From: ***An environmental history of the world : humankind's changing role in the community of life***



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5: The Middle Ages

Gazing down over the world from above in the Middle Ages, in AD 1300 perhaps, one of the heavenly creatures which people thought existed, an angel or a dragon or the swift eagle Garuda might have discerned changes since ancient times: swathes of forest removed; new machines being used, plowing taking place faster over longer stretches of field, trade reviving and extending further. The huge seas bore little traffic as yet, but there were daring Polynesian voyagers, Chinese junks, and Inca rafts in the Pacific, European and Arab traders on the Mediterranean Sea and Indian Ocean, Vikings venturing in the Atlantic to Iceland, Greenland, and far western Vinland, and Maya canoes in the Caribbean and Gulf of Mexico. These were widely separated pioneers on nearly empty waters. But the sky visitor would have observed more people on Earth. Built-up areas were spreading, and with them, clearance, erosion, and advancing desert. The Earth as a whole was, however, full of life in many thriving ecosystems. Parts of the continents were still covered with forests. Those places might have looked wild, but peoples had lived there for centuries or millennia, and had learned to subsist within their local ecosystems. Elsewhere, the rate at which humans were altering the face of the Earth was slow but accelerating. It was not proceeding at a steady pace, but it was faster than it had ever been. Certain societies were learning skills that would in future times become more effective. They were learning to learn about the world—haltingly, with insufficient methods—but learning nonetheless. In the age to come, they would break forth upon the rest of the Earth. Preparations for rapid modern changes were made in the Middle Ages.

The Middle Ages constituted a period in which the relationship of human societies to nature varied greatly in parts of the world distant from one another. The oikoumene, as the Greeks called the inhabited Earth, was not what it was to become, a world united by travel and communication. While civilizations in continental regions were not completely isolated, the degree of contact was much less than it would be in later periods. Patterns of increasing economic activity and growth were sporadically interrupted by stress and decline. At times ecosystems suffered from overuse; at other times they recovered and flourished. Human societies, too, alternately burgeoned and faced disasters against which they often had no effective defenses. They worked with what they had, and demonstrated creativity in ways of dealing with the natural world. Important new discoveries occurred in technology, exploration, education, government, and agriculture. Their success or failure often depended on the degree to which they understood and were able to adapt to ecosystems. For example, during the North Atlantic warm period between 980 and 1,450 settlers from relatively mild Scandinavia lived in Greenland. When the Little Ice Age arrived, climatic stress forced them to abandon their farms and hamlets, while local Inuit communities, with a cultural heritage formed in the Arctic, survived.

Technological inventions prepared the way for modern attempts to control nature, but they also enabled management of the environment to a significant extent during the Middle Ages. A new moldboard plow drawn by as many as eight oxen, and a draft harness that enabled more efficient use of horses at the same task, made possible the opening of northern Europe's heavy, wet soils to agriculture.1 Windmills and water wheels supplemented human and animal energy in tasks such as raising water for irrigation and the processing of grain, wood, and stone. Improved sailing vessels in Europe, China, and Polynesia made exploration and long distance trade more possible than before, along with the introduction of exotic species and products valuable enough to be worth carrying. Chinese inventors devised iron plows, clocks, magnetic compasses, printing presses, and cannon long before they became known elsewhere. Mining and metallurgy improved, providing materials for tools used in agriculture, forestry and hunting, and weapons for war; the mines and smelters increased demand for wood, depleting forests and producing pollution.

Knowledge of the natural world increased, if at a leisurely pace compared with later times. An important intellectual tool for the manipulation of nature, mathematics, received an indispensable aid with the invention of positional notation and the zero in India by the eighth century. Exploration and trade brought information about natural phenomena in distant places. Christian and Muslim writers of books called bestiaries recorded wonders of nature, animals both real and mythical, in words and pictures.2 Herbals contained useful advice on the medical properties of plants. Chinese books on medical materials also contained descriptions of animals and plants, but were interested in them only insofar as they might benefit human health.

Biology as a science had not yet begun; Aristotle's writings had a revival in high medieval Europe, but the interest in them was mainly philosophical and theological. Cosmology received attention: European scholars viewed the Universe as a series of concentric shells leading outward from Earth through the rings of the Moon, Sun, and planets to the stars fixed in their sphere, moving in accord with the primum mobile. And beyond that? The greater circles of the heavens, and beyond even them, God Himself. The eyes of mystics saw that the divine was the center and Earth, though the uttermost, worthy of contemplation as the handiwork of God. The learned doctors wanted humans to care for the world in accord with God's word and classical understanding. They thought wisdom, as embodied in scriptural revelation and classical philosophy, should precede analysis in understanding the natural world. But in that endeavor, the true order is the other way; analysis must come first. Mundane folk gathered that the immense distance that separated God and the spiritual from nature left nature open to human exploitation. Especially in urban centers, people seem to have had less sense of oneness with life, and a greater confidence that they might change the Earth for the better. In the next age, they would change it more, but whether for the better can be argued.

Many Christian theologians thought nature could serve as a book of truth, a second “scripture” revealing the purposes of God, but the attitude of the medieval Western Church was not always so affirmative. Pope Innocent III, during the thirteenth century, saw man as equal to the beasts, but thought that this equality lowered man. He wrote:

“‘The Lord God formed man from the slime of the earth,’3 an element having less dignity than others…Thus a man, looking at sea life, will find himself low; looking upon the creatures of the air, he will know he is lower; and looking upon the creatures of fire he will see he is lowest of all…for he finds himself on a level with the beasts and knows he is like them. Therefore the death of man and beast is the same, and the condition of them both is equal, and man has nothing more than the beast. Of earth they were made, and into earth they return together.’4…. What then is man but slime and ashes?”5

Compared with that statement, the attitude of Francis of Assisi is like day contrasted with night. A sermon to the birds is the most widely known incident of Francis’ life; he also preached to fish and flowers, and made peace with a wolf.6 A rare spirit in the Middle Ages, he discerned the presence of God in the diversity of created beings, and desired humans to rejoice in this. He expressed a life-affirming, creation-affirming joy which did not immediately dissolve the multiplicity of created beings into oneness, but delighted in their individuality. In his poem, the Song of Brother Sun, he named created entities one after another and praised them with God, emphasizing their number and distinctness. The Italian word he used to describe the productions of Mother Earth is diversi, “diverse.”7 If God's grace is mediated to people through water, wine, bread, and oil, why cannot it also be received from any creature?8 Francis once appeared before Innocent to ask permission to preach, and the Pope demonstrated unusual good sense in not ordering the saint to keep silent.

Educational systems concentrated their efforts on the study of great classical or sacred works of the past. Older attitudes to nature were therefore preserved from generation to generation. Preparation in the Chinese examination system included study of Confucius and Mencius. Traditional attitudes prevailed in which human control of nature was assumed to be the order of things. Humans were regarded as the proper beneficiaries of human action, so it was understandable that inheritors of the Confucian tradition emphasized the use of nature, not its preservation. Indians studied the Sanskrit classics, which upheld many ideas of the gods and nature that tended to reverence for living beings. To most Indians, the world was a marvelous place, teeming with animal-shaped gods and god-bearing animals. They perceived that particular species and forests should be protected. But even there practical life made demands against the spiritual. The great Arabic schools not only closely explicated the Quran and associated Islamic traditions, but also preserved and commented on Greek works of science. Europe gave birth to the university, with all its potential for teaching and the advancement of knowledge. In the Middle Ages its leading concerns were not the natural sciences, but philosophy, theology, and the professions of law, medicine, and the Church. Still, there was much in all of this that inculcated, and reveals, attitudes to nature.

One important factor that helps determine the pattern of human effects on the environment is the degree of social management that is possible. Many countries were monarchies moderated by decentralization, as in medieval European feudalism. This made it difficult to coordinate production and use of goods and resources. Implementation of an agricultural policy, for example, would have faced local resistance. The Inca government was an exception, as a section of this chapter will explain. The more civilized states often were threatened by the raids or conquests of mobile peoples. States, cities, and feudal domains fought one another, and military operations inflicted damage on agriculture and the environment, sometimes deliberately.

Environmental changes caused by humans took place at different rates around the inhabited world. The expansion of agricultural land, coordinated with growth in population, was substantial in Europe before AD 1300, in China with the exception of the Mongol period, in India (where invasions episodically reversed it), in Southeast Asia, and in the Andes. Northern Europe adopted three-field crop rotation, an efficient system that raised levels of production. Irrigation and drainage works redirected water to supply agriculture and urban centers. New food plants were introduced, and others were grown over a larger area. Rice culture expanded in China, southern and Southeast Asia, and Indonesia. Banana and yam cultivation spread through sub-Saharan Africa. Monks and gentry introduced rabbits to England; the first definite record is of a warren at Guildford in 1235.9 They spread and altered the landscape by devouring vegetation.

Deforestation, already severe in areas like the Mediterranean in ancient times, took an uneven toll during the Middle Ages. The removal of Europe's forest cover was as complete by 1300 as it is today. After the Black Death disastrously reduced human population, forests spread again for a time. China lost extensive forests; India less so. In west Africa, clearings around villages extended further, sometimes joining adjacent ones, but village forests and sacred groves preserved tree cover. With a combination of selective removal of timber and planting of favored trees for fruits, nuts, and other products, the forest composition there reflected human tendance.10 In southern Africa, the growth of Great Zimbabwe, a center of mining, metallurgy, and trade that used wood for fuel, caused deforestation and erosion in its neighborhood. All the continents (except Antarctica) still possessed forests, and in areas such as the rainy tropics and the north Asian taiga and North America, they were vast, but not uninhabited. Overgrazing by the herds of pastoralists was intense in some regions, particularly the margins of the desert zone that stretches across Africa and Asia. This may have been a factor in the movements of the so-called nomadic peoples mentioned above. Both deforestation and overgrazing, by removing the vegetative cover, exposed the land to soil erosion.

The destruction of wildlife continued in the Middle Ages. Hunters killed the United Kingdom's last native brown bear in the tenth century. Kings, Rajahs, and Emperors reserved forests for hunting, but killed thousands of animals. A single robe for Henry IV of England required 80 skins of ermine and 12,000 of squirrel. By 1526 the last British beaver perished.11 Elk, auroch and European bison diminished in number, because of the expansion of agriculture which restricted their habitats, and from hunting.

Population increased during the Middle Ages in the areas of the world where there was intensive agriculture, and paralleled the expansion of food production. The increase, however, was far from steady, and there were episodes of depopulation. Perhaps the most severe of these episodes was the outbreak of the bubonic plague, which emerged from Yunnan in southwest China during the Mongol dynasty around 1250. China, the most populous region of the world, suffered from the plague and the disruptions that followed the Mongol conquest simultaneously, resulting in a catastrophic loss of human lives. The population dropped from perhaps 115 million in 1200 to 60 million in 1350, then recovered to 110 million in 1500 under the Ming dynasty, a rate of growth which taxed food resources.12 Mongol soldiers spread the disease to the Crimea in 1346, from where ships carried it to Egypt and Europe. Europe lost as much as one-third of its people in a decade. While the plague may be called a natural disaster, it must be remembered that it was humans who spread its vectors, rats and fleas, across the Old World. By 1500 the European population had recovered to the level of 1300. Nature had only a brief respite.

Florence and the European scene: the barriers to growth

As I sat gazing over Florence from the Piazzale Michelangelo, I recalled the panorama landscape by Giorgio Vasari of the same view, a city set in a bowl of mountains. But they are not wild mountains. They are terraced and planted with the grapevines from which the Chianti I was sipping is made, the fields divided by walls, dotted with villas and farmhouses. The trees are those that bear olives and other fruit, or the ornamentals that Italians love, slender cypresses, poplars, and umbrella pines that have been planted since Roman times, although today they compete with eucalyptus from Australia. Many houses are embraced by climbing bougainvilleae from Brazil with their thorns and brilliant petal-like bracts. It is an intimate, anthropogenic landscape. It has changed repeatedly since the city was named Florentia. Vasari's painting, “The Siege of Florence,” dating from 1558, shows few trees; the hills look desolate even though he painted them green. Did he show the scene the way it looked in his day? That was a time of war when timber was scarce and expensive; the price of oak had tripled in the previous 90 years and would quadruple again over the next 20,13 and almost every available tree might have been cut. But in early medieval times the mountains above the valley of the Arno had good forests.

In the year 1054, when nine-year-old Countess Matilda became its mistress, Florence was a town of 20,000 whose trading families fortified themselves in stone-and-timber towers and talked about the need for a wall. In 1300, Florence had five or six times its former population, a wall embraced seven times the space of the earlier one, and the factious merchant oligarchy was constructing a new city hall (the Palazzo Vecchio) and a vast new cathedral dedicated to Santa Maria del Fiore. Beyond other cities Florence epitomizes the history of the European environment and economy during those centuries of growth and the disastrous decades that followed.

Florence became a powerhouse of finance and trade that catalyzed economic expansion. It was the leading banking center in Europe, an industrial giant, and one of the most populous cities. Florentine businessmen bustled everywhere in civilized Eurasia. Its gold coin, the florin, first minted in 1252, “was the preferred and most widely used means of payment both within Europe and beyond.”14 The ecosystem the city depended on was not limited to Tuscany, or even Italy, but covered a wide swath of Europe and the Mediterranean basin. The great Florentine companies, the Bardi and Peruzzi and their rivals, profited from the expansion.15 They were trading firms and banking houses, and their business included buying and selling merchandise and raw materials, supervising manufacture, financing trade, exchanging currencies, lending money, and doing the accounting necessary to these transactions. Sometimes they served as tax collectors for kings and as international spies, going so far as to arrest fugitives and turn them over to their royal clients for punishment.

Florentine companies gave substantial loans to monarchs, whose position strengthened as the Holy Roman Emperor and Pope demonstrated their inability to unite Europe under secular or church leadership. Money went to the kings of France and Naples, but most importantly to the English king to secure a supply of raw material from the island which, compared with Italy, was a “developing country.” An agreement provided customs exemptions for wool exported to factories in Florence. The need for loans was a symptom of the fact that around 1300 the vigorous growth of the European population and economy had overshot environmental limits.

The medieval period was not the time of stagnation that the popular mind imagines. “From about the year 1000, European society embarked upon a period of sustained growth which continued until the early fourteenth century.”16 Population almost tripled, and the number of settlements increased proportionately. Large towns grew into full-fledged cities, and faced problems of waste disposal, pollution, water supply, and flooding.17 Such rapid expansion of economy and population over a large area had never occurred before. In his definitive study of the Great Famine, William Chester Jordan presents statistics indicating an increase for England between 1050 and 1300 of between 330 and 385, and for France between 285 and 340 during the same period, with similar rates for Germany and slightly smaller ones for Scandinavia. These figures cluster around 2 percent per year. While this is not extreme by modern standards, it was then unprecedented. Jordan says, “Almost all scholars believe that these figures, however problematic any single one of them may be, reveal a population under stress, because the economic growth necessary to sustain the standard of living had slowed long before the population itself leveled off.”18I would say that the momentum of population growth had caused it to pass the limits set by the environment and medieval technology.

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Figure 5.1 The city hall (Palazzo Vecchio) and cathedral of Santa Maria del Fiore, both of which were under construction in Florence at the height of the city's economic affluence and financial dominance near the end of the thirteenth century. Photograph taken in 1959.

A major mover of economic expansion was the wool trade; Florence sponsored it across much of the continent and became an industrial textile center. England was a major source of wool; there were more than three million sheep on the island by the time of the Domesday Book (1086), and they increased afterwards. Wide areas were cleared for pasture. Monasteries, particularly those of the Cistercians, deliberately sought “wasteland” for the simultaneous salvation of environment and soul.19 They knew that the Bible portrayed forest and wild country as places of solitude, temptation, spiritual enlightenment, and penance.20 But they also found that clearing led to profit as their herds multiplied, since wool was as good as money: the ransom of Richard the Lion- Hearted was paid in 50,000 sacks of wool.21 Walter Map joked at the time that if monks could not find deserts to settle in, they would create them, presumably by overgrazing the pastures.22 The appetites of sheep can be destructive, but Map's jibe was not entirely fair, because some English Cistercian abbeys had tree plantations and kept enclosures to protect the seedlings.23

The wool trade was an important activity of the great companies emerging in Florence.24 It supplied raw material for an industry that produced fine woolens and added to the city's prosperity. Giovanni Villani, in the 1330s, stated that there were 200 shops belonging to the wool guild in Florence, with 30,000 employees altogether.25 They turned out 80,000 bolts of cloth annually, selling them for 1,200,000 florins. Water from the Arno's clear tributaries was used to wash wool and provide energy for water mills used in fulling cloth. Clothmakers took every bit of wool the local sheep produced, and looked to distant sources.26 Merchants drew on the fleeces of southern Italy, North Africa, and the Merino flocks of Spain, but the English trade had the most far-reaching effect on the Florentine economy for good and ill. The demand for wool across Europe caused a rapid augmentation of the flocks, increasing the impact on forests and grasslands. Sheep can be destructive of grass cover when there is excessive grazing, and this, especially in the highlands, contributed to soil erosion. New breeds of sheep bore more and better wool, but also tended to strip the soil of vegetation more efficiently. As greater numbers of Europeans were being clothed, the land was being unclothed.

The period of rapid growth from about 1050 to 1300 saw a transformation of the European landscape from one predominantly forested, “a sylvan sea with only isolated islands of human habitation,”27 to one where forests had been reduced to isolated fragments. Jean Gimpel emphasizes the extent and importance of deforestation during that period, and gives many sources of evidence for the unfortunate process.28 Landholders encouraged peasants to open lands to agriculture that had been woodlands, marshes, and moors, and to establish new villages and towns. Machiavelli opined, “There is nothing more worthy the attention of a great prince, or of a well-regulated republic, or that confers so many advantages upon a province, as the settlement of new places.”29 Settlers saw woods as a barrier and often burned them off.30 “Everywhere, the forest receded before the logger's axe and the settler's plow.”31 The use of saws also increased.32 The major purpose of forest removal was to expand the area under cultivation and pasture, thus increasing the wealth of the nobles and churchmen who controlled the land. Some landowners put little value on forests. Albericus Cornu, canon of Notre Dame de Paris, ordered his woods cleared, remarking that they had “for so long been so useless that they were a burden rather than a source of income.”33

Far from being worthless wastes, forests represented an indispensable source of resources for the medieval economy. Wood and charcoal were virtually the only fuels for heating, metallurgy, and manufacture of glass, tile, bricks, and pottery. Five times the volume of wood is required to produce the same amount of heat energy at the point of use if it is first turned into charcoal rather than burned directly, but charcoal can give a more intense heat and less smoke than wood.34 The manufacture of one ton of iron required the annual increment of 12 hectares (30 acres) of productive forest.35 Wooden torches supplied lighting. Carts and ships, weapons and musical instruments, dishes and sometimes shoes, were made of wood. Wines were stored in oaken barrels. Castles and fortifications were often constructed of timber. Even stone buildings had wooden roofs and required scaffolding during construction. This was the age when great cathedrals arose, and as Romanesque architecture turned to Gothic, spaces enlarged for multicolored windows. It took 100 square meter of forest to produce 1 square meter of stained glass.36 All these uses hastened forest removal.

Builders noticed shortages of timber as early as the twelfth century. Abbot Suger had to search far for trees to roof his church of Saint-Denis.37Hansa ports such as Lübeck made a lucrative business of shipping timber and forest products including pitch, honey, and furs from Baltic lands.38 These would not have found a market so readily had forests still been plentiful in other sections of Europe.

The lands dependent on Florence went through similar deforestation. In the eleventh century there were rich forests in the mountains of the upper Arno. “A large tract of still unexploited forest” of oak and chestnut was granted to monasteries by the bishop.39 Collection of pig-rent indicates a sylvan landscape, since pigs found acorns and other favorite foods in forests. By the fourteenth century, sheep and cows, which prefer grassland pasture, outnumbered pigs in this area. When Florence conquered Pisa and needed to build a navy, there was no suitable timber left in its own territory, so the commune had to look elsewhere.

One indication of the loss of forests was a series of measures intended to preserve them. Monarchs in western Europe reserved large areas of forest mainly to serve as hunting reserves. A major part of the food at table in medieval courts was venison from the royal forests. An issue between King and barons in England was that Henry II, Richard I, and John had enlarged the reserved forests and subjected them to special laws. Royal forests constituted one quarter of England's territory. The famous Magna Carta wrested from King John gave permission for an inquiry into the administration of forests. The Forest Charter of 1217 allowed deforestation of lands formerly taken, another defeat for royal power. Hunting with dogs was still strictly limited, except for the king, but the penalty for taking the king's deer illegally was reduced to fine or imprisonment; formerly it was death or dismemberment. Robin Hood may be legend, but poaching of the King's deer is historical fact; in the years 1263–87, an average of eight cases of Trespass of Venison occurred annually in Sherwood Forest, and in one year there were eighteen.40

The King of France also appropriated forests for himself. The Ordinance of Brunoy, issued by Philip VI in 1346, ordered royal officers of Eaux et Forêts to supervise exploitation of forests while keeping them perpetually in “good condition.”41 The king also tried to limit deforestation on land outside royal domains, but met with opposition by nobles and parliament.

The Republic of Venice saw forest protection as essential for a steady supply of shipbuilding timber. The doges, the elected chief magistrates, prohibited unauthorized export of timber from the neighboring Alps, and limited the glassmaking industry to the use of wood unsuited for ships.42 Other Italian cities tried to safeguard wood supply. One commune near Siena in 1281 required every member inheriting a portion of land to plant ten trees a year.43

Measures such as these met with at most partial success. Dante's Divine Comedy, set in 1300, began in a dark forest, but there was little forest near Florence then. Stone and marble often replaced scarce timber in building. Shortages of charcoal for metallurgy appeared, and bricks, which require firing, became more expensive. Wine prices increased due to a scarcity of oak for casks. “By the end of the thirteenth century the price of wine was determined by the availability of casks rather than the quantity or quality of the vintage.”44 Loss of tree cover increased the severity of floods as water from storms poured down denuded slopes. Florence, located on the banks of the capricious Arno, was and is vulnerable to flooding. The disastrous flood of 1333 broke all four of the bridges and inundated the city center. The shrinking of forests was a pivotal cause of the environmental crisis of the fourteenth century.

The food supply was unable to keep up with the increase in population. During the twelfth and early thirteenth centuries, new land in northern Europe could be cultivated with the moldboard plow, horse power, and the three-field system of crop rotation, resulting in increased food production and population growth. These agricultural improvements, however, were directed at increasing production, not at taking care of the land. Medieval agronomic writers were predominantly concerned with estate management, not sustainability.45 Even in the South, where lighter soils still responded to older methods, more farmers meant more production until every tillable scrap of ground was utilized. But by 1300 in the European heartland, villages were everywhere and forests almost nowhere. Where could new farms be opened? The ecosystems outside those already occupied might be modified for pastoralism, but were unsuited to agriculture.

Between 1100 and 1300, food supply was adequate. While failures in distribution produced local shortages, history records no widespread famines. In the early fourteenth century, with little new land available for agricultural expansion, the increase in production failed. After that, serious famine occurred every ten years or so. A Florentine grain merchant, Domenicho Lenzi, reported in the early fourteenth century that the surrounding territory produced only enough grain to feed the city for five months of the year.46 The rest had to be imported, but weather, crop failures, and war made supply insecure.

From 1315 to 1317, the Great Famine ravaged northern Europe. Though heralded by an unusually wet season that was blamed for crop failures, its underlying cause lay in the uncontrolled expansion of the preceding two centuries and the disregard for the continent's ecosystems that accompanied it. Which factor weighed most heavily in causing the crises of the fourteenth century, climatic change or human activities, is a debated question. The study of climatic change in the medieval period is improving, but has not yet become an exact science. A recent attempt to establish a global temperature record for the past few centuries using data from tree rings, ice cores, ice melt indices and historical records of temperature and precipitation went back only to 1400.47The further back the data are pressed, the greater the margin of error becomes, so characterizations of climate in this period must be tentative. Some scholars maintain that the average climate between 1180 and 1299, the span of the most rapid population growth in Europe, was a warm period when agricultural production flourished, but that cooler and wetter conditions prevailed in the early fourteenth century.48 This is the opinion of Christian Pfister and associates, who have constructed a database of climatic evidence from documentary sources.49 “Climate” is a smooth curve showing the cumulative effect of the sharp changes we know as weather, and it is weather that directly affects the growth of crops. The wet, cold summer of 1315 and the stormy period that followed may have had more to do with the onset of the Great Famine than did a long-term variation in average climate. Either change had a disastrous effect only because the growth of the European population, and the depletion of resources, had put the Europeans in a precarious position. The weather was a sudden strain that revealed the weakness of the ecological situation.

Marginal lands had lost fertility. Although horses were a source of energy for plowing, many more were used for war, and all ate quantities of oats that might have fed the increasing numbers of poor peasants. Fewer oaks meant less pork. The medieval village was a sustainable ecosystem when it had the expansive landscape of earlier times to interact with, but in the overcrowded fourteenth century it proved unstable.

From the 1320s, crop failures struck Italy. Florence suffered; food prices were the highest in the peninsula.50 Famine struck in 1329, and the price of wheat rose three to five times above former levels. Starvation returned ten years later at a time when it was difficult to pay for food imports because the commune had a huge war debt. This was the time of the condottieri, when bands of mercenary soldiers roamed the countryside and offered “protection” to cities that would hire them, as Florence had done. At that unlucky moment, another calamitous financial blow fell on the Florentines.

Edward III had squandered the money he had borrowed from bankers to prepare for what became the Hundred Years War. By 1339, his exchequer was empty and he abrogated his debts. This disaster caused the bankruptcies of the banking houses of Bardi, Peruzzi, and seven other families.51 The 1340s saw the lowest ebb of the Florentine economy. Hundreds of citizens went bankrupt, and hundreds starved in the famines of 1345–7. Property values plummeted and wages shrank as much as 45 percent. Wars and the need for grain from overseas raised the public debt even higher, and the Commune of Florence declared bankruptcy.

Then the Black Death arrived. Between 1347 and 1351, plague killed one-quarter to one-third of Europe's population. Three-fifths of the Florentines, about 60,000 people, died. Seven more outbreaks occurred in the following 80 years. Europe was in economic and environmental crisis already. Agricultural productivity had declined due to the mistreatment of the land during the period of unrestrained expansion. The weakened condition of the European population due to famine and lack of resources made the loss of life worse than it would otherwise have been. Some writers have suggested that the Black Death relieved the ecological crisis, reducing the population to a level that no longer pressed so hard on the carrying capacity of the land. During the following economic depression, new forests spread over depopulated land and healed wounds left by the former exploitation.

Europe recovered, as did Florence, although it took a long time. In 1850, Tuscany still had two million fewer people than it did in 1300.52 But even after the disasters, Florence led the Renaissance. Assessing a suggestion made by Robert Lopez, Charles Bowlus said, “The artistic achievements of the Italian Renaissance were made possible because surplus capital, which in an earlier period would have been reinvested in commerce, agriculture, and industry, was during the fourteenth and fifteenth centuries invested in the arts due to the uncertainties of the marketplace.”53 Were Florentines reacting to bitter experience?

The environmental history of Florence in the high Middle Ages epitomizes that of Europe. Florence had taken the role of leader in the European economy, and was dependent not just on the ecosystem of Tuscany, but on all of Europe. Kings had borrowed money from the Bardi and Peruzzi and squandered it on war. Florence, and all of Europe, had borrowed environmental capital from the ecosystems of the continent, and just as surely squandered it. They might have liked to renege on their debts, but unlike money debts, environmental debts cannot be renounced. In the fourteenth century, nature sent bill collectors54 in the shape of resource scarcities, famine, and perhaps the Black Death itself. Florence, in the context of European expansion, had come up against environmental limits.

The evidence shows that the medieval economy, at the level of technology then available, grew to the extent that the European ecosystems were no longer able to support it. While I do not impute any evil intentions in this regard to European farmers or incipient industrialists, it was human activities that caused the crisis. Jean Gimpel began his chapter on the medieval environment by saying, “The industrialization of the Middle Ages played havoc with the environment of western Europe.”55 A few paragraphs later, he underlined those words by adding a well-considered judgment that can serve as a summary: “…the fact remains that medieval man brought about the destruction of Europe's natural environment. He wasted its natural resources, and very soon felt the consequences of his destructive activities…”56