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Filipe Duarte Santos

Humans on Earth

From Origins to Possible Futures

 Springer

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*To my grandchildren Constança, Matilde,
Vicente, Frederica, and Sebastião*

Foreword

Earth Systems Are in Trouble

“We are at a turning point,” writes Filipe Duarte Santos, “as regards the essential resources of food, water, and energy. Demand already exceeds what can be sustained at current levels of consumption. [And] competition between states will be further increased by population growth and climate change impacts.”

Professor Filipe Duarte Santos, a physicist and scholar of environmental sciences at the University of Lisbon, provides a sweeping, thoughtful view of the role of humans in shaping our modern world. Beginning with a short history of the Universe, he crafts an easily accessible narrative, weaving together an exploration of the laws of physics, an examination of human evolution, and an illuminating discussion of the roles played by art, religion, science, and technology.

Professor Santos’ broad scope brings to mind the work of another physicist, Murray Gell-Mann, who opens his book, *The Quark and the Jaguar*, with the challenge: someone must dare to take a look at the whole. This author’s discussion of Bayes’ theorem (which enables us to improve our analysis of current situations by incorporating new evidence!) is particularly helpful as we look ahead to the major choices we face, especially regarding the means of generating energy. (The author serves on the United Nations’ Intergovernmental Panel on Climate Change.)

As Professor Santos leads us through the era of human dominance, he concisely captures the collapse of civilizations and the social movements that challenged — and continue to challenge — established orders.

The discussion then brings us to a critical juncture: the conflict among *Homo sapiens* in World War II that also marked an acceleration of our conflicts with nature. In a poignant set of passages most relevant to today’s world, Professor Santos discusses the Bretton Woods Agreements that were made in 1944 at the end of the war. These agreements marked a rare moment of clear-sightedness, with the implementation of new rules and institutions to steer civilization. (The changes in rules of trade were hammered out under the visible hands of John Maynard Keynes (UK) and Harry Dexter White (US), whose biographies are delightfully recounted in these pages.) The rules — 1. free trade in goods, 2. fixed exchange rates, and 3. constraints

on the movement of capital — heralded a period of post-war prosperity. Their unraveling in 1971 gave birth to the modern period of unregulated finance.

In the closing chapters of Professor Santos' panoramic examination of our collective home, Western society's potential decline, paralleled by China's ascendancy, emerges as a challenge to all. Can today's leaders reach new agreements that will protect humans and the planet?

Writing this foreword in August 2011, as world markets tumble and financial empires teeter, I can only hope we will choose a route similar to Bretton Woods, and consciously and collectively craft a new world order.

As with the Marshall Plan in 1946, today's world will need new funds to complement the governance structures that guide sustainable development. And, as the call rises from a growing number of Professor Santos' European neighbors — though not yet from the U.S. — the necessary funds would best be raised through levies on over-bloated financial transactions born of deregulation, rather than bled from financially-strapped nations.

With the health of forests, marine life, food systems, and humans threatened by mounting economic and environmental instability, the present book sets a well-lit stage on which to examine today's challenges for our powerful, though not always far-sighted, species.

Boston, Mass.
August 2011

Paul R. Epstein, M.D., M.P.H.

Preface

The best of prophets of the future is the past

Lord Byron, Journal, 28 January 1821

Optimism is our duty. We are all co-responsible for what is coming

Karl Popper, Berlin, 17 December 1993

It is our privilege to live in an extraordinary age and to belong to an admirable civilization. Our skill, ingenuity, and determination over many centuries, supported by science and technology, have allowed part of humanity, mainly those who live in the industrialized countries, to enjoy an excellent quality of life compared with previous generations. We have easy access to modern medicine and health care. We have comfortable homes. We have good, drinkable running water, and a ready supply of energy to meet our everyday needs. We have a marvellous freedom of movement on land, sea, and air, and indeed prodigious mobility that allows us to move swiftly from one side of the Earth to the other. There are excellent conditions for reaching the various levels of education and professional training. Information and communication technologies have given us a remarkable facility of access to data, knowledge, and opinion. We are now able to communicate from practically every point on the globe with our families, friends, and colleagues. Generally speaking, we enjoy a good level of security, in our homes and urban areas. Most are convinced that all this has been permanently acquired and that in time it will spread everywhere and reach everyone in the world. We implicitly assume that continuous growth will assure social and economic development and an increasing quality of life for all. As regards the scarcity of natural resources and possible negative impacts on the environment, we are generally convinced that it will always be possible to substitute for exhausted resources and repair environmental degradation.

It looks like a dream. But will it last? Is it really sustainable? Those who do not yet enjoy such well-being are fighting desperately to obtain it. But will it be possible to extend the dream to the whole population of the world?

On the dark side, there are indications that the future is likely to become increasingly uncertain. Poverty, hunger, and serious health problems, such as tuberculosis, malaria, and HIV infections, persist in some parts of the world, and affect an unacceptably large number of people. The staggering social and economic inequality of the world's richest and poorest continues to grow. Over the last two centuries, human activities have begun to have a noticeable impact on global terrestrial systems, in particular on the climate, and also on the biosphere by reduction of biodiversity. The accelerating pace of human activity has created multiple and intertwined glo-

bal challenges. There is a non-negligible probability that energy, food, and water crises may happen in the current century. The impact of unabated climate change, including rising sea levels and acidification of the oceans, environmental degradation associated with a fast-increasing world population that aims at rapid economic convergence, scarcity of natural resources resulting from increasing per capita use, rising resistance to antibiotics, nuclear proliferation, and international terrorism are examples of the serious challenges facing all of us today and in the near future.

On the bright side, since World War II, we have witnessed a remarkable acceleration in social and economic development worldwide, which has lifted hundreds of millions of people out of poverty and improved the quality of life of many more. This successful spike of global development has mainly been based on the increasing dissemination and application of science and technology, better political and economic structures and institutions, higher levels of production and consumption, increasing globalization through the integration of national economies into the international economy, increased mobility and migration, development of more robust energy systems, and increasingly widespread access to energy services. But what we must ask now is whether it will be possible to maintain this great acceleration in a sustainable way, especially as regards the environment and natural resources. How might we be able to do that?

There are various answers to these questions arising from different economic and environmental outlooks. Some emphasize that there are limits to our present growth paradigm and that we will inevitably encounter crisis if we disregard them. Others are convinced that we can overcome all the projected obstacles, and that our inventiveness and skills, supported by the development of science and technology, will always be able to solve collateral problems that may appear along our path to growth.

Beyond these different approaches, there is a broad consensus that humanity will face crucial challenges in the 21st century regarding the sustainability of its development paradigm. What is the nature and origin of this situation, and why are we experiencing it today? What is the role of science and technology in the relatively long process that has led up to it? What does science have to say about limits and about the future of our environment in the short, medium, and long term?

To answer these questions we must first look into the past. There is a profound and unbreakable link between our past, present, and future. Our current challenges and our ability to deal with them are largely determined by the essential characteristics of human nature, which were forged in the biological evolution that led to the emergence of *Homo sapiens*, and later in the ensuing cultural evolution. The presence of humans on Earth is of course an integral part of the history of the universe and there is no way we can divorce ourselves from it. There is no escape now or in the future from its fundamental physical laws. These are essential and pose insurmountable limits to our dreams.

In order to address our collective future and scrutinize our options, it is thus advisable to begin by reflecting upon and understanding our history. Science has given us the wonderful faculty to reconstruct, often with amazing detail, the past of our species, of life on Earth, and of the universe as a whole. The same scientific

methodology has given us the possibility to project the long-term future of the Earth, the solar system and the universe. In this long process, the presence of humans on Earth is just a remarkable epiphenomenon. How sustainable is this episode and how long will it last? What are the driving forces that will determine its duration?

The main aim of the book is to focus on our present and future challenges as humans on Earth in the broad context of our cultural evolution and the unfolding long-term evolution of our earthly and cosmic environments. We are currently at a sensitive time as regards the impact of human activities on the Earth's systems. We may reduce the uncertainty and the risks projected into the future by creating a path of sustainable development. Science gives us the possibility to construct plausible and coherent socio-economic scenarios for the future. It is therefore possible in principle to choose between various options for the development of humanity. We may or may not respect the ethics of intra- and intergenerational solidarity. We may or may not create a future human development path that avoids irreversible environmental degradation. We may or may not increase the risks of future energy, food, and water crises. The following pages are an invitation to reflect upon these questions. They are an invitation to analyse and think about the past, the present, and the seeds that we are sowing for our common future.

The book presupposes that the methodologies of the modern sciences will allow us to observe, interpret, and understand the natural and social phenomena, and constitute a reliable tool to build a sustainable development paradigm. It is also founded on the conviction that the capacity of science and technology to solve our current problems and challenges is limited, whatever the realm of their application.

The present book is a modified and updated version of a previous one published in Portuguese by Gradiva in 2007.

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Lisbon, Portugal
June 2010

Filipe Duarte Santos

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