"Carrying Capacity" – the Moral Economy of the "Coming Spaceship Earth"

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Abstract

To problematize how in the sustainability discourse environmental limitation has become discursively effective through merging scant "resources" and spatial constraint, the paper will examine the concept of "carrying capacity". The concept has served ecologists as a principle to define the maximum number of representatives of a given species that a habitat can support indefinitely, without permanently corrupting the environment. The terms in which limited spatial capacity was spelled out and acted on can be traced back historically to van Leeuwenhook's estimations in the 17th century about the number of people the earth could support and to von Liebig's "Law of the Minimum" in the 19th century, which has been used as a natural base for quantitative calculations of populations being constrained by whatever survival "resource" is in shortest supply.

The paper will outline how in the "environmental decade" of the 1960s and early 1970s, population growth became a key concern in a survivalist discourse, as population sciences mathematically related finite numbers of people to limited available capacity (Ehrlich, *The Population Bomb*, 1968). The paper will investigate how this functional relationship was performed and instituted by the programmatic outline of the "Coming Spaceship Earth" (Boulding 1966). The figure of the "spaceship", coming as a response to the environmental crisis, associated an affirmative future vision of human survival within limited space by prospectively realizing a tight economy of natural metabolism through technoscientific intervention and administration (Ehrlich/Harriman, *How to be a Survivor: A Plan to Save Spaceship Earth*, 1971). Studying the discursive articulations of "spaceship earth" and its carrying "capacity", the paper will explore how the "spaceship economy" involved a moral economy of efficiency and liability, which deeply shaped contemporary terms of "sustainable development" as a (population) management problem.

Preface: The Age of the Spaceship

The year: 2022. The Place: New York City. The population: 40 Million [Fig. 1]. Industrial pollution and greenhouse effect have destroyed the environment; food is hardly available. Smog and heat make life almost unbearable. Congestion, poverty, hunger, and corruption dominate the city. A huge police force is needed to keep the masses in control. Food production and distribution are controlled by a single company, the "Soylent Corporation". Fresh vegetables, fruit, and meat are a luxury of the rich; the masses are fed with synthetic nutrients based on proteins from soy beans and ocean plankton. Their food comes in small, tasteless bits and pieces: Soylent Yellow, Soylent Red, and Soylent Green, sold on Tuesdays to the starving crowd.

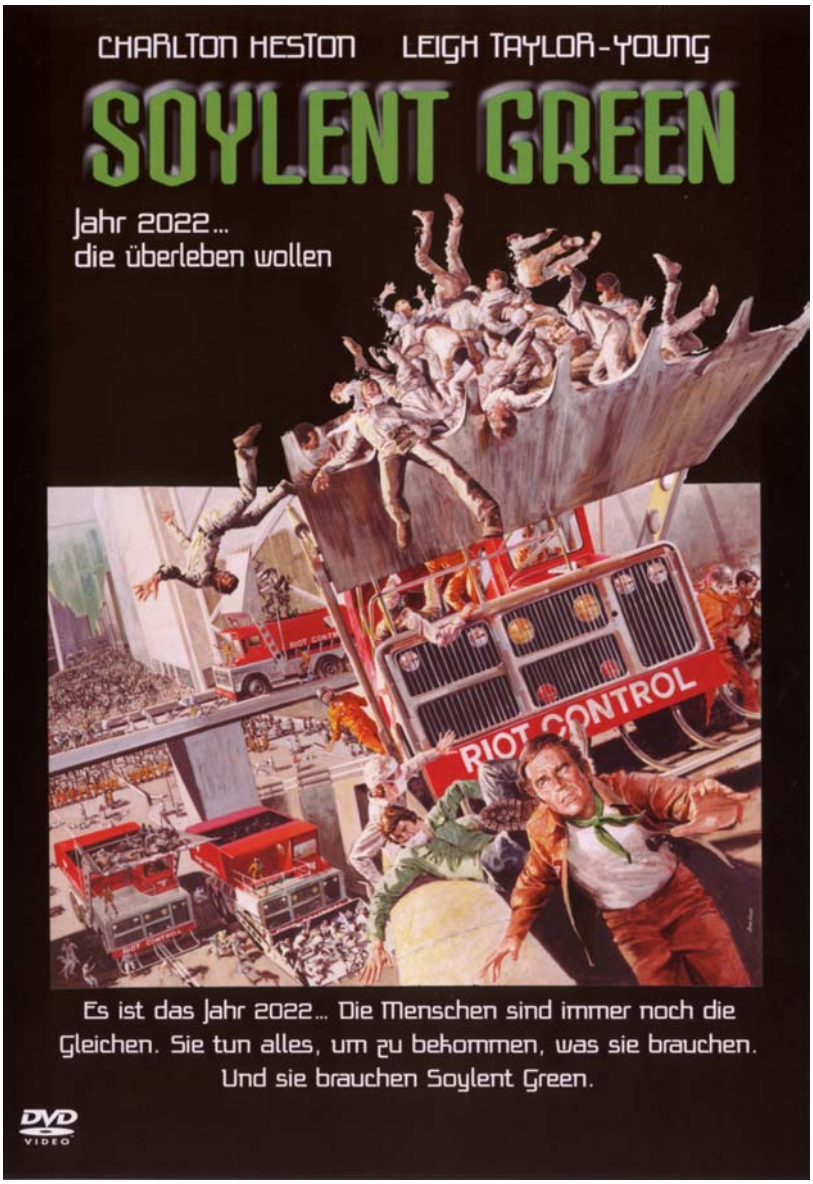

Fig. 1:
"Soylent Green" (USA 1973)

"Soylent Green" is a troubling dystopia produced in the US in 1972 and released in 1973. What is commonly classified as "Science Fiction" was, according to director Richard Fleischer, neither about science, nor was it pure fiction or fantasy.[1] His scenario was designed to make a statement about some of the pressing issues of the late 1960s and early 1970s. His idea was to show the near future 50 years ahead as a result of humanity's ignoring the pressing issues of population growth and environmental pollution.

Undeniably, this is a movie about limits and limitation. The screenplay was based on a novel by Harry Harrison called *Make Room! Make Room!*, which appeared in 1966.[2] The title at once signifies an overcrowded world and the merciless police practices of riot control. The book's argument about extreme population growth, environmental degradation, scarcity, mass uprising, and mass mortality is quite common for its times and has been the topic of many texts of the era, like Fairfield Osborn's *Our Plundered Planet* in 1948, and *The Limits of the Earth* in 1953, Karl Sax's *Standing Room Only* in 1955, Paul Ehrlich's *The Population Bomb* in 1968, or George Borgstrom's *Too Many* in 1969.[3] Their question was: "How Many People Can the World Support?"[4] Some predicted that, with the present rate of population growth, "in 600 years the entire earth would provide only one square yard of land per person".[5]

The Problem of the Spaceship: "Capacity"

In the same time priod, another scholar contributed to the discourse of limits, though with a different objective. In his lecture "Of Other spaces" held in 1967, Michel Foucault labeled the 20th century the "epoch of space". He maintained "that the anxiety of our era has to do fundamentally with space."[6] Foucault used demography or *human topography* to argue that space in the 20th century had become an issue of *siting* and *placement*: "This problem of the human site or living space is not simply that of knowing whether there will be enough space for men in the world […], but also that of knowing what relations of propinquity, what type of storage, circulation, marking, and classification of human elements should be adopted in a given situation in order to achieve a given end."[7]

My paper is concerned with the scientific and technological *regimes* of efficiency within this broader discourse of a limited earth.[8] I will focus on the concept of "carrying capacity", which today is defined as the "maximum number of organisms that an area or habitat can support without reducing its ability to support the same number of organisms in the future".[9] "Carrying capacity" ("Tragfähigkeit" in German) is interesting in regard to Foucault's notion of "biopolitics", since its definition points to quantifiable life ("number of organisms"), to sustaining life ("support"), and to a limit of life ("maximum number") in relation to a spatial unit ("habitat"). So my argument is that "carrying capacity" involves not only the notion of spatiality and of finiteness, but also a certain technology of *accounting*, directed towards life and environment. The concept involves a *mathematic* and a *"moral" economy*, to use a term which Lorraine Daston introduced to science studies.[10] Limiting the earth to a sphere which was to *contain* and to *sustain* all life produced a fundamental shift in the perception of the

conditions of life. Reflecting on movies like "Soylent Green" and on Foucault's claims, "carrying capacity" is not simply about limited space or too many people. It is about the *storage*, the *circulation*, and the *classification* of *human elements*. As my research is still at a beginning, I can only give a draft of the "moral economy" of populations in the later 20th century, a draft of how a taxonomy of people framed notions and solutions of "sustainability".

The Mathematics of the Spaceship: *Storage*

In 1972, when "Soylent Green" was produced, the Club of Rome's report *The Limits to Growth* was published and the first global environmental conference took place, the United Nations Conference on "Human Environment" in Stockholm.[11] It was the first "earth summit" to constitute global awareness of environmental pollution and depletion. Thus, "Soylent Green" linked two major concerns of its times: "population explosion" and "ecocide", to use two widespread terms. In director Fleischer's words, the film was all about "overpopulation" and "overpollution".

This link was established by an impressive 2 minute entrance sequence of images and music. The sequence draws a visual and aural tableau of the 20th century. It stars out with some long shots showing the optimistic times of rising industrialization in the beginning of the century, signified by the first fragile cars and primitive airplanes. This rather moderate heading into modernity is accompanied by a slow waltz. We then observe the century proceeding: The pictures are replaced by modern industrial settings and the output of mass production; we see smoke stacks and arrays of cars coming from the assembly line. As the music picks up speed and changes to a quick beat, the succession of pictures accelerates as well; the screen splits as images double and then multiply, changing with rising frequency. Also, *what* we see changes: more and ever more people in frantic succession. The images come in colour now, denoting the post World War II modes of living and consumption. We see urban crowds of the 1950s and 1960s. Within this frenetic rhythm of pictures and music, we begin to recognize the effects of rising industrial pollution pointed out to us by dying trees, industrial waste, smog, and by people wearing masks. Then the music slows down to the beat from the start, the images slow down, and we know that we have again moved on in time: Now we watch waste areas, destroyed forests, barren industrial sites. The sequence "comes to a grinding halt" with the sight of the thickly polluted cityscape of New York City.

This "cleverly devised" montage matches in its visual and acoustic structure the "Logistic Growth Curve" which population ecologists referred to to describe the development of a

population over time [Fig. 2].[12] The S-shaped curve relates population size and time according to a "natural law" of growth or development, set up by the biologist Raymond Pearl and his colleague Lowell Reed in the early 1920s.[13] The "constraining factor" in the growth pattern, the biologists explained, was that many populations were *confined* to a limited area. Because of these limitations, their development was characterized by exponential growth up to a "point of inflection" when environmental feedback were to cut in, and subsequently, progressive deceleration would occur.[14]

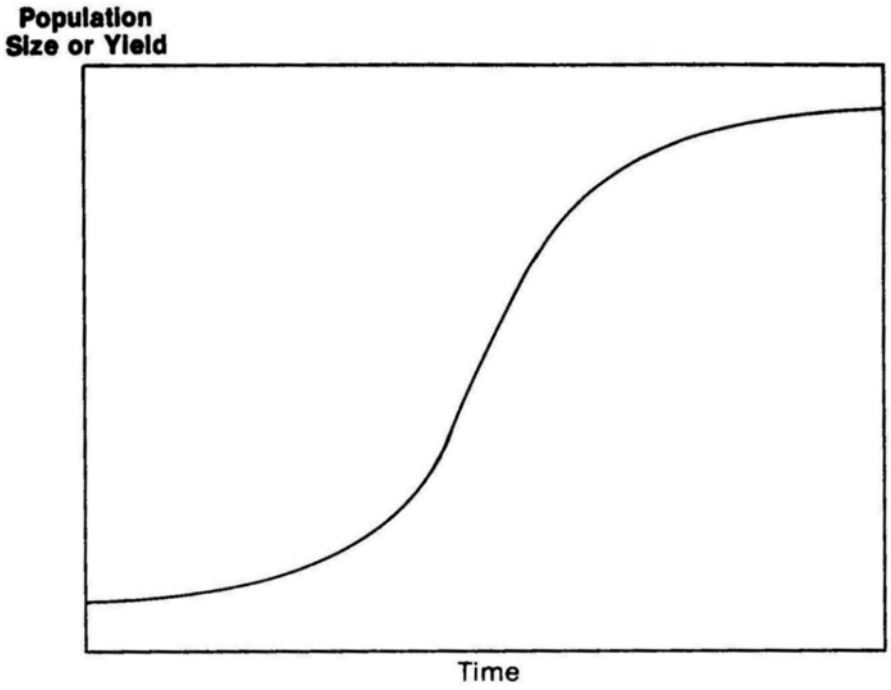

Figure 3-1. The S-Shaped Biological Growth Curve

Fig. 2

This mathematical model, derived from glass jar residents, was held valid to describe human development as well. It served as a warning to avoid "overshooting" – that is, to avoid growing too far and then collapse. In 1978, Lester Brown gave another vivid example of this relation in his book *The Twenty-Ninth Day*. The president of the World Watch Institute used the image of a "global lily pond": If a lily pond of single leafs, he asked, whose number doubles each day, is completely full on the thirtieth day, when is it half full? The answer was: on the twenty-ninth day.[15] The global lily pond, so his warning, may already be half full.

The empirical world population growth curve presented in that time illustrates why the contemporaries deemed their situation so unique in history [Fig. 3]: It was not the population being roughly 3 billion people, but the "nature" of growth being considered exponential, that is, the population having doubled within less than a century and increasing at a rate that anticipated another doubling within one generation. Western society considered itself positioned at the *end* of an exponential process of growth where limits appear very suddenly. Stanford biologist Paul Ehrlich warned in 1968: "Clearly, a long history of exponential growth does not imply a long future."[16]

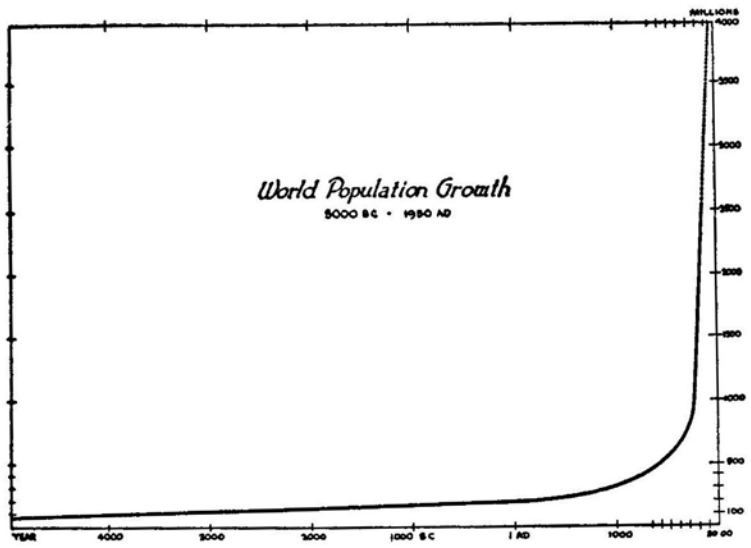

FIGURE 3
WORLD POPULATION GROWTH (5000 B.C. to 1950 A.D.)

Fig. 3: "World Population Growth"

"Unprecedented Growth" may be the two words used most in the crucial documents of the "environmental age". Thomas Malthus already around 1800 published thoughts on the "principle of population", proposing simple mathematical structures to grasp the developments of population and food supply: According to Malthus, the number of people tended to increase geometrically, while food supply increased only arithmetically. This straightforward mathematical representation of a phenomenon became something like a "law". In the early 1950s, Fairfield Osborn regarded the world "under the control of the eternal equation – the relationship between our resources and the numbers as well as the needs of our people."[17] The relation "finds expression in a simple ratio wherein the numerator can be defined as 'resources of the earth' and the denominator as 'numbers of people.' The numerator is *relatively* fixed and only partially subject to control by man. The denominator is subject to substantial change and

is largely, if not entirely, subject to control by man."[18] Combining "pressures" and "resources" in a basic ratio, a mathematical fraction, opened up new perspectives of managing the problem. It was framed as an accounting problem: Osborn concluded: "We have now arrived at a day when the books should be balanced. But can they be?"[19]

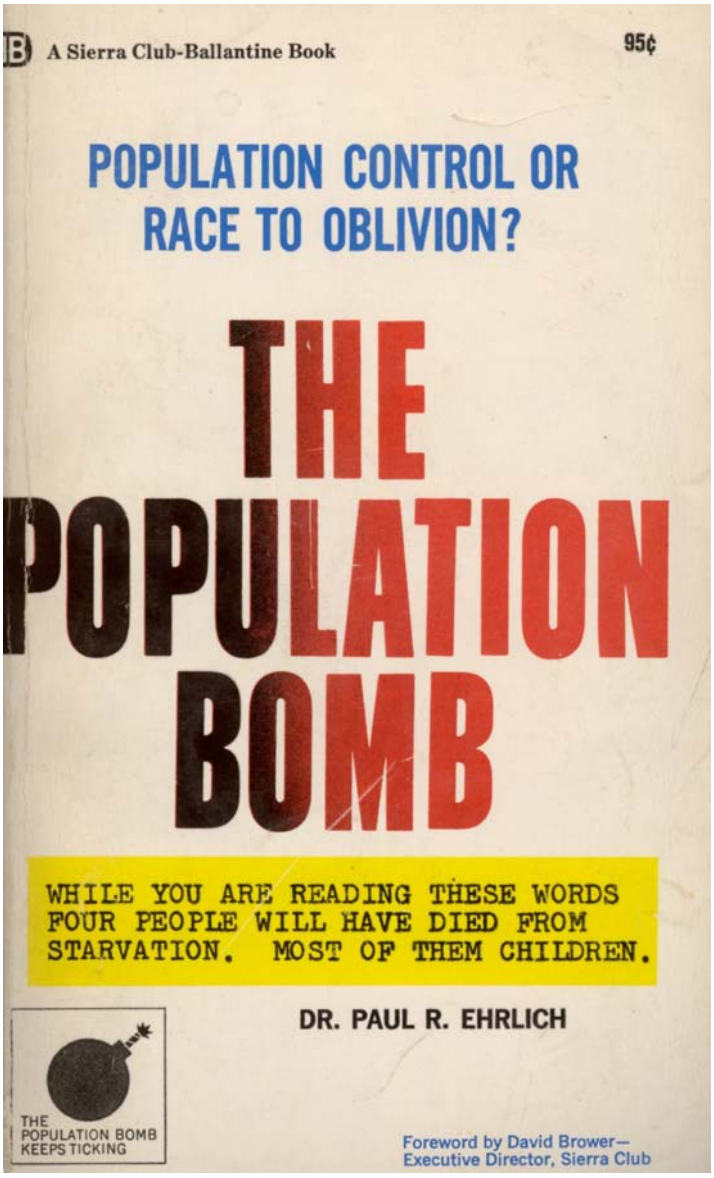

Fig. 4: "The Population Bomb Keeps Ticking"

To Paul Ehrlich and his colleagues, it was not the hydrogen bomb but "the Population Bomb" which kept "ticking" [Fig. 4]; "all [problems of the world at present] can be traced easily to too many people"[20]. "In just two or three years [!] it became possible to question growth, to suggest that DNA was greater than GNP"[21]. Ehrlich, entomologist and in 1968 professor of biological sciences at Stanford University, took an interest in human population studies and environmental ecology and became a leading figure in what was called "human ecology". He turned the population-resources-environment relation into a mathematical *equation* which held that "Environmental disruption = population x consumption per person x damage per unit of consumption".[22] Within this mathematical frame, the question was not simply "How Many People Can the World Support?" Instead, it became: "What is the *optimum number* of human beings that the earth can support?"[23] This question was explicitly stated as a problem of *storage*, of efficient allocation of humans to a limited cargo space.

The Economy of the Spaceship: *Circulation*

A concept of constraint had been long familiar to biologists, determined by the "maximum sustainable yield of a natural biological system".[24] The yield in turn varied according to a local system's size and regenerative powers. This notion goes back to Justus von Liebig's "Law of the Minimum" of agricultural chemistry, formulated in the mid-19th century. "Liebig's law" was generalized to predict that populations of any species will be constrained by whatever survival "resource" is in shortest supply.[25] It was newly theorized by the economist Kenneth Boulding. On the occasion of a conference on "environmental quality" in Washington 1966, he reflected on the "economics of the coming spaceship earth", signifying the "transition from the illimitable plane to the closed sphere"[26]. Earlier civilizations, Boulding stated, had made the experience that there "was almost always somewhere beyond the known limits of human habitation"[27], "there was always some place else to go when things got too difficult"[28]. The "closed earth of the future"[29] however would require a new economy: The "cowboy economy", the throughput-oriented economy of the illimitable plains, would have to be superceded by the "spaceman economy", the cyclical system of the closed sphere, capable of material reproduction, and externally sustained by energy inputs only.[30]

"Spaceship earth" framed and directed the discourse on population in a specific way: It designed an economy of "circulation" and a technology of flows, of material exchange and renewal. Although to Ehrlich the day seemed "far away when food for billions is grown on synthetic nutrients in greenhouses free of pests and plant diseases, when the wastes of civilization are recycled entirely by technological means, and when all mankind lives in surroundings as sterile and as thoroughly managed as those of […] an Apollo space capsule",[31] serious attempts were made at the time to chemically synthesize food, to study artificial photosynthesis, and to mass-cultivate fungi or single-celled algae like "Chlorella"[32], substitutes which indeed make an easy leap to futurist visions like "Soylent Green". The image of the "spaceship earth" was strained with hopeful or sarcastic assessments of the possibilities of interstellar transportation and colonization of far away planets. Paul Ehrlich and Richard Harriman organized their entire book *How to be a Survivor: A Plan to Save Spaceship Earth* in 1971 around the metaphor of spaceship earth, from the "Size of the Crew" via the "Control Systems" to a new culture of "Spacemen" needed.[33]

"Spaceship earth" formulated instructions as to the technology and the people it involved. Both the cynicism of population biologists like Ehrlich and the technocratic optimism of the so-called "Cargoists"[34] illustrate that the difference between the technical "life-support" sys-

tem of the space-capsule and the biospheric system of the earth had become marginal. "We are all astronauts"[35], Richard Buckminster Fuller asserted in his 1969 essay *Operating Manual for Spaceship Earth*[36], and he argued: "We have hitherto never regarded our spaceship earth as an integrally constructed machine which for the purpose of permanent efficiency has to be conceived of and handled as a whole.[37] Since "an operating manual was not delivered"[38], Fuller considered humankind confronted with the challenge of self-instruction to become the operator of the planetarian complex of "life support and maintenance systems"[39].

The Moral of the Spaceship: *Classification*

It is unclear who would steer "spaceship earth" with a "global brain"[40]. It is clear, however, that the figure of "spaceship earth" marked the planet as a *temporary* environment. "Men in a spaceship are not locked in one place, but become perpetual travelers"[41]. The ship is a cultural image of temporality, transition, and transience. It is the figure of the early modern "voyages of discovery" and, likewise, of the end of the "lost horizon"[42] that closed the "World Frontier" in the 20th century. To Foucault, it is the "heterotopia par excellence", indicating its spatial singularity, and the "greatest reserve of the imagination".[43] The ship is also the figure of confinement and of complete dependence, as Ehrlich's picture of the "ever-shrinking planet" conveys:[44] "It is obvious that we cannot exist unaffected by the fate of our fellows on the other end of the good ship Earth. If their end of the ship sinks, we shall at the very least have to put up with the spectacle of their drowning and listen to their screams."[45] "Will they starve gracefully, without rocking the boat?"[46] Within the last decades, paroles like "the boat is full" served to limit migration within the "globalized" world, especially to detain "them" – refugees from underdeveloped countries.

It is not surprising then, that the term "carrying capacity" in the 1960s began to creep from biology into human ecology and demography, later seeping into the vocabulary of the UN officials and of political decision makers and economic advisers on a "global" scale.[47] And the research question changed again: It was not only: What is the "optimum number" of people which spaceship earth was able to carry? But also *Who may go?* Biologist Karl Sax, professor of botany at Harvard University, with regard to Malthus recommended either "positive checks" – high death rates – or "preventive checks" – low birth rates. One of these, he claimed, would be needed to control population growth.[48] "The Challenge of Overpopulation", he maintained, was that "nearly two-thirds of the world's people live at little above subsistence levels; yet these are the people who have the highest birth rates." What

mattered to him was that "[a]ll advances in agriculture and industry could be absorbed by excessive population growth […]."[49] Who exactly is threatened becomes clear when looking at the picture to the text [Fig. 5], where we see North America go up in flames.

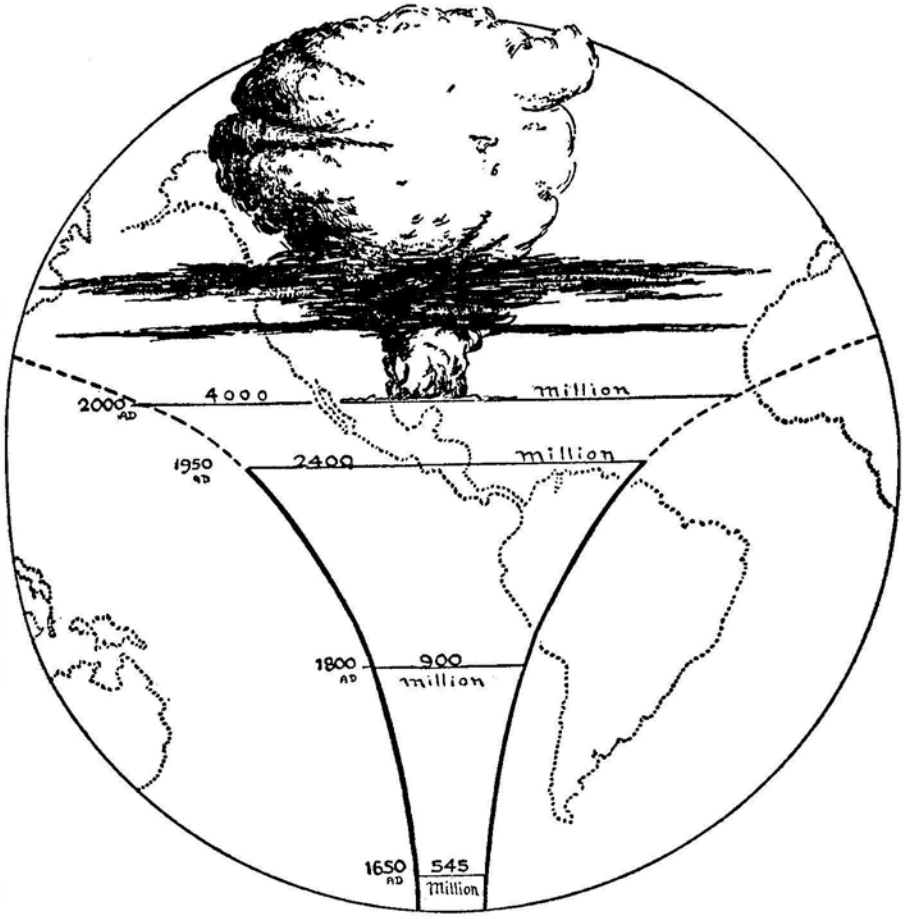

FIGURE 10

THE CHALLENGE OF OVERPOPULATION

The present species of man has lived on this earth for at least 50,000 years and his primitive ancestors for more than 500,000 years. But the world population did not reach 500 million until the sixteenth century A.D. Since 1650 the world population has increased from about 600 million to 2,500 million; at present growth rates it will reach 4,000 million by the year 2000 A.D.

Nearly two-thirds of the world's people live at little above subsistence levels; yet these are the people who have the highest birth rates. The greatest population growth, or potential growth, is in countries that do not now produce adequate food for their present populations. All advances in agriculture and industry could be absorbed by excessive population growth — and the only result of increased production would be more people living in poverty. Poverty and ignorance are greater threats to our modern civilization than the hydrogen bomb.

Fig 5: "The Challenge of Overpopulation"

"Too many people – that is why we are on the verge of the 'death rate solution.'"[50] Although Ehrlich is cynically speaks of the "surplus people"[51] to be taken care of, he is serious in his option for "population control" as "the conscious regulation of the numbers of human beings to meet the needs, not just of individual families, but of society as a whole."[52] He suggests a

"triage" system for the "classification of nations" into those, who are in the situation to give international aid ("us", the Western world, particularly the US), those who may undergo the demographic transition without drastic help, those who may succeed to self-sufficiency with food aid, and, finally, the tragic category of undeveloped countries without hope that should not receive more food.[53]

The Resolution of the Spaceship: "Sustainability"

In 2022, living people are "surplus" and encouraged to consent to euthanasia. The dead are waste; their bodies are disposed of by garbage trucks. We learn that the Soylent Company handles the great numbers of human corpses in a most efficient and profitable way by transforming them directly into food for the living. "Soylent Green is people!" This outcry in the end of the movie has acquired "cult" status in the last decades.

Even though this form of "circulation" has not been realized, the late 20th century *has* devised new ways to control and regulate the lives and deaths of people on a global scale.[54] What I tried to point at is that notions of "life support" were mainly based on *scientific* and *technological* reasoning and design. Paul Ehrlich's equation was later turned into the well-known "I=PAT"-formula, calculating the human "Impact" on the environment from the product of "Population" (number of people), "Affluence" (average per-capita consumption of resources), and "Technology" (inflicted environmental damage).[55] Formulas such as this are *prescriptions*, they are instructions on *how* to see, which often *divert* from understanding global distributions of power and of wealth.[56]

So the question that comes up is not *Who may go?* But *Where?* A concept like "carrying capacity", based on effective calculus, tends to *produce* categories like "overpopulation" or "surplus".[57] It is important to study this "moral economy" of efficiency and liability resulting from the arithmetic of the "coming spaceship earth" that also shaped contemporary terms of "sustainability" as a (population) management problem.

Notes

1 The 2003 film DVD provides informative supplementary material: first, an extra audio track from 2003 with the retrospective commentaries by director Richard Fleischer and by the leading actress Leigh Taylor Young

who played the figure of Shirl; second, a short documentary with the title "A Look into the World of Soylent Green".

2 Harrison, Harry, *Make Room! Make Room!*, Garden City, New York, Doubleday 1966.

3 Osborn, Fairfield, *Our Plundered Planet*, Boston, Little, Brown & Co. 1950 [1948]; Osborn, Fairfield, *The Limits of the Earth*, Boston, Little, Brown & Co. 1953; Sax, Karl, *Standing Room Only. The World's Exploding Population*, Boston, Beacon Press 1960 [orig. 1955 under the title *Standing Room Only. The Challenge of Overpopulation*]; Ehrlich, Paul R., *The Population Bomb*, New York, Ballantine ^{4}1969 [1968]; Borgstrom, Georg, *Too Many. A Study of Earth's Biological Limitations*, New York, Macmillan 1969.

4 Fremlin, J. H., "How Many People Can the World Support?" *New Scientist* No. 415, 29 October 1964, pp. 285-287.

5 Sax, *Standing Room Only*, preface, p. xii.

6 Foucault, Michel, "Of Other Spaces", *Diacritics*, spring 1986, pp. 22-27 [orig. "Des Espaces Autres", manuscript 1967], quotes p. 22, 23.

7 Ibid., p. 23.

8 This is the focus of my current work in the research project NEDS – "Sustainable Development between Throughput and Symbolism: Guiding Principles of the Economic Construction of Ecological Reality in European Regions", funded by the German Ministry of Education and Research (# 624-40007-07 NGS 11). The responsibility for contents of this paper lies with the author; see also Höhler, Sabine, ",Raumschiff Erde': Umweltwissenschaftliche Konstruktionen des globalen Lebensraumes im späten 20. Jahrhundert", in: Schröder, Iris, Höhler, Sabine, Natter, Wolfgang (Eds.), *Welt-Räume: Geographien des globalen Zeitalters*, Frankfurt a. M., Campus 2005 (in preparation).

9 Barbier, Edward B., Burgess, Joanne C., Folke, Carl, *Paradise Lost? The Ecological Economics of Biodiversity*, London, Earthscan 1994, glossar p. 229.

10 Daston, Lorraine, „The Moral Economy of Science", in: Thackray, Arnold (Hrsg.), *Constructing Knowledge in the History of Science*, (*Osiris*, Second Series, Vol. 10), 1995, pp. 3-2, referring back to E. P. Thompsen; Daston, Lorraine, Vidal, Fernando (Hrsg.), *The Moral Authority of Nature*, Chicago/London, The University of Chicago Press 2004.

11 Meadows, Donella H., Meadows, Dennis L., Randers, Jørgen, Behrens, William W. III, *The Limits to Growth. A Report for the Club of Rome's Project on the Predicament of Mankind*, London, Earth Island Limited 1972.

12 "The S-Shaped Biological Growth Curve"; Brown, Lester R., *The Twenty-Ninth Day. Accommodating Human Needs and Numbers to the Earth's Resources* (A Worldwatch Institute Book), New York, W. W. Norton 1978, p. 69.

13 Kingsland, Sharon E., *Modeling Nature. Episodes in the History of Population Ecology*, Chicago/London, The University of Chicago Press 1995 [1985], Chapter 3 „The Quantity of Life", pp. 50 ff., paragraph "The Logistic Hypothesis", p. 64 ff.

14 Brown, *The Twenty-Ninth Day*, p. 70.

15 Ibid., introduction p. 1 and back cover.

16 Ehrlich, *The Population Bomb*, Prologue, p. 11.

17 Osborn, *The Limits of the Earth*, p. 77.

18 Ibid., p. 207.

19 Osborn, *Our Plundered Planet*, p. 43.

20 Ehrlich, *The Population Bomb*, p. 67.

21 Ibid., Foreword, p. 14.

22 Holdren, John P., Ehrlich, Paul R., "Human Population and the Global Environment", *American Scientist* 62 (1974), pp. 282-292, here p. 288.

23 Ehrlich, *The Population Bomb*, p. 167, my emphasis.

24 Brown, *The Twenty-Ninth Day*, concerning the history of "carrying capacity" see p. 12 ff., quote p. 13.

25 Liebig, Justus von, *Die Chemie in ihrer Anwendung auf Agricultur und Physiologie* (2 Parts), Braunschweig, Vieweg 1865 (8. Ed.), Part 2: *Die Naturgesetze des Feldbaues*, p. 223 ff.

26 Boulding, Kenneth E., "The Economics of the Coming Spaceship Earth", in: *Environmental Quality in a Growing Economy*, Essays from the Sixth RFF Forum on Environmental Quality held in Washington, March 8 and 9, 1966, ed. by Henry Jarrett, Baltimore, Johns Hopkins Press 1966, pp. 3-14 [Reprint in: Boulding, Kenneth E., *Beyond Economics: Essays on Society, Religion, and Ethics*, Ann Arbor, University of Michigan Press 1970 (1. paperback edition; orig. 1968), pp. 275-287], see p. 4.

27 Ibid., p. 3.

28 Ibid. Boulding dates the notion of the "global nature of the planet" (p. 3 f.) back to the time past World War II and to space flight. Currently, mankind experienced the "transition from the open to the closed earth" (p. 4). On "Whole Earth" and "Full Earth" as pictured first in an extraterrestrial photography realized through the technoscientific venture of space flight see Cosgrove, Denis, "Contested Global Visions: *One-World*, *Whole-Earth*, and the Apollo Space Photographs", *Annals of the Association of American Geographers* 84 (1994) 2, pp. 270-294; Jasanoff, Sheila, "Image and Imagination: The Formation of Global Environmental Consciousness", in: Miller, Clark A., Edwards, Paul N. (Eds.), *Changing the Atmosphere: Expert Knowledge and Environmental Governance* ("Politics, Science, and the Environment"), Cambridge, Mass., MIT Press 2001, pp. 309-337.

29 Boulding, "The Economics of the Coming Spaceship Earth", p. 9.

30 Ibid.: "I am tempted to call the open economy the 'cowboy economy,' the cowboy being symbolic of the illimitable plains and also associated with reckless, exploitative, romantic, and violent behavior, which is characteristic of open societies. The closed economy of the future might similarly be called the 'spaceman' economy, in which the earth has become a single spaceship, without unlimited reservoirs of anything, either for extraction or for pollution, and in which, therefore, man must find his place in a cyclical ecological system which is capable of continuous reproduction of material form even though it cannot escape having inputs of energy."

31 Holdren/Ehrlich, "Human Population and the Global Environment", p. 283.

32 According to Sax, *Standing Room Only*, p. 110, the "Chlorella" project was a mass culture of single-celled algae in the Carnegie Institution.

33 Ehrlich, Paul R., Harriman, Richard L., *How to be a Survivor: A Plan to Save Spaceship Earth*, New York, Ballantine 1971.

34 Catton, William R., *Overshoot: The Ecological Basis of Revolutionary Change*, Urbana/Chicago/London, University of Illinois Press 1980.

35 "Wir sind alle Astronauten". Buckminster Fuller, *Bedienungsanleitung für das Raumschiff Erde*, p. 43.

36 Buckminster Fuller, Richard, *Bedienungsanleitung für das Raumschiff Erde und andere Schriften*, ed. by Joachim Krausse, Amsterdam/Dresden, Verlag der Kunst 1998 [orig. Engl.: *Operating Manual for Spaceship Earth*, Carbondale, Southern Illinois University Press 1969]. Allegedly, Fuller used the term "Spaceship Earth" already in 1951 in a discussion about the US space rocket program, see Krausse, Joachim, "Buckminster Fullers Vorschule der Synergetik", in: Fuller, *Bedienungsanleitung für das Raumschiff Erde*, pp. 213 ff., here p. 252.

37 "Wir haben bisher unser Raumschiff Erde nie als integral konstruierte Maschine angesehen, die zum Zwecke dauerhafter Leistungsfähigkeit als Ganzes begriffen und bedient werden muß." Ibid., p. 48.

38 Ibid.: "keine Bedienungsanleitung mitgeliefert".

39 Ibid., p. 49: "von Lebensversorgungs- und Lebenserhaltungssystemen".

40 Sachs, Wolfgang, "Astronautenblick – Über die Versuchung zur Weltsteuerung in der Ökologie", in: *Jahrbuch Ökologie 1999*, München, Beck 1998, pp. 199-206, see p. 204. See p. 202 f. on "Menschenfreies Wissen", p. 204 f. on the "Metapher vom Steuermann (griech.: *kybernetes*)" and on speaking of "Staatsschiff" since Plato as a basis for calling the "Herrschaft der Kompetenten" (p. 204). Sachs warns of "Ökokratie" (p. 205).

41 Kuhns, William, *The Post-Industrial Prophets. Interpretations of Technology*, New York, Harper and Row 1971, Chapter 10 "Leapfrogging the Twentieth Century. R. Buckminster Fuller", pp. 220-246, see p. 222.

42 Osborn, *The Limits of the Earth*, p. 78, on Magellan.

43 Foucault, "Of Other Spaces", p. 27.

44 Ehrlich, *The Population Bomb*, p. 81. See also Ehrlich/Harriman, *How to be a Survivor*, Chapter 1, p. 1 ff.

45 Ehrlich, *The Population Bomb*, p. 132.

46 Ibid., p. 133.

47 According to Lester Brown, it was only since the 1977 UN conference on Desertification that the term began to creep from biology into the vocabulary of the UN officials and to political decision makers and economic advisers on a "global" scale. Brown, *The Twenty-Ninth Day*, concerning the history of "carrying capacity" p. 12 ff. It was again Ehrlich who pointed out that "human carrying capacity" is an appropriate measure of population.

48 and effect the "Demographic Transition"; Sax, *Standing Room Only*, p. 11 ff.

49 "Poverty and ignorance are greater threats to our civilization than the hydrogen bomb." Ibid., p. 177.

50 Ehrlich, *The Population Bomb*, p. 69.

51 Ibid., p. 21.

52 Ibid., p. 11.

53 Ibid., p. 159; the concept was taken from William and Paul Paddock's book *Famine–1975!* Ehrlich categorized Libya into the second, Pakistan into the third and India into the last group.

54 A historical change can be discerned from the humanism in the fifties (for example Fairfield Osborn, who tries to convince, to state certain points of view, who is concerned) to a pragmatism in the late sixties and early seventies (Paul Ehrlich and his colleagues, who demonstrate, who make predictions, and who are rather cynical), to a veritable biologism in the eighties (ecological "realists" like William Catton, who prove, who give facts, who are certain of what they state).

55 Daily, Gretchen C., Ehrlich, Paul R., "Population, Sustainability, and Earth's Carrying Capacity", *BioScience* 42 (1992) 10, pp. 761-771, quote p. 762.

56 The corresponding study (according to Karl Sax) is Myrdal, Alva, Vincent, Paul, *Are there Too Many People?*, New York, UNESCO (Manhatten Publishing Company) 1950. My aim here is neither to discuss strategies and measures of "population control" or environmental strategies nor to resolve the ongoing debates between "doomsayers" and technological optimists; see Taylor, Peter, "Technocratic Optimism, H. T. Odum, and the Partial Transformation of Ecological Metaphor after World War II", *Journal of the History of Biology* 21 (1988) 2, pp. 213-244; Mendelsohn, Everett, "The Politics of Pessimism: Science and Technology Circa 1968", in: Ezrahi, Yaron, Mendelsohn, Everett, Segal, Howard (Eds.), *Technology, Pessimism, and Postmodernism*, Dordrecht, Kluwer 1994, pp. 151-173; on "survivalism" Dryzek, John S., *The Politics of the Earth. Environmental Discourses*, Oxford, Oxford University Press 1997; a good outline of the different discourses of the environment of the time gives Jamison, Andrew, *The Making of Green Knowledge. Environmental Politics and Cultural Transformation*, Cambridge, Cambridge University Press 2001. It would be interesting to study the fierce debate and famous bet that Paul Ehrlich lost to the technocratic optimist Julian Simon about the future state of the world. Simon, Julian L., *The Ultimate Resource*, Princeton, Princeton University Press 1981; Simon, Julian L., Kahn, Herman (Hrsg.), *The Resourceful Earth. A Response to Global 2000*, Oxford, Basil Blackwell 1984.

57 In today's ecosystems literature, "carrier functions" have become a central element of the earth's "life support functions" and the number of people has become the "load". "Systems", "limits" and "functions" have become evident foundations to reason with: "In ecology, the notion of ecological limits is generally linked to the system's carrying capacity." Barbier/Burgess/Folke, *Paradise Lost?*, p. 44, 45. Malthus' principle of 1798 has been reformulated accordingly: "The cumulative biotic potential of the human species exceeds the carrying capacity of its habitat." Catton, *Overshoot*, p. 126.

Figures

Fig. 1: "Soylent Green" (USA 1973), movie placard.

Fig. 2: "The S-Shaped Biological Growth Curve". Source: Brown, Lester R., *The Twenty-Ninth Day. Accommodating Human Needs and Numbers to the Earth's Resources* (A Worldwatch Institute Book), New York, W. W. Norton 1978, p. 69.

Fig. 3: "World Population Growth". Source: Sax, Karl, *Standing Room Only. The World's Exploding Population*, Boston, Beacon Press 1960 (orig. 1955: *Standing Room Only. The Challenge of Overpopulation*), p. 35.

Fig. 4: "The Population Bomb Keeps Ticking". Source: Ehrlich, Paul R., *The Population Bomb*, New York, Ballantine 1968, title page.

Fig. 5: "The Challenge of Overpopulation". Souce: Sax, Karl, *Standing Room Only. The World's Exploding Population*, Boston, Beacon Press 1960 (orig. 1955: *Standing Room Only. The Challenge of Overpopulation*), p. 177.