Environmental History 4

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The Basic Environmental History

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The Basic Environmental History

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Environmental History and other Histories. A Foreword

Environmental history has by now acquired a history of its own. The theme has been treated by generations of scholars who have produced a great number of research studies and compared notes and findings in numerous conferences, associations and academic journals. The fields of interest are many and varied, as are the methods of survey, which have often matured at the crossroads between arts and humanities, social and natural sciences.

What is Environmental History?

The recurring debate on "what is environmental history?" has received numerous and basically converging responses. One of the most concise considers that its purpose is the study of "man and the rest of nature". A decidedly controversial definition in respect of the distinction, when not contraposition, between the human world and the natural world, underlying dominant cultural and scientific tradition, not only in historical studies, in the modern world. With regard to the object and to the end proposed by studies in environmental history, it would, however, appear more incisive to speak of a discipline that has the purpose of studying the relationships between man and the environment in their historical dynamics.

The definition presents various original heuristic implications, but ultimately it is probably more suitable and tends to suggest a holistic approach to the history of man and nature. An approach which, moreover, is widespread among environmental historians, largely derived from studies in natural history, historical ecology, forest history, historical geography and concerned primarily with delineating the numerous changes in the natural environment—from the history of climate change, to changes in landscape or forest cover, from the history of natural disasters to that of epidemics or the variation in animal species, which have been induced by or, on the contrary, condition man's social life. Furthermore, the above-mentioned disciplines remind us that the history of relationships between man and nature did not begin with studies in environmental history, nor with the work by John Perkins

Marsh, but had already been put forward in the early eighteenth century in Germany with the work of Friedrich Stisser. That definition and that approach, however, risk depicting the relationship between human societies and the natural world in excessively naturalistic terms, thus overshadowing the tension between the two areas or considering it as solved. The natural world and human societies are more easily understandable when they are considered as two systemic and complex realities, fully interactive with each other. The dynamics of the natural world, or, better, of the ecosystems and the dynamics of anthropic societies are the most strongly interactive with each other because they rest on the same material, physical, chemical and biological base. But for this very reason, an irreducible state of tension is created which sometimes opens the way to widespread conflict.

In history the tension between anthropic dynamics and ecological dynamics has always been an evident reality, albeit with different modes, intensities and outcomes. It was during the twentieth century, however, that it developed and expressed its explosive power. The main cause for this marked discontinuity was technological development which basically reversed the relationship of dependency between the environmental context and the anthropic context; since then, at least in the short term, human societies have been more successful in adapting ecosystems to their needs rather than the reverse, as occurred previously.

The enormous and, at times, threatening consequences of this change in reciprocal adaptability remind us that—as Donald Worster noted—men are more than ever simultaneously agents and victims of environmental history. But they also induce us not to stop at considering only the most sensational changes in landscape, extinction of animal species or the most conspicuous forms of pollution and to perceive behind these phenomenons the emergence of the most critical forms of tension intrinsic in the constant interaction between the reproductive dynamics of anthropic and environmental systems. These reproductive dynamics proceed through a partial, yet continuous, reciprocal incorporation between the two systems. In turn, this incorporation occurs with processes and intensities which are mediated and progressively redefined by available technology. The outcomes are the consequence of the interaction between reproductive mechanisms and therefore reflect the capacity of anthropic and environmental systems to reproduce through a succession of equilibrium and disequilibrium phases. Increasingly over the last century and latter decades, the negative effects of the dynamics between man and nature have become more and more evident. As a consequence of the rapid change in environmental structures, the sustainability of the reproduction processes of anthropic systems—those that permit the satisfaction of basic needs and the more complex manifestations of social life—has become more and more uncertain. Moreover, the very concept of sustainability, however widespread in political spheres, is subject to growing criticism in scientific circles. The idea of the sustainability of development based on the conservation of a determined quota of systems defined as “natural”, is largely a cultural construction given that, strictly speaking, systems that are really natural are now very limited on a planetary scale. More often it is naturalness on the rebound after previous anthropic impacts, or semi-naturalness, whereas the sustainability necessary for the life of man refers to

environmental parameters, rather than to quotas of naturalness for the conservation of various animal and vegetable species. The return to nature proposed by much of environmental literature, as a remedy for the disequilibria referred to above, at least from the nineteenth century onwards, is in effect largely the result of the cultural hegemony of currents of thought in Northern Europe and North America which have imposed the value of natural landscapes on that of cultural landscapes which for four or five centuries have represented the template, as described in the Grand Tour literature.

The aim of environmental history is, therefore, to rebuild the relationships and interactions between anthropic and environmental systems, as they were historically set up. Environmental history moves from its awareness of the relative autonomy that characterises the reproductive dynamics of both. It is gradually freeing itself of the merely conservationist perspective that has characterised and still characterises most of its approaches, because its object of study is strictly the changing transformative equilibrium that is set up between social systems and ecosystems. In fact, the relationships between them have anything but a static nature, but rather processual, because it stretches over time and is therefore eminently historical. In other words, historicity is an intrinsic quality in relationships between anthropic and environmental systems precisely because they interact during their respective reproduction processes which, far from reproducing their initial conditions—have a developmental and transformative nature. It also follows that historicity is manifold, if we consider the different levels over which it spreads—"historical times, biological times" wrote Enzo Tiezzi over 30 years ago—but profoundly unitary because anthropic and environmental systems are ultimately part of the same context: the former are, however, an expression of one of the most specialised of the innumerable biological forms that populate the latter.

In conclusion, environmental history is, by definition, a field of tension. Not only, as referred above, because attention can be calibrated to the relationship between man and the rest of nature, privileging either its unitary profile or internal dualism. But—and this is the aspect that most interests us—because, while it develops as a distinct disciplinary area, at the same time it proposes to be a means of critical comparison with more consolidated areas of historical research: economic history, urban history, the history of technology, the history of ideas and cultural history, the history of public policies and, last but not least, social history. On the other hand, it is no coincidence that many scholars from the above-recalled fields of research have become animators of environmental history, bringing with them debatable issues fuelled by the motivating force, sensitivity and knowledge of environmentalist mobilisation which in the 1970s spread throughout Europe, the United States and more widely in Asia, Africa and the American continent. And indeed they have impregnated environmental history research with traditions and cultural and social experiences from their various areas of origin.

Another Point of View: Themes and Suggestions

The essays in this volume mainly reflect this acceptation of environmental history and aim to compare, stimulate and even contest widely consolidated knowledge and compartmentation of predominant historiography. Altogether, the collection of essays make the book first and foremost an introductory instrument to the main themes of environmental history, illustrating its development over time, methodological implications, results achieved and those still under discussion. However, the problem is not that of proposing environmental history as another, distinct and, as such, delimited disciplinary area in search of legitimacy in its own right. Or to offer an overview of the main research studies and consequently the potentialities of environmental history. Quite the opposite, for the overriding aspiration is to show that the doubts, methods and knowledge elaborated by environmental history have a heuristic value that is far from negligible precisely in its attitude to the most consolidated major historiography. For this reason, this book gives an overview of the main themes of environmental history as it is an essential component of the basic knowledge of global history. But, at the same time, it introduces specific aspects which are useful both for anyone wanting to deepen his/her studies of environmental historiography and for those interested in one of the many disciplinary areas—from rural history to urban history, from the history of technology to the history of public health, etc.—with which environmental history, often with some difficulty, develops a dialogue.

The choice of themes, therefore, is not encyclopaedic, but intentionally selective. The expositive approach does not consider environmental history from within, as a primary disciplinary area, nor does it illustrate the making of this historiography. On the contrary, it endeavours to place environmental issues within a much wider field of research and its manifold thematic stratifications. Least of all, the book intends to denounce the gravity of environmental issues—not because they are not serious or worthy of denunciation—but because its concern is primarily with promoting knowledge of the past rather than recounting the present-day crisis.

Circumscribed, but nonetheless challenging, tasks. We hope to succeed in our undertaking. Nor is it the task of the book, let alone of this introduction, to identify dominating lines in the environmental history of the planet, or of any other continent or other thematic area. We do not propose to give a brief outline of the environmental history of the planet or part of it. Many already exist, albeit frequently characterised by limits and typical of attempts to reduce to a global-scale processes that are decidedly more complex which can only be studied on a local scale. We shall merely summarise introductory knowledge, but also—while making no claim to sufficiency or exclusivity—propose methods and analytical and interpretative concepts, the fruit of long and qualified experience acquired by the authors of the essays in their respective areas of research and, more in general, of their in-depth knowledge of European and global environmental historiography.

Various essays have different approaches. All share a comprehensive overview of their own theme and develop a narration that necessarily leaves in the

background the history of policies and practices and environmental conflicts. But the choice of the central theme and expositive style responds to different criteria, because the preference is given to descriptive and interpretative efficacy rather than to analytical orderliness. In some cases, a certain environmental medium has been used as barycentre: soil, air and water. In others, a process, such as growth, has been taken as the main theme, and a certain factor, like energy or the interaction between a multitude of factors has been considered. Or, again, production and reproduction processes have been used as a reference, to examine, in one case, waste and residues and, in another, the most acute and serious critical manifestations, chiefly those caused by inappropriate, and therefore risky technologies. Lastly, in another case, the chief observation point is the urban structure that organizes media, resources and processes. Without prejudice to these distinctions, echoes of each of these different approaches can easily be perceived in all the essays.

Likewise, various asymmetries are also seen in the capacity of each essay to communicate critically with the other historical disciplines: a capacity that is unquestionably evident and incisive in the case of urban history or, for example, of economic growth problems or the role of energy, but—on the contrary—forcedly more restrained in the case of environmental history of the soil, an area of investigation still in its infancy. Each essay deals with numerous distinct themes and those that generally circulate, return and in various ways aggregate all together in the essays. Particularly worthy of attention is the vast theme of growth, in the sense of material and, consequently, economic growth, because it deals with the connection between nature and social development, growth being none other than the use of natural resources to the advantage of human society. So to study growth from the viewpoint of environmental history means not only proposing responses to many aporias or highlighting choices, paths, crises, etc., but—as Tello and Javier recount in their essay—explaining how economic growth takes place. On the other hand, precisely the theme of growth shows how the nature/society connection has an intrinsic historicity, because its processuality not only determines different ways of realization—depending on the various factors available—but determines its cyclicity, since the availability of resources depends on their characteristics and therefore is a constitutive rather than a marginal growth factor.

The other theme that is closely linked and, to a large extent, recurrent since it is crucial in mediating between nature and society, is technological development. Technology is the means by which portions of nature become available resources for the productive and reproductive processes of anthropic societies: it is the instrument of what the economists call their valorisation, in other words, of their utilisation for economic and social development. So technology—with its specific modes of action—largely determines the methods, intensities and outcomes of the incorporation of part of the ecosystems in anthropic processes. Also for this reason, the technological question largely characterises and supports many essays in the book. It applies to the use of soil, especially after agricultural practices underwent great innovation with the advance of industrialization. But of similar relevance is the story of water, air or waste or, evidently, risks, accidents and disasters caused by the use of technology in industrial society. It is understandably at the centre of the

environmental history of urban systems which, by definition, are the outcome of the functional integration of numerous technologies aimed at diversifying and articulating the social life of a multitude of people and, at the same time, making it less dependent upon nature's reproduction cycles.

In other words, it is evident that the themes dealt with, the approaches and methods of research and interpretative proposals—far from being self-referential and determined by ideological and militant impulses—establish a close, albeit critical, dialogue with the questions and results of consolidated major historiography. Environmental history has the merit of broadening the view of historical reflection. Because, metaphorically speaking, it forces taking into consideration other points of view, other methods of knowledge and other disciplinary competences. But also in a real sense, because environmental history has an intrinsic spatial dimension that is difficult to define, since it continually calls upon the cohesion or concatenation of ecosystems and always refers to the direct connections that unite the local context to the global context.

Even a brief overall consideration confirms that the essays in this book have several common and peculiar traits which deserve to be stressed because they highlight the richness of the environmental historical approach. Only apparently more extrinsic is the question of periodisation, the conceptual barycentre of every historical reflection. In a formal consideration, the periodisation adopted varies in the different essays: in one respect it is easy to perceive the tendency to stretch backwards in respect of the present in search of anchors to account for the body of changes, but also their different ways of gathering together. In another respect there is a common second tendency to concentrate narration in the centuries that are closest to us. This arrangement is partly for practical reasons—to respond to present-day doubts—but above all derives from environmental history's historiographic solicitations: over the last two centuries anthropic societies have succeeded in making an unparalleled and exceptional impact on the natural world leading to an undoubted acceleration in the history of environmental changes. Those changes have always occurred, sometimes with important, indeed catastrophic, consequences in local and regional and even continental contexts—suffice it to recall the so-called "Columbian exchange" which followed the mass arrival of Europeans on the American continent—but from the end of the eighteenth century, they acquired an unprecedented rhythm, intensity and extension on global scale.

Generally speaking, the essays do not, however, treat their respective themes in a systematically global dimension, aimed at embracing the entire planet as a whole. They do, however, endeavour, with inevitably diverse possibilities and results—to assume a worldwide perspective that takes into account the plurality of the planet's experiences, their connections in history and in the present. Within these coordinates it is easy to perceive first that environmental history is simultaneously the history of relationships between anthropic systems and ecosystems and the history of man's knowledge of nature, as well as the history of the policies and practices that have consequently been implemented. So, for example, the environmental history of soil tells us about technical knowledge, agricultural practices, the culture of agricultural societies, which have characterised much of human history. But it

looks at anthropic practices (the use of forests, livestock breeding, cultivations, irrigation, etc.), hinging on the ecosystem in which they are immersed and which they influence, in the awareness that those practices are within that ecosystem; they are the mode of constructing man's ecological niche. So they do not alter a given equilibrium in itself, but introduce themselves into transformative dynamics that are wide-ranging and more complex. An analytical perspective reminds us that the natural, environmental dimension is a constituent of anthropic practices, not only preliminary to them.

This observation should, in turn, be placed in relation to another which, as various essays suggest, attributes to technology—insofar as it is a crucial instrument of mediation between nature and society—a key role in determining the periodisation of environmental history, marked by the transition between successive states of equilibrium between social structures and ecosystems. Not because technological innovations shape periodisation deterministically, maybe after the hypothetical formation of environmental bottlenecks caused by the obsolescence of a technology and a corresponding depletion of a primary resource. But rather because the transition to different ways of relating between society and environment—for example in the epochal transition to the large-scale exploitation of fossil fuels, the treatment of urban waste, the change in use of agricultural land, etc.—hinges on technological innovations which at times are seen to be comparatively more remunerative as much in terms of cost as in use value, in the exploitation of one natural resource or another which they allow to be incorporated in social reproduction processes. So even in this regard anthropic dynamics—those relating to the economic profitability of a certain technology—and ecosystem dynamics—deriving from its environmental impact—are inextricably intertwined.

The integration between social factors and ecological factors is in fact at the centre of the analytical and interpretative models proposed by environmental history. Whether the approach is "socio-metabolic", borrowed from ecological economy, "urban metabolism" or "ecological heritage", the essays in this book prove their originality and fecundity, compared with traditional approaches which consider development and social changes determined almost exclusively by intrinsic cultural or institutional factors. To consider the capacity, or lack of it, to introduce portions of ecosystems into anthropic systems and the methods for realizing it, as decisive explicative factors of the dynamics of social development is however an extremely innovative and promising approach. Mainly for two reasons: First because it calls for greater attention to the quantity and quality of the overall patrimony of available resources—in the various contexts—for social development. Second, and more in general, because it prompts the abandonment of a solipsistic, accumulative and linear vision of social development and invites consideration of the fact that the circulation of resources (between ecosystems and anthropic systems, but to a likewise significant extent also within these) fuels close interaction between the various systems.

That interaction, and the flows and exchanges that fuel it—even more so following the epochal changes induced by the advent of urban-industrial society—frustrate all investigations that consider social development separately, territory by

territory and country by country. But they impose the repositioning of development processes in a multiplicity of spatial, local, regional and global contexts that accounts for the procurement of the resources that fuel them, the dislocation of residue from anthropic processes and above all of the interaction and accumulation phenomenons consequent to those flows. The result is a conception of development as a composite and plural process, of variable intensity, with a helical trend and partially reversible. The only one that makes it possible to explain the otherwise misleadingly defined "aporias" of development and to fully assess the sustainability of present social and ecosystem structures, if not of future ones. Because, even in the case of environmental history, although knowledge of the past does not place us in a position to foresee the future, it undoubtedly gives us a better understanding of the times in which we live.

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Contents

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assalariat. L'illa de Mallorca, 1400–1660, Documenta Universitària-Biblioteca d'Història Rural, Girona [Farms, rents and wage-labour. Majorca Island, 1400–1660]. En Enric Saguer, Gabriel Jover i Helena Benito (2013) *Comptes de senyor, comptes de pages. Les comptabilitats en la història rural*. Documenta Universitaria-Biblioteca d'Història Rural [*Landlor accounts, Peasant accounts. Accounting in Rural History*]. He has published in journals like *Revista de Historia Económica-Journal of Iberian and Latin American Economic History, Histoire & Mesure,* among others.

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(2012): Fertilizing methods and nutrient balance at the end of traditional organic agriculture in the Mediterranean bioregion: Catalonia (Spain) in the 1860s, *Human Ecology* 40(3):369–383; or (with Ostos, J.R., 2012): Water consumption in Barcelona and its regional environmental imprint: a long-term history (1717–2008), *Regional Environmental Change* 12(2):347–361.

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Chapter 1
Energy in History

Paolo Malanima

Abstract The topic of energy is of central interest today. Although a long-term view can be useful in order to clarify contemporary trends and future perspectives, scholarly literature provides little information on the consumption of energy sources by past societies, before the beginning of the 20th century. In the following analysis, the topic of energy will be discussed from the viewpoint of economics, with a long-term historical perspective. After a brief introduction in Sects. 1.1 and 1.2 will examine some definitions and concepts, useful when dealing with energy and the role of energy within the economy. Section 1.3 will focus on the relationship between humans and energy in pre-modern societies. Section 1.4 will discuss the energy transition, that is changes in energy and environment from the early modern age to the present day. In the Conclusion (Sect. 1.5) general estimates will be proposed of past energy consumption on the whole.

1.1 Introduction

Scholars disagree about the role of energy within the economy. An optimistic view is shared by many economists. Their opinion is that raw materials played virtually no role in the modern development of the economy, as growth depended and continues to depend on knowledge, technical progress and capital. The contribution of natural resources to past and present growth is almost non-existent; and energy is a natural resource. After all energy represents today—they say—something less than 10 % of aggregate demand in the advanced economies.

Scholars with interest in environmental changes support the opposite view on the role of material goods and nature in the economy. Environment and natural materials played an important function in the development of human societies and in history on the whole. Energy in particular is of central importance in economic

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life and is also a central concern, given the heavy impact of energy consumption on the environment, especially in the last two centuries. Material underpinnings to economic success are not to be underrated, in their opinion.[1]

1.2 Definitions and Concepts

1.2.1 An Economic Definition

In daily life we have direct contact with matter, but not with energy. Matter can be touched, its form described and it is to be found underfoot as well as around us. With energy it is different. Its indirect effects are only perceived deriving from changes either in the *structure,* that is the molecular or atomic *composition* of matter, or in its *location* in space, such as in the case of a stream of water or wind, whose potential energy we can exploit. In both cases effects such as movement, heat or light reveal the presence of what we call energy from about 200 years.

In physics energy is defined as the ability of bodies to perform work.[2] Since work is the result of force by distance, then energy includes any movement of some material body in space together with the potential energy deriving from its position. Heat as well is the result of the movement of the components of matter. When dealing with the economy and then with the interrelationship between humans and the environment, our definition must be a little different. We could define energy in economic terms as *the capacity of performing work, useful for human beings, thanks to changes introduced with some cost or effort in the structure of the matter or its location in space*. Solar heat is of primary importance for the existence of life. The definition of energy in physics includes it. Since it is a free source of energy, it is not included in our economic definition; whereas the capture of solar rays by means of some mechanism in order to heat water or produce electric power is included. In the first case solar heat is not an economic resource, while it is in the second. The formation of biomass in a forest is a transformation of the Sun's energy by the plants through photosynthesis and is not included in this definition either. On the other hand, firewood is included, which is a part of forest biomass used by human beings for heating, cooking and melting metals. Food is a source of energy in economic terms, since its consumption enables the performance of useful work and its production implies some cost. Food for animals is only exploitable, and then it is an economic resource, when metabolised by those animals utilized by humans for agricultural work. It is their fuel, and, since the power of the working animals is exploited by the people, its calories have to be divided among the consumers (such as the fuel of our cars today is divided among the population and is part of their per capita consumption). When consumed by wild animals in a forest, however, these

[1] On these topics see the first two chapters of Kander et al. (2013) chaps. 1 and 2.

[2] Useful the discussion of the definitions of energy in Kostic (2004, 527–538) (2007).

calories are not a source of mechanical power for humans and then are not included in our calculation of past energy consumption. Both fossil fuels used today and uranium are also energy carriers. They were not until a quite recent epoch, since they were not utilized in order to produce economic goods and services.

Although the definition of energy in physics is much wider than in economics, the definition here proposed is much wider than the ordinary meaning of the term energy. Many people immediately think of modern sources, when speaking of energy, and do not include daily food consumption. It is well known that working animals played a central role in pre-modern agricultural economies, but their feed is not considered as a main source of energy for humans. The lack of a clear definition, common to most contributions devoted to the history of energy, prevents from the possibility of calculating energy consumption in past societies.

1.2.2 Energy and Production

In the long history of technology, main developments consisted in the increasing knowledge about the possibility of "extracting" energy from the input of natural resources. The production process and the role of energy can be represented by the following diagram (Fig. 1.1).

The diagram can be seen as an illustration of the ordinary production function:

$$Y = AF(L, R, K).$$

Labour (L) and capital (K), the factors of any productive process of useful goods and services (Y), can be better defined, from the viewpoint of energy, as *converters* able to extract energy from resources (R) in order to transform materials into commodities. Y is in fact a function (F) of the converters. The progress of technical knowledge embodied in A, plays a central role in the production function. In one

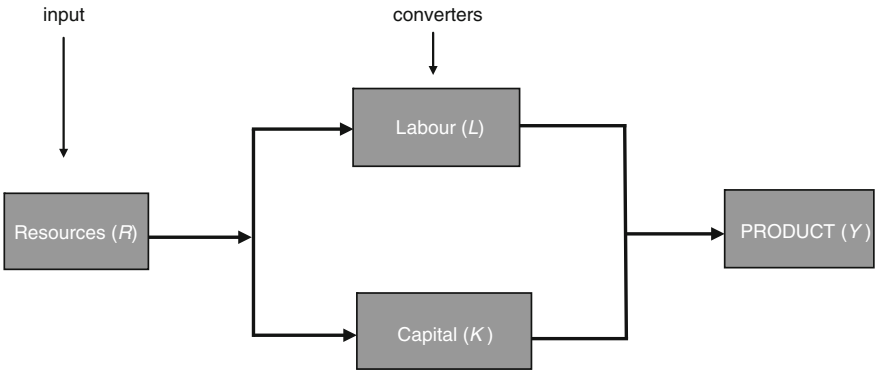

Fig. 1.1 Natural resources, converters of energy, product

sense, energy is the main input; that is to say, the main input is that part of matter (resources *R*) transformed by the converters, that is by workers (*L*), who metabolize food, and capital (*K*), which transforms some materials such as firewood, coal, oil, gas and electricity into mechanical work, heat and light.

The increase in productivity of energy, as a consequence both of discoveries of new sources and technologies (*macro-inventions*) or improvements in the exploitation of those already existing (*micro-inventions*)[3] can be represented by the following ratio:

$$\pi = \frac{Y}{E}$$

where Y is output (in value) and E is the total input of energy in physical terms (in Calories or joules or any other energy measure). The formula represents the productivity of energy, that is the product generated by the unit of energy. It is the reciprocal of the better known energy intensity (i), or the energy we need to produce an unit of GDP:

$$i = \frac{E}{Y}$$

In the previous diagram, energy productivity is the result of the ratio between the final product (in money) and the input of matter (food, coal, oil…) transformed into energy by the converters (in kcal, joules…). It is a measure of the efficiency of the energy converters from a technical viewpoint. The result is also conditioned by changes in the structure of the product. The increasing importance of less energy intensive sectors can result in an increase in energy productivity (or decline in energy intensity) even without any technical change.

1.2.3 Energy and History

At the end of the 20th century, per capita energy consumption, on a world scale, was about 50,000 kcal per day; that is 76 GJ per year, including traditional sources. About 80 % of this consumption was represented by *organic fossil sources*; coal, oil and natural gas. Nuclear energy represented 6 % and hydroelectricity 2 %. This 8 % was the *non organic* contribution to the energy balance. The remaining 12 % consisted of biomass, i.e. *organic vegetable sources* (Table 1.1). If the waste utilized in order to produce energy is excluded, the rest of this 12 % was composed of food for humans and working animals (today a marginal source of power), and firewood, an important item of consumption only in developing countries.

[3] For the terms "micro-" and "macro-inventions" see Mokyr (1990).

Table 1.1 Daily and yearly per capita consumption of energy worldwide around 2000 (kcal, Toe and %)

	Sources	kcal per capita per day	Toe per capita per year	(%)
3	Non organic	4,000	0.15	8
2	Organic fossil	40,000	1.47	80
1	Organic vegetable	6,000	0.22	12
		50,000	1.84	100

Source IEA, *World Energy Outlook 2010*, OECD/IEA, Annex A, Tables for Scenario Projections
Note Organic Vegetable food, firewood and feed for working animals; *Organic Fossil* coal, oil, natural gas; *Non organic* nuclear, wind, hydro, photovoltaic. Toe = ton oil equivalent = 10 million kcal

This composition of the energy balance reveals the strata of a long history of technical conquests.[4] The history of energy technology is nothing else than the chronological analysis of our present energy balance, in order to single out the various ways of extracting energy from matter to produce heat, movement, light, work etc. Following Table 1.1, we will track the history of energy consumption from the most remote layer (1) that is *Organic vegetable sources*, to the development of *Organic fossil sources*, the intermediate stratum (2), and subsequently to the progressing *Non organic sources* (3), which will be the basis of our future energy systems.[5]

From the viewpoint of energy, the long history of mankind could be divided into two main epochs (corresponding to the first two lines of Table 1.1):

- *First epoch* the about 5–7 million years from the birth of the human species until the early modern age, that is about 5 centuries ago, and
- *Second epoch* the recent history of the last 500 years, which has witnessed a fast acceleration in the pace of energy consumption.

In the first long epoch, energy sources were represented by *food for humans*, *fodder for animals* and *firewood*, that is biomass, with a small addition of *water* and *wind power*. The second epoch witnesses the rapid partial replacement of the old sources by *fossil carriers*, which became and still are the main energy sources. While in the first epoch energy was scarce, expensive and environmental changes heavily influenced its availability, during recent history energy has been plentiful, its price relatively low and the influence of the energy consumption on the environment considerable.

[4] Still important on the big changes in the history of energy is the book by Cipolla (1962).

[5] "Organic economies" is the expression used by Wrigley (1988). With reference to the history of energy, the same term of "organic" had been used before by Cottrell (2009), See also Wrigley (2010).

Here is a synthetic view of the sources characterizing these two main epochs:

First epoch	Second epoch
Food	Coal
Firewood	Oil
Fodder (for working animals)	Primary electricity
Water power	Natural gas
Wind power	Nuclear power

Although the energy system prevailing today is apparently different from the simple digestion of food (the first energy source), or from the burning of firewood by our primitive ancestors, it is based on the same principle, which is the oxidation of Carbon compounds by breaking their chemical ties. Since Carbon compounds are defined in chemistry as organic compounds and organic chemistry is the chemistry of organic compounds, we could define all the energy systems which have existed until today as organic and the economies based on those organic sources as *organic economies*. Coal, oil and natural gas, the basic sources oxidized today in order to bring about organized, that is mechanical, work, heating or light are carbon compounds such as bread or firewood. The difference between pre-modern and modern energy systems depends on the fact that, until the recent energy transition, organic vegetable sources were exploited, whilst from then on organic fossil energy sources became the basis of our economy. Since organic vegetable sources of energy were transformed into work by biological converters (animals) and fossil sources are transformed by mechanical converters (machines), we are able to distinguish past economies according to the system of energy they employed and the prevailing kind of converters in:

1. *organic vegetable economies* or *biological economies*;
2. *organic fossil economies* or *mechanical economies*.[6]

Given the importance of energy in human history, changes in the use of this main input mark the evolution of humans in relation to their environment much more than changes in the use of those materials, such as stone and metals, ordinarily utilized by the historians to distinguish the main epochs of human history.

[6] In chemistry "organic" refers to Carbon compounds. The term has been used by F. Cottrell and A. Wrigley (see the previous footnote) to distinguish past agricultural economies (whose base was an organic energy system) from modern economies (based on mineral fossil sources). However, fossil fuels are also organic compounds. To avoid misunderstandings I think it useful to distinguish "Past agricultural organic vegetable economies" from "Modern organic fossil economies".

1.3 Pre-modern Organic Vegetable Economies

At the end of the 18th century three were the main economic sources of energy; corresponding to three different kinds of biomass. According to the age of the discovery and exploitation of these three sources, three ages can be distinguished in the distant past (that is in the First epoch identified in Sect. 1.2.3). The original source was *food*, the second was *firewood* and the third was *fodder for working animals*. A relatively small contribution came from two other carriers: *falling water*, the potential energy of which was exploited by watermills; and *wind*, utilized both by sailboats, and, much later, mills.

1.3.1 The First Age: Food

Since the birth of the human species some 5–7 million years ago, and then for some 85–90 % of human history, food was the only source of energy. In this long period, the only transformation of matter in order to engender movement and heat was the metabolism of organic material either produced spontaneously by plants and vegetation or converted into meat by some other animal consumed by humans as food. Although nothing certain can be said about energy consumption per head at that time, given the stature and physical structure of these early humans, consumption per day of about 2,000 Cal could be plausible. Their own body was the early machine used by humans. An animal body is not very efficient in the conversion of energy. Only 15–20 % of the input of energy, that is 300–400 Cal, is transformed into work, while the rest is utilized in order to support the metabolism and dispersed in the environment as heat and waste. The economic output of these far ancestors consisted in collecting, transporting and consuming this original input of energy.

1.3.2 The Second Age: Fire

The use of fire has been the main conquest in the history of energy.[7] The first evidence of fire being used by humans refers to several different regions of the world and can be dated between 1 million and 500,000 years ago. Fire was a conquest of independent groups of humans in several parts of the world and the main source of energy for several millennia. Its use spread slowly. In this case, as in the case of food, an estimate of the level of energy consumption by our distant ancestors can only be speculative. As far as is known for much more recent ages, the level of firewood consumption in different regions in pre-modern times may have varied from 1 kg per head per day to 10 in cold climates, that is between

[7] On the discovery of fire see particularly Perlès (1977) and Goudsblom (1992).

3,000–4,000 and 30,000–40,000 Cal. A daily consumption of about 1 kg per capita could be assumed for the humans living in relatively warm climates. In northern regions firewood consumption was considerably higher. Fire could be used for heating, cooking, lighting, and for protection against wild animals. Although, with fire, Calories per head drastically increased from 2,000 to 3,000–4,000 per day or more, that is 5–6 GJ per year, the efficiency in its use was very low. The useful energy exploited by the population did not exceed 5 % of its Calories, the rest being lost in the air.

1.3.3 The Third Age: Agriculture

During the Mesolithic, the end of glaciations and the rise in temperature enabled humans to increase the cultivation of vegetables and particularly cereals. The overall availability of energy in the form of food increased dramatically and supported the growth of population. In per capita terms, the perspective is different. Since population increased rapidly in the agricultural regions of the World, availability of food per head did not increase. A diet based on cereals represented a deterioration, as is witnessed by the decrease in stature following the spread of agriculture. Agriculture, as the main human activity, progressed quite slowly, if we compare the diffusion of this technological conquest to the following ones. From the Near East, where primarily developed 10,000 years ago, agriculture progressed towards Europe at the speed of 1 km per year. Within 3,000 years, agriculture reached northern Europe. At the same time, the new economic system was spreading from northern China and central America, the regions of the world where agriculture independently developed at the same time or a little later than in the Near East.

A new development in the agricultural transition took place during a second phase: from about 5,000 years until 3000 BCE. The period can be considered as a true revolution. The fundamental change was represented by the taming of animals, (oxen, donkeys, horses and camels), and their utilization in agriculture and transportation. Humans' energy endowment was rising. If we consider a working animal as a machine and divide his daily input of energy as food—about 20,000 Cal—among the humans who employed him, consumption per head may have increased by 20–50 % or more, according to the ratio between working animals and human beings; which is not easy to define for these distant epochs. Only about 15 % of this input represented, however, useful energy, that is energy converted into work.

During this age, several innovations allowed a more efficient utilization of humans' power, fuels and animals; e.g. the wheel, the working of metals, pottery, the plough, and the sail. The sail was previously used, but it only spread widely during this revolutionary epoch. The use of wind was the first example of the utilization of a non-organic source of energy, not generated by the photosynthesis of vegetables. Labour productivity rose markedly. Even though some changes in the agricultural energy system also took place in the following centuries, technical