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Resource Scarcity

Related terms:

Biodiversity, Ecology, Groundwater, Karst, Microbiology

Economics of Energy Supply

Jeffrey A. Krautkraemer, Michael A. Toman, in Encyclopedia of Energy, 2004

7.1 The Hotelling Valuation Principle for Assessing Resource Scarcity

An illustration of the methods for testing the resource scarcity implications of the depletable energy supply model involves the relationship between average reserve value and current net price using cross-section data. Miller and Upton argued that this relationship can be written as follows:

$$\frac{V_0}{S_0} = \alpha + (P_0 - C_0). \qquad (7)$$

Here V_0 denotes reserve value, S_0 is the resource endowment, and P_0–C_0 is the price net of extraction cost; the term α, which can be positive or negative, reflects influences such as changing cost and price trends. The model was found to be consistent with pooled, cross-section data from December 1979 to August 1981 for 39 oil- and gas-producing firms in the United States. A subsequent test of the Hotelling valuation principle using data from August 1981 to December 1983 produced a quite different result: in that analysis, an increase in the net price translated into an increase in average reserve value less than half as large.

An explanation for why the Hotelling Valuation Principle might overvalue reserves, at least in the case of oil and natural gas production, is that it affords producers greater flexibility for choosing output than they actually have. The extraction of petroleum over time is restricted by declining well pressure as the reservoir is depleted. If the rate of extraction declines at the rate *a* because of declining well pressure, the average reserve value is

$$\frac{V_0}{S_0} = \frac{a}{a+r-g}(P_0 - C_0), \tag{8}$$

where *g* is the expected rate of change in net price. This example and others in the literature provide strong empirical evidence that a simple model of finite resource depletion does not adequately explain the observed behavior of depletable energy resource prices and in situ reserve values. This is not terribly surprising, given the many other features of depletable resource supply already discussed—such as exploration for and discovery of new deposits, technological change, and capital investment—that alter the implications of finite availability. It seems clear that these other factors have overshadowed finite availability of the resource as determinants of the observed dynamic behavior of nonrenewable resource prices and *in situ* values.

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Mechanisms underlying the relationship between biodiversity and ecosystem function

Claudia Guimarães-SteinickeAlexandra WeigeltAnne EbelingNico EisenhauerJoaquín Duque-LazoBjörn ReuChristiane RoscherJens SchumacherCameron WaggChristian Wirth, in Advances in Ecological Research, 2019

4.1 Intra-annual changes in functional diversity effects on plant development

Our Hypothesis 2 stated that, during periods of peak biomass, resource scarcity strengthens the importance of functional diversity (FDis) in controlling productivity, because plants will be driven towards resource partitioning (Allan et al., 2011; Roscher et al., 2011, 2016; Tilman, 1997). In contrast, we did not expect resource partitioning to play a significant role during the recovery phases after winter or mowing, when above- and belowground resources are abundant. Despite the significant interaction between functional dispersion and time in both plant species pools and years for the spatial pool, we only found one date where functional diversity affected mean height in the expected positive direction (April 15th, 2015 in the spatial pool).

Yet, FDis exhibited a negative effect for one date in parallel with a positive effect of species richness. In 2014, we did not find a single date with a significant effect of FDis, and we can only speculate about the cause of these counterintuitive results. It is conceivable that the significant interaction with time in both pools in 2014 and the spatial pool in 2015 has a sustained influence over the entire growing season, but is never strong enough to emerge as significant when focusing on single dates. This is true at least for the spatial pool, where species with deep roots and tall stature suited to capture space (tall herbs) are mixed with species that can densely fill space above- and belowground, i.e., mostly grasses with high specific root length and thin leaves (Hooper, 1998).

The negative effect of FDis on biomass productivity in 2015 may arise as an artefact created by collinearity with species richness (the correlation between FDis and SR was 0.64 for spatial pool and 0.51 for the temporal pool in 2015) (Venail et al., 2015) or because species richness takes over the representation of the complementarity signal. This may happen when the traits underlying FDis do not sufficiently represent the true mechanism underlying the resource partitioning. For instance, we may have missed essential root traits for nutrient uptake from the soil, as these may be more important for plant performance than leaf traits (Schroeder-Georgi et al., 2016). FDis in the temporal pool did not emerge as a significant predictor at single dates; it was only marginally significant on July 28th (again, despite a significant interaction of FDis with time in 2014) (Table 1). This is less surprising as one would expect that temporal resource partitioning arising from mixing species with different phenologies would not be detectable at individual dates but rather requires performance data integrated over longer time periods (Cardinale et al., 2007b; Kahmen et al., 2006; Ravenek et al., 2014; Tilman et al., 2001).

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Exploring the knowns and unknowns of international fishery conflicts

Jessica Spijkers, in Predicting Future Oceans, 2019

37.1.2 Accelerating drivers of conflict

Likely environmental drivers of fishery conflict such as climate change and increased fishery resource scarcity are ramping up. Climate change is driving unprecedented geographic shifts in marine animals by altering water temperatures, ocean currents, and coastal upwelling patterns, with fish already shifting into new territory at an average of 70 km per decade [10] and shifts only expected to accelerate [9]. Shifting fish species have already posed serious governance challenges resulting in international conflict, as exemplified by the shift in migration and spawning area of the northeast Atlantic mackerel mentioned earlier that sparked an ongoing inter-state conflict [3]. Such international disputes, triggered by shifting species, are likely to increase in the future [9]. Many of the world's Exclusive Economic Zones (EEZs) are likely to receive one to five new climate-driven transboundary stocks by the end of the century, and the number of EEZs receiving the stocks increases with global temperature [9].

At the same time catches from wild capture fisheries have declined [11] which can pose additional security challenges. Declining fish catch and deteriorating coastal environments can incentivize an illegal race to fish [12] and illegal, unreported, and unregulated (IUU) fishing has become increasingly problematic in Asia, with especially the Chinese fleet being pinpointed by Northeast Asian neighbors Japan, South Korea, and North Korea for transboundary poaching [8]. As actual incidences of international fishery conflict continuously occur in both the developed and lesser developed areas of the world [3,8,13], and suspected drivers of fishery conflict are ramping up, policy makers are warned to anticipate an increase in clashes over fishery resources [9].

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National Security and Energy

Wilfrid L. Kohl, in Encyclopedia of Energy, 2004

3.1 Long-Term Outlook for Oil Supply

The oil shocks of the 1970s and their associated uncertainties led to major questioning about future oil resource scarcity, as highlighted by the publication of the Club of Rome study, "The Limits to Growth." After the oil price collapse of 1986, this view was less prevalent. However, at the end of the 1990s debate had begun on the future of oil supplies, spurred by articles in prominent journals by geologists Colin Campbell and Jean Laherrere, who argued on the basis of applying the Hubbert curve to the world that conventional oil production would peak in the first decade after 2000 and set the stage for a coming oil crisis. (King Hubbert was a famous U.S. geologist who correctly predicted that U.S. oil production would peak in approximately 1970.) Their argument was based on the proposition that all large oil fields have already been found and that world reserve data are inaccurate, especially in the Middle East, where several OPEC member countries suddenly and mysteriously increased their reserve figures in the late 1980s. According to these pessimists, world recoverable oil reserves at the end of 1998 were estimated at 1800 billion barrels, and world production could peak by 2010 if not sooner. A similar perspective is presented by geologist Kenneth S. Deffeyes in his book, “Hubbert's Peak: The Impending World Oil Shortage.”

Among the leading opponents of this view are economists M. A. Adelman and his associate Michael Lynch, who pointed out serious limitations of the Hubbert curve and emphasized the role of investment and new technology in expanding reserves. Oil reserves are better viewed as inventory, which is replenished by investment. Depletion is constantly delayed by new knowledge and advances in production technology. Oil supply forecasts have tended to be dominated by a pessimistic bias.

In 2000, the authoritative U.S. Geological Survey (USGS) published its latest estimates of world oil and gas reserves outside the United States that have the potential to be added during the period 1995–2025. The estimated volumes of undiscovered conventional oil are 20% greater than the 1994 estimate. The potential addition to reserves from reserve growth (e.g., due to applications of new technology) is also very large. When the new mean global estimates are combined with previous estimates for the United States, the USGS contends that worldwide ultimately recoverable reserves (URRs) of conventional oil total 3.021 trillion barrels, and natural gas liquids (frequently added to oil estimates) total an additional 324 billion barrels. URRs include cumulative production to date, identified remaining reserves, undiscovered recoverable resources, and estimates of "reserve growth" in existing fields. The 1994 USGS estimate listed URRs of conventional oil at approximately 2.3 trillion barrels.

The new USGS estimates have been adopted by two organizations that regularly publish widely respected energy market forecasts. Both the IEA in its 2001 "World Energy Outlook" and the U.S. Energy Information Administration (EIA) in its "International Energy Outlook 2002" take an optimistic view of future world oil supply and conclude that proven oil reserves are adequate to meet demand until 2020, with a world production peak to occur sometime thereafter. In addition, the world has very large reserves of unconventional oil, including Venezuelan heavy oil and Canadian tar sands, which will become economic to produce at higher oil prices. In short, the world appears to have sufficient oil reserves for the foreseeable future.

An important factor in the increased estimates for oil reserves, especially for oil reserve growth, is the recent advances in oil production technology, which have improved success rates and lowered costs of finding oil and production. These advances include three- and four-dimesional seismic for locating and evaluating underground deposits; directional drilling; floating production systems; deep-water platforms; and the general widespread application of computers and information systems by oil companies and service contractors to improve analysis, management, and communications. Direct production costs for the international oil companies are estimated to average $3–6/barrel worldwide.

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Changing Environmental Condition and Phosphorus-Use Efficiency in Plants

Amitav Bhattacharya, in Changing Climate and Resource Use Efficiency in Plants, 2019

Abstract

Intensive use of phosphorus (P) in agriculture has raised concerns about its sustainability due to potential resource scarcity and its nonudicious use, which

has led to serious environmental pollution. Plants possess a number of adaptive mechanisms to cope with phosphorus stress leading to changes at morphological, physiological, biochemical, and molecular levels. A comprehensive understanding of these adaptive responses is required to improve phosphorus-uptake efficiency, partitioning, and utilization, together with other agronomic approaches, which would result in meeting the sustainability challenge of phosphorus delivery to crops. Phosphorus is often an important limiting factor for crop yields, but rock phosphate as fertilizer is a nonrenewable resource and expected to become scarce in the future. High phosphorus input levels in agriculture have led to environmental problems. One of the ways to tackle these issues simultaneously is by improving the phosphorus-use efficiency of crops through breeding.

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Thermodynamics and Economics, Overview

Robert U. Ayres, in Encyclopedia of Energy, 2004

5 Further Implications of the Second Law of Thermodynamics

Many economists, as well as most physical scientists, assume that the relationship between economics and the second (entropy) law of thermodynamics concerns resource depletion and scarcity. In this belief. they are, in a sense, disciples of the late Nicolas Georgescu-Roegen, who famously said, “The entropy law is the taproot of economic scarcity” and many other words to that effect. As noted at the beginning of this article, the economy is a system that extracts low-entropy resources from the environment and rejects high-entropy wastes back into the environment. Although solar energy was the original source of fossil fuels that accumulated in the earth's crust during the Carboniferous Era several hundred million years ago, humans are dissipating those resources at a rate thousands or even millions of times faster than the resources were created.

An aspect of the depletion argument concerns recycling. One consequence of the second law of thermodynamics is that recycling can never be 100% efficient. At first sight, this would imply that scarce materials such as platinum must actually disappear from the surface of the earth, and this is not the case. What is true is that as the quality of the resource base declines toward the average in the earth's crust, the amount of exergy required to extract and reconcentrate it increases to a maximum. In a finite planetary environment, the concentration of a scarce metal can never fall below the average. This means that recycling will become more difficult over time but will never become impossible.

The idea that economic growth must be limited by physical resource scarcity actually has quite a long history. It goes back at least to Thomas Malthus, who saw arable land as the limiting factor. During the 19th century, Jevons worried about future availability of energy from coal. Since 1919, there has been a series of predictions that petroleum reserves are about to run out, with each "crisis" being followed by new discoveries and another glut. Scarcity worries were behind the neo-Malthusian "limits to growth" thesis, propounded during the 1970s by the Club of Rome. However, an authoritative study of minerals published by Resources for the Future strongly indicated that scarcity, as indicated by price, production, and reserve trends, was not yet a problem for any exhaustible mineral resource. A follow-up in 1979 seemed to confirm that result.

The long-running debate between neo-Malthusians (who worry about scarcity) and "cornucopians" (who do not) remains unresolved. It is, in any case, beyond the scope of this article.

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Foraging in Plants: the Role of Morphological Plasticity in Resource Acquisition

M.J. Hutchings, H. de Kroon, in Advances in Ecological Research, 1994

6 Foraging and Resource Integration in Clonal Plants

If part of an integrated clonal plant growing under low resource levels imports resources from another part of the clone growing under more favourable conditions, one would expect that morphological responses to local resource scarcity will be damped as a result of the elevation of internal resource concentrations. Surprisingly, it appears that this is not always the case. Instead, integration may even intensify the morphological responses to local growing conditions (see Alpert, 1991; Evans, 1992). The physiological mechanism behind this reaction and the functional significance of integration for local foraging responses deserve further study. One hypothesis to explain this result is that augmentation of the local response could stimulate a behaviour which would promote escape from locally unfavourable conditions. Integration could thus increase foraging efficiency in a patchy habitat, in contrast to suggestions made by de Kroon and Schieving (1990). The importance of local foraging and integration for resource acquisition may markedly increase if habitat patches are characterized not by some level of favourability, but instead by an adequate supply of some resources and an inadequate supply of others. The consequences of plasticity and integration in such a multiple-resource habitat patch structure are only now beginning to be considered.

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The Resilient City Metaphor to Enhance Cities' Capabilities to Tackle Complexities and Uncertainties Arising From Current and Future Climate Scenarios

Adriana Galderisi, in Smart, Resilient and Transition Cities, 2018

2.1 Introducing the Resilient City Metaphor

The resilient city metaphor is nowadays widely used to depict a city that is capable of withstanding, absorbing, and recovering from sudden events and chronic stresses, caused by heterogeneous pressure factors (resources scarcity, economic crises, natural hazards, climate change, etc.). This metaphor is grounded in a widely debated concept—resilience—that has been used with different meanings since ancient times and intensely investigated and conceptualized starting from the 19th century, according to different disciplinary perspectives, from mechanics and physics to psychology, from ecology to economy, sometimes with controversial outcomes (Alexander, 2013).

Along the evolutionary path of the resilience concept, both objects and objectives of resilience studies have progressively enlarged. The focus has shifted from single elements (materials, individuals) to systems (natural, social) and, more recently, to coupled systems (socioecological; socioecological-technical). Meanwhile, the initial goal of resilience studies moved from the idea of improving elements and systems' capacity to bounce back, by recovering the previous equilibrium state after a crisis, toward a “bounce forward” perspective (Manyena et al., 2011), which includes the strengthening of systems' essential structures and functions and the improvement of their ability to anticipate, in order to better drive complex adaptive systems towards new equilibrium states.

The resilient city metaphor has become prominent in the context of urban studies in the last decade, and it is also heavily emphasized in all of the latest documents on both sustainable development (UN, 2012, 2015a) and disaster risk reduction (DRR) (UN, 2015b). It has also been widely promoted among practitioners and decision makers by different international campaigns. The prominence gained by this metaphor finds its roots in the growing complexities and uncertainties arising from the numerous and interconnected challenges threatening cities (urban population growth; urban development patterns; consumption and degradation of natural resources; natural, human-induced, and coupled hazards; and changes in climate features and related impacts). Thus, resilience has been more and more widely interpreted as a relevant approach for better understanding and managing the interwoven systems of humans and nature as well for empowering cities to better deal with current and emerging challenges and, above all, with the increasing impacts of climate change. Nevertheless, some scholars have raised the idea that “much of what has been recently labeled ‘resilience’ is ‘old wine in new bottles’” (Weichselgartner and Kelman, 2015), that the subject is still vague, has different conceptualizations, and that resilience practices often have been developed without fully accounting for theoretical debate.

Therefore, in the following discussion we will focus on what is new in resilience thinking and how it is informing or could inform resilience-building processes at city scale.

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Learning instruments

V. Ratna Reddy, ... Wendy Sue Merritt, in Integrated Approaches to Sustainable Watershed Management in Xeric Environments, 2019

Section IV

8.0 **Collective Choice:**

8.1

Is your cropping decision collectively made, or is it your own decision? 1-Collectively, 2-Own

8.2 Is this decision motivated by: (1) profits or (2) resource scarcity (Physical, Natural, Financial, Human, Social, etc.)?

8.3 Have you ever planted crops that were profitable but were prohibited by the village committee due to their bad impact on water levels? Yes/No

8.4 (If answer to 8.1 is collective)—During a collective decision over crop choice and groundwater use, do you think that the group is concerned about a small user group, overall community welfare, and resource sustainability?

8.5 (If answer to 8.1 is collective)—During a collective decision over crop choice and groundwater use, are you concerned about the welfare of the larger group? Yes/No

If yes, in what conditions you will leave the collective?

8.6 To what extent is your welfare taken into account in the collective decision-making process? High, medium, or low (choose)

8.7 Do you observe any discrimination or biases in collective decisions because of income or caste or political/social status? Yes/No

9.0 **Long-term sustainability**

9.1 Are you aware of climate change and its impact on agriculture? Yes/No

If yes, give details on how?:

9.2 Do you think droughts are happening because of climate change and global warming? Yes/No/Not sure

9.3 Do you believe that: (1) the water situation will improve in future or (2) that groundwater will be lost in future?

Why do you think so?

9.4 In your opinion, how long would groundwater be lost?

9.5 Is the present rate of groundwater exploitation in your village sustainable? Yes/No

Give Details on the number of wells that can sustain groundwater levels in your village.

9.6 Do you think watershed development in the upstream of your village is reducing the water flows into your village water bodies (like tanks and groundwater aquifers)? Yes/No

If Yes, Explain.

9.7 Are you planning to cope with increasing water scarcity in future? Yes/No

If YES, What will you do differently?

If NO, Why?

9.8 What would you do with your land if you ran out of water? 1-Continue to cultivate, 2-give it on lease, 3-sell, 4-other (specify)

9.9 What is your alternative plan for survival if agriculture becomes unviable in the future?

9.10 How are you getting prepared to deal with future uncertainties related to agriculture?

9.11 Do you expect to sell your land at a high profit in the future if urban growth happens in your region? Yes/No By how much?

9.12 In your opinion, which of the five capitals (explain indicators) would help you most in this regard (need to mention specific indicators rather than capitals)?

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Land–Water–Energy Nexus of Biofuels Development in Emerging Economies

Thapat Silalertruksa, Shabbir H. Gheewala, in The Role of Bioenergy in the Bioeconomy, 2019

Abstract

Sustainable biofuels development is essential to many of the emerging economies. However, biofuel promotion creates a unique linkage between food, water, land, and energy. The rapid increase and widespread use of biomass for biofuels production is facing the challenge on resource scarcity. The magnitude of impact will vary significantly across regions and countries depending on the size of the biofuel targets adopted, the key technologies,

biomass feedstocks identified, and especially the water availability and scarcity level of that particular region of biofuel promotion. This chapter presents the land–water–energy nexus challenges of biofuel development and life cycle–based indicators that can be used for the nexus assessment. The case study of bioethanol promotion in Thailand and its effects on land, water, energy, and greenhouse gas impacts are discussed. Recommendations for further sustainable biofuel production along with the nexus management are provided.

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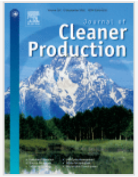

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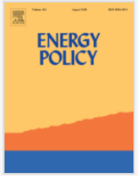

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