydropower instead. The transition from fossil to renewable energy (which is already thousands of years in the past by the time the protagonist awakes) is described as having been traumatic, but – interestingly – not primarily for technological reasons. Instead, vested interests delayed the transition for economic and political reasons; not a common expectation for the adoption of new technologies in the pulp SF of the time. Thus, to the extent that the development of new energy sources was difficult, the lack of innovation was due not to intrinsic difficulties, but to social and political resistance.

Scarcity stories written at the time of the first major spike in resource prices were considerably more pessimistic about technological solutions. Harry Harrison's *Make Room! Make Room!* from 1966 is set in an overpopulated future United States where the main adaptation to the low per-capita availability of resources is that people have increasingly switched to vegetarian diets because meat has become too expensive. The film version, *Soylent Green* (released in 1973) famously predicts that dead bodies would be used to produce food and that people might be bred for food as well – an innovation clearly chosen for shock value rather than for its plausibility as a solution to food scarcity. Harrison's novel was published before Paul Ehrlich's *Population Bomb*, which predicted hundreds of millions of people imminently dying of starvation, and which brought population growth to broader public attention, but the novel's themes resemble those of the subsequent population debate. Harrison explicitly references the pessimistic Malthusian reasoning about population growth:

‘I'll tell you what changed’. He shook the boot at her. ‘Modern medicine arrived. Everything had a cure. . . . Old people lived longer. More babies lived who would have died, and now they grow up into old people who live longer still. People are still being fed into the world just as fast – they're just not being taken out of it at the same rate. . . . So the population doubles and doubles – and keeps on doubling at a quicker rate all the time.’  
(Harrison 173)

John Brunner's *The Sheep Look Up* from 1972 deals primarily with environmental degradation, but also mentions increased per-capita scarcity of natural resources, notably food and water, and is similarly bleak about humankind's future prospects. Other than a few environmental extremists, nobody makes a serious attempt to deal with the approaching environmental collapse, and while there are corporations that seek to profit from selling water purifiers and non-contaminated food, their products are either defective or fraudulent:

It was a filter cylinder from a Mitsuyama water-purifier. It was discolored . . . and the close-packed plastic leaves it was composed of had been forced apart. . . . ‘That’s what all the faulty ones look like’, Pete said. ‘Mack’s found three like that already today.’ (Brunner, *The Sheep Look Up* 321)

‘. . . what he’s worked out is this. If you divide the amount of home-grown produce Puritan sells per year into the amount of ground you’d need to grow it on, there literally isn’t enough uncontaminated land left in North America. . . . And he’s analyzed their stuff, and as I say about half of it is no better than you can get in a regular supermarket.’ (Brunner, *The Sheep Look Up* 261).

Despite the profits that could be made by providing functioning solutions, what little corporate funding goes into research on improved food and water provision is clearly insufficient. In his next novel, *The Stone That Never Came Down*, Brunner does suggest that better management of resources might be possible, but only after society has been transformed by a drug which makes humans wiser by artificial means; if humanity is left to its own (current) devices, the assumption appears to be that the portrayed problems will remain insoluble.

Sam J. Lundwall’s *2018 A.D. or the King Kong Blues* from 1975 portrays a future where the oil crisis has become a permanent fixture of the world economy, and suggests that there will be no solution to the problems caused by the high energy prices. Instead, consumers are depicted as having accepted the higher energy prices for decades, and governments worldwide have quietly tolerated a permanent shift in global economic power to the remaining oil producers.

None of these scarcity stories, emblematic of their period, has politicians seriously contemplating alternatives that would permit society to cope more adequately with the envisaged scarcity problems; nor do they describe commercial interests being incentivized by high resource prices to develop new technologies. In reality, in most cases the high resource prices of the early 1970s changed the incentives for innovation and resource exploration and led to increased availability of the resources in question, in line with the standard economic analysis. Moreover, as pointed out by David Brin in the afterword to his novel *Earth*, one of the reasons an environmental catastrophe was averted was that the “sheep” of Brunner’s title *did* look up before it was too late, and began to demand more stringent environmental policies from their politicians.

Nonetheless, the pessimism of the 1970s SF novels about the scope for better husbandry of the world’s natural resources was well in line with the perceptions of the time. The prevailing popular perception of corporations at the time was that they were maintainers of the status quo, dominated by managers more interested in carving out stable empires within their corporations rather than by stockholders interested in making profits through developing new products (see e.g. John Kenneth Galbraith for a description of the mainstream opinion of the time). In line with this, although corporations feature prominently in both Brunner’s and Lundwall’s scarcity stories, none of these entities seek to make money by developing technologies that would reduce the resource scarcity problems discussed in the stories, even though such technologies would be hugely profitable; instead, the corporations that feature chiefly seek to increase their share of the profits from the status quo or to fool customers into purchasing ostensible solutions that do not actually work.

The decline in the prices of most raw materials after the 1970s led to reduced public concern about physical resource scarcity; SF echoed this reduced interest. During the late 1970s, 1980s and 1990s, few explicit scarcity stories were written. Stories where key resources become scarce and where this results in widespread poverty, such as Octavia E. Butler’s *Parables*, typically explain such scarcity as the outcome of social disintegration rather than as an outcome of physical scarcity per se. As Hee-Jung Serenity Joo notes, these novels are about “the U.S. becoming a third world nation” (283), with its social and economic collapse leading to, among other things, local resource

scarcity. While global environmental problems form part of the background in the books, their narratives are not about global resource scarcity per se. Furthermore, other nations in this imagined future world are described as doing substantially better. The key problem is thus portrayed as being social resource scarcity rather than physical resource scarcity, i.e. the main constraint on resource availability is a poorly functioning society, not physical resource scarcity per se.

During the first decade of the new century, the prices of many natural resources began to rise again. Rising incomes in many developing countries, especially in Asia, led to increasing per-capita consumption of food in such countries, pushing up the cost of many staple crops (see e.g. Stage et al.). The investment boom, especially in China, drove up prices for many raw materials, while the overall boom in the world economy drove up prices for oil and other energy sources (see e.g. Radetzki and Wårell). At the same time, climate change became a major issue on the global policy agenda. Climate change was linked to concerns about rising energy prices and the lack of viable alternatives to fossil fuels, as well as to concerns about impacts of a changed climate on food production and on water availability. In fact, global per-capita production of most of these resources (including food, raw materials and oil) actually rose during this period, but global demand for the resources rose even faster, driving up their prices (see e.g. Radetzki and Wårell or Stage et al.). Where water availability became an issue, it was primarily linked to unclear water legislation that encouraged the wasteful use of water, rather than to physical water availability that was not enough for household needs (see e.g. World Bank). Nonetheless, the rising prices made their mark on popular perceptions and the topic of looming resource scarcity resurfaced in SF. Many authors have been pessimistic both about the future climate, about future energy availability and about the future of modern civilization overall.

Robert Charles Wilson's *Julian Comstock* stories (*Julian: A Christmas Story* and *Julian Comstock: A Story of 22nd-Century America*) are set generations after a global environmental and economic collapse which brought down civilisation. In this future world, humankind has been able to recover and re-establish a civilisation reminiscent of the 1800s, but for several decades there has been no attempt at further recovery. Thus, despite the fact that there are large nations again, embroiled in more or less continuous warfare, none of the warring parties have actively attempted to adapt warfare technologies from the 1900s to the available natural resources. Instead, all sides appear relatively content to remain at the level at which they have stabilised, despite the potential advantages of improving their technologies further. Nonetheless, "the ongoing War . . . had engendered new industries that employed mechanics and wage-laborers in large number [and this] might eventually transform the traditional rural economy" (Wilson, *Julian Comstock: A Story of 22nd-Century America* 102), so despite the rulers' wish to keep society at the level where it has stabilised, industrialised warfare is beginning to cause structural changes in other parts of the economy as well. The protagonists' attempts at reforming their society ultimately fail, but the implication is thus that social and economic change will come anyway.

In Bacigalupi's *Windup Girl* stories from 2005 through 2009 ("The Calorie Man", "The Yellow Card Man", *The Windup Girl*), set in an energy-scarce future where concern about climate change has led to strict constraints on the use of what little fossil energy remains, technology outperforms its current counterparts in many areas (notably biotechnology). However, despite the stories being set in a future where many decades of high energy prices would presumably have made innovation in the energy area extremely profitable, very little appears to have happened in that respect. Research in improved energy storage is mentioned, but the investigated technology is unworkable in practice and is mainly used as a smokescreen for industrial espionage (Bacigalupi, *The Windup Girl* 8). The main energy innovation is that, thanks to genetic modification, ethanol crops have become more productive. However, biogas and wind power appear permanently stuck at roughly the levels they were at when the stories were written. There is little mention of other non-fossil energy sources such as hydropower, solar power or nuclear power, and there appears to have

been little corporate or public research on developing new energy technologies – despite the potential profits to be made by doing so. The first of the stories (Bacigalupi, “The Calorie Man”) suggests that patent and intellectual property rights regulations have become even more stringent than in our present, and this could perhaps help to explain the limited innovation; nonetheless, it does appear likely that the huge potential for profits would encourage firms to seek ways around these patent regulations. Thus, a key assumption in these pessimistic energy-scarcity stories seems to be that, even once geopolitics have stabilised in response to the new energy-scarce situation in the imagined future, a century of high energy prices would have less impact on energy-related innovation than a few years of high energy prices actually had in our own world.

Bacigalupi’s subsequent *Ship Breaker* novels (*Ship Breaker* and *The Drowned Cities*) from 2010 and 2012 more realistically portray energy and natural resource scarcity as being caused by social breakdown rather than by physical scarcity. Analogously to Butler’s earlier novels, these novels are set in a post-collapse United States reminiscent of failed states in today’s developing world; however, while the world outside the United States is not described in much detail, it has apparently adapted and moved on, and has technologies superior to those available today. As with the earlier Butler works, therefore, these newer novels can be seen as examples of social, rather than physical, resource scarcity.

The peak of the food price spike in 2008 saw the publication of the first *Hunger Games* novel (Suzanne Collins, *The Hunger Games*; it was followed by *Catching Fire* in 2009 and *Mockingjay* in 2010), set in a future where food production per capita has remained low for many decades, following an ecological collapse. Panem, the state portrayed in the novels as having replaced the former North American nations, is clearly isolated from the rest of the world: there is no mention of the world outside North America in any of the novels. Thus, there is no pressure to innovate from external enemies or competitors. Despite this, there has also clearly been considerable technological progress since our time, but the government has diverted this innovation effort into areas other than food production, and at least some of the hunger in the novels is evidently – as in our own time – due to inequitable distribution, rather than insufficient production, of food:

But the real star of the evening is the food. Tables laden with delicacies line the walls. . . . Whole roasted cows and pigs and goats still turning on spits. Huge platters of fowl stuffed with savoury fruits and nuts. Ocean creature drizzled in sauces or begging to be dipped in spicy concoctions. Countless cheeses, breads, vegetables, sweets, waterfalls of wine and streams of spirits that flicker with flames. (Collins, *Catching Fire* 88, on festivities among the upper class)

All I can think of is the emaciated bodies of the children [at home]. (Collins, *Catching Fire* 92)

The clear implication is that, once the oppressive government has been overthrown at the end of the third novel, food scarcity is going to be relieved as well.

The water-scarce future portrayed in the recent short film *The Sand Storm* (released in 2014) – where the unreliable public water supply in a Chinese town causes people to purchase water from vendors – would be easily recognisable to denizens of cities in many present-day developing countries.<sup>2</sup> However, the main causes of poorly functioning public water supply in such cities are misallocation of existing water and insufficient investment in water delivery infrastructure rather than physical water scarcity per se (see, for instance, World Bank), and it seems likely that more

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<sup>2</sup> One difference compared to most present-day developing countries is that in the film the vendor delivers water to people, rather than people having to go to the vendor for water. Thus, from the perspective of the consumer, water delivery actually works better in the film than it does in many developing countries today.

investment in public infrastructure, and prioritising household water use over other uses, could have prevented the water supply problems in the film as well.

In the most recent of the post-apocalyptic Mad Max movies, *Mad Max: Fury Road* (released in 2015), a large-scale environmental collapse has led to widespread water scarcity, but water is available to those with sufficient technology and access to water is primarily portrayed as a political issue. In the water-scarce future portrayed in Bacigalupi's *The Water Knife* stories from 2007 through 2015 ("The Tamarisk Hunter", *The Water Knife*, "A Hot Day's Night"), reduced physical water availability has similarly been exacerbated by poorly functioning social structures. While a decades-long drought has reduced the physical availability of water in the western US in the future portrayed in the stories, it is clear that water rights and water legislation are major factors driving the plots:

The problem wasn't lack of water or an excess of heat, not really. The problem was that 4.4 million acre-feet of water were supposed to go down the river to California. There was water; they just couldn't touch it. (Bacigalupi, "The Tamarisk Hunter" 66).

There is still water, and there would presumably be more than enough water for household use if it were allocated differently or if households were able to move to areas where it was in more plentiful supply. However, a weak federal government is unwilling to revise national water legislation, unwilling or unable to prevent individual states from restricting unwanted immigration from other states, and unable to prevent states from taking matters into their own hands and enforcing water rights through physical force. While unfortunately not completely unrealistic, this weak federal government is central to making the plots in the stories possible; had federal policies been different, prioritising water for household use over enforcing agricultural water rights, the problems in all three stories could have been resolved quickly. Bacigalupi has himself noted (see e.g. Brian Calvert) that reallocated water and investments in improved technology could have solved the problems in the stories, but that – by removing the key driver of the plots – this would have made the stories less interesting and detracted from the points that he wanted to make about contemporary water and climate policy.

Scarcity stories provide an interesting example of how application of the social sciences – economics, in this case – has changed in SF over time. The commodity price spikes in the early 1970s and in the first decade of the new millennium were both associated with predictions of imminent physical resource scarcity, and both spikes inspired a number of SF stories set in resource-scarce futures. However, judging from the selection of stories discussed here, the rationale for continued resource scarcity in these stories has shifted between the two price spikes – at least to some extent. In the first generation of scarcity stories, it was taken as a given that humankind would be unable to deal with the problems posed by increasing physical scarcity and that, regardless of the economic incentives which resource scarcity tends to generate, innovation and changes in resource management would not be enough to resolve those problems. In the second generation of scarcity stories, a growing number of stories justify continued resource scarcity as being caused by poorly functioning societies, rather than by physical scarcity. This increased emphasis on resource scarcity as a primarily social rather than physical phenomenon is entirely in line with mainstream economic analysis of the topic. Thus, the bar for how the social sciences are used in SF continues to be lower than that for the natural sciences, but it may at least be rising.

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