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Quantitative Dynamics of Human Empires

Quantitative modeling of social systems shows a large component of automatic drives in the behaviour of individual humans and human society. Studies of the formation and breakdown of twenty diverse empires operating over almost three thousand years describe these processes with utmost clarity and paradigmatic simplicity. Taking territorial expansion as the basic parameter, we show that it can be represented in time by a single logistic equation in spite of the complicated sequences of events usually reported by historians. The driving forces of empire, leading to expansion and saturation at 14 days of travel from the capital, can be reduced to testosterone and progesterone.

Anthropological basis of human settlements and empires

Many things humans do automatically and to which we pay little attention result from millennia of evolution of our behaviour. Territorial organization is an example central for our subject of creation of empires. Animals that can retreat in a protected area, such as a cave, usually have a basic instinct determining how much time they can spend outside where the dangers are higher. Extensive measurements by Yacov Zahavi in the 1960s and verified since show that, almost independent of geography, humans spend about one hour or slightly more outside, for example, travelling. A person courts danger staying outside the home base, which is protected by fortifications, alliances, intimate knowledge of the environment, and magic, which gives confidence. As ancient and medieval cartographers wrote, outside one's own area "Hic sunt leones" or "Hic sunt dracones" (here be lions or dragons).

The hour of traveling or wandering defines quite precisely the tessellation of territory into tiles of about 5 km diameter, the length a person can travel in one hour by walking. If the home or village is in the centre, then a person can daily visit the periphery and return, marking and establishing territory. The natural primitive area of control, by the famous πr^2 , is thus a patch of about 20 square km.

Within the patch, usually at the centre, sits a village, so the grid of villages has basic spacings of 5 km. If a village succeeds and becomes, finally, the capital of an empire, it will fill the original patch of 20 square km, but no more, with a maximum population of one million people or 50,000 per square km. Old capitals including Rome, Susa, and Marrakesh respected the rule.

To change the size of the patch, one has to change the speed of movement. Cars since Ford's Model T have a mean speed about 40 km per hour, so a city where cars provide the basic transport system can cover a patch with a 40 km diameter and thus an area upwards of 1000 square km. This scheme fits Mexico City, and its population is growing logistically to 50 million, or 50,000 per square km just like ancient Rome. As these basic

instincts determining human settlement have developed and operated over millions of years, we can be confident they will not change overnight.

The basic tiles, villages, may organize into a larger cluster, often of seven, and the central one then acquires some special property, such as hosting a weekly market. As outlined by Konstantinos Doxiadis, clusters then can organize in a supercluster of seven and have a city in the middle where, for example, a monthly market is held, and many crafts and forms of commerce can find a place. The game can continue as long as it does not interfere with another basic instinct.

Social animals including *homo sapiens* have hierarchical organizations that have various purposes, one of them regulation of access to resources. Thus, if the pack kills a buffalo, no fight disturbs consuming it. Number One of the pack eats first and so on. We may define ethics as pre-agreed division of spoils. The hierarchy is continuously refreshed, with occasional or periodic ruffles to readjust the ladder. Sociologist William Whyte in his 1956 book, *The Organization Man*, neatly described the process for economic organizations such as GE and Ford. An important point is that written organograms or organization charts rarely correspond to real ones.

Here we take a daring anthropological leap and assert that the mechanism that fixes the size of empires, and the functioning of business organizations, comes from the depth of time. Every month men in a community had a precious resource to share, the fertile women, who had the habit of synchronizing their menstrual cycle with the moon. At the center of the biology is the hormone progesterone, rising and falling, signalling to sperm and pregnancy. Such a precious resource as fertility called for resetting the hierarchies every 28 days, as managers do under various disguises in the economic organizations with their monthly meetings. When the Czar wanted to reaffirm the belonging of Vladivostok to the Russian empire in front of the nervous emergence of Japanese power, he built the very expensive Transiberian *military* railway to send messengers there in just 14 days. Alaska was hopeless to reach in 14 days, so the Czar had sold it to the United States.

Empires in fact have always had a maximum extent or distance from the capital of 14 days, and for that reason the administrations make miracles in speeding up the transport system. As we shall see, the Persian empire had horsemen making 500 km per day in relays. Rome had 90,000 km of superbly paved roads for the horses and carriages of the messengers, and the Inca empire had 40,000 km of unpaved roads for its chasqui runners who could go in 14 days from the capital Cuzco to the final frontier. An empire, an emperor, must reproduce the basic hierarchy. Here we may say we see testosterone as the driver.

Not all empires could afford or maintain the travel time rule, especially the very large ones, so empires fail to attain or sustain their goals. As we shall discuss, the Spanish empire was mostly on the western side of South America, and Britain had immense territories in India and Asia, and the weak and dangerous solution was to have a Viceroy, a stand-in, to take care of the current affairs with appropriate local distances. The most unlucky or unwise empire was perhaps Portugal, whose government decided to go to Brazil when Napoleon menaced Lisbon. The Lusitanians even founded a Brazilian Em-

pire. After Napoleon's demise, the Lusitanians returned across the Atlantic, and the Brazilian Empire declared its independence. When the metropole cannot reach the frontier in 14 days, tenuous tricks come into play.

Finally, empires are large structures incorporating a variety of cultures, customs, and crafts under the same roof. They have large means and naturally cradle advances in civilization stimulated by cross-fertilization. Culture can be exhibited, together with palaces, gold, and precious stones. The learned are also a visible ornament of the powerful. Similar mechanisms have been active at the level of cities since ever, and provided the first rung in developing modern civilization. In our perspective "modern" means the last 10,000 years, although humans were already much evolved earlier, as cave paintings and many other artefacts show. But, the city provided the network of services and interests that permitted complex operations to be performed and the formation of complex cultures.

The fact that empires, like cities, are born by basic instincts is transparent from their number. The Wikipedia article "List of Empires" offers more than one hundred fifty, and more surely existed, now undocumented, for example in Africa. The Estonian and American political scientist Rein Taagepera offers data on about eighty empires.

Historians may of course differ on the precise extent of imperial control. We rely on the assessments of Taagepera, the most thorough scholar we have found in this field. While we recognize uncertainty exists in the data, we think the overall power and consistency of the findings mean that revisions of the data would not affect the general findings. Definitions of empire typically involve concepts such as fealty and homage, which translate into payment of taxes and military service and other forms of submission or subjection. International relations and law experts describe empires as large sovereign entities whose components are not sovereign.

For each empire, we look at the shape of its development, in particular whether it expanded in the s-shaped or logistic curve that characterizes many biological growth processes, such as the increase in height of a sunflower or the number of persons infected in an epidemic. We look at the time the process required to expand from 10% to 90% of its completion. We look at the midpoint or inflection of the process, when the rate of growth peaked, one might say the time of peak aggression. And we look at the area the empire aimed to control, its niche. Sometimes we replot the data of the s-curve on a semi-logarithmic chart where the final height or saturation is normalized to 100%, and the growth shows as a straight line that emphasizes the orderliness of the process. Sometimes we also plot the data as a bell-shaped curve showing the changes in area through time.

Let us now take a tour of twenty empires, looking for regularities in their growth and demise. We examine in more or less chronological order the Achaemenid, Carthaginian, Roman, Frankish, Islamic Caliphate, Seljuk, Ottoman, Delhi, Inca, Aztec, Spanish, Portuguese, Mongol Huan, Manchu-Qing, Mogul, Russian, French, British, USA, and European empires.

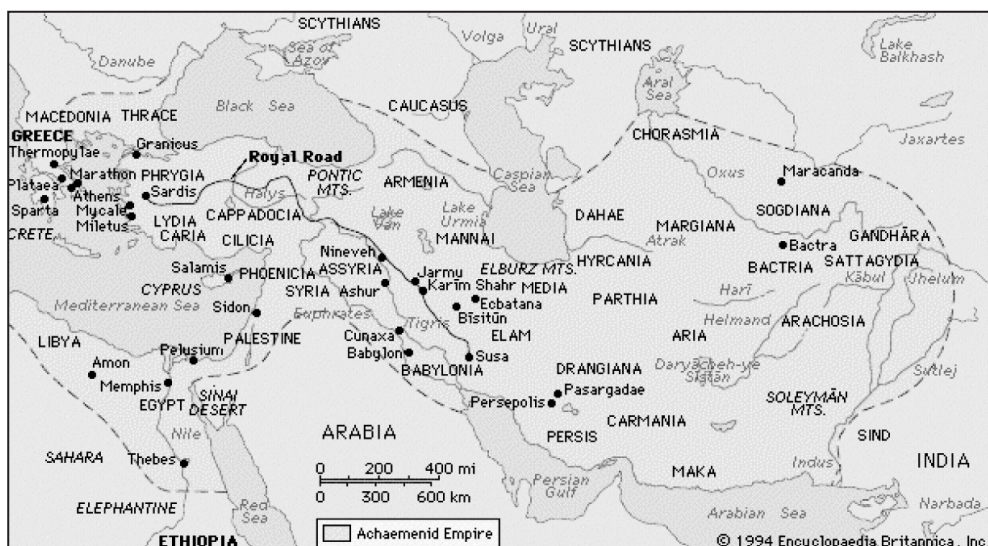
Achaemenid Empire

This huge Persian empire (550–330 Before Christian Era [BCE]) at the height of its power encompassed approximately 5.4 million square km, one-third more than the Roman empire at Rome's peak. Sympathetic historians portray the Persian empire as a successful model of centralized administration with a government working to the advantage and profit of many. While the empire was divided in twenty-three provinces or satrapies to facilitate administration, the king kept overall control through a sophisticated system of couriers running and riding on robust horses day and night, winter and summer, over a well-developed network of imperial roads. The USA postal system adopted the Achaemenid empire's motto. Within the 2,500 kilometers of highways, the most impressive stretch was the Royal Road from Susa to Sardis, built by command of Darius I. Crucially, relays of mounted couriers could reach the remotest of areas in fifteen days. Despite the relative local independence afforded by the satrapy system, royal inspectors, the "eyes and ears of the king," toured the empire and reported on local conditions. With such an extensive empire a kaleidoscope of peoples was unavoidable and the Persians, like the later Romans, accepted diversity provided it was wrapped in recognizable Persianity.

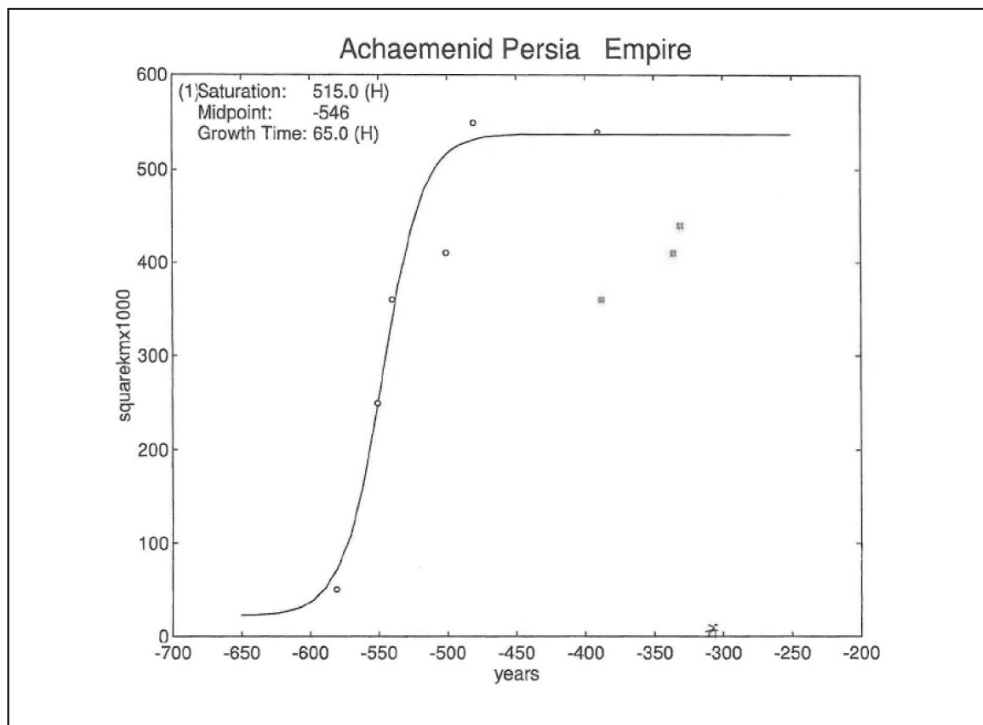
The Achaemenid empire took 65 years to grow from 10% to 90% of its extent, with a midpoint point of 546 BCE. Cyrus the Great reigned at the inflection point. Historians debate whether "the times make the man." It certainly helps to work at the midpoint of growth. After saturation the empire survived for more than a century. It was well administered and had an ethical philosophy: speaking the truth was a basic principle inculcated from childhood and telling lies prosecuted up to the level of capital punishment, which sounds curious in our times. The Persians were beaten in the battle of Thermopylae by a bunch of the most sophisticated liars of antiquity, the Greeks.

Imperial post roads connected the important cities. Along the Royal Road between Sardis and Susa there was a post station every fourteen miles, where the king's couriers could obtain fresh horses, enabling them to cover the 1600-mile route in a week. "Nothing mortal travels so fast as these Persian messengers," wrote Herodotus. "These men will not be hindered..., either by snow, or rain, or heat, or by the darkness of night." These words were at one time used as the motto of the United States Postal Service.

[Herodotus History 8.88, trans. G. Rawlinson.]



-580	Achaemenid Persia	0,50	0,50 Taagepera, 1979: 121
-550	Achaemenid Persia	2,50	2,50 Taagepera, 1979: 121
-539	Achaemenid Persia	3,60	3,60 Taagepera, 1979: 121
-525	Achaemenid Persia	4,10	4,10 Taagepera, 1979: 121
-500	Achaemenid Persia	5,50	5,50 Taagepera, 1979: 121
-480	Achaemenid Persia	5,40	5,40 Taagepera, 1979: 121
-390	Achaemenid Persia	3,60	3,60 Taagepera, 1979: 121
-387	Achaemenid Persia	4,10	4,10 Taagepera, 1979: 121
-335	Achaemenid Persia	4,40	4,40 Taagepera, 1979: 121
-330	Achaemenid Persia	0,00	0,00 Taagepera, 1979: 121



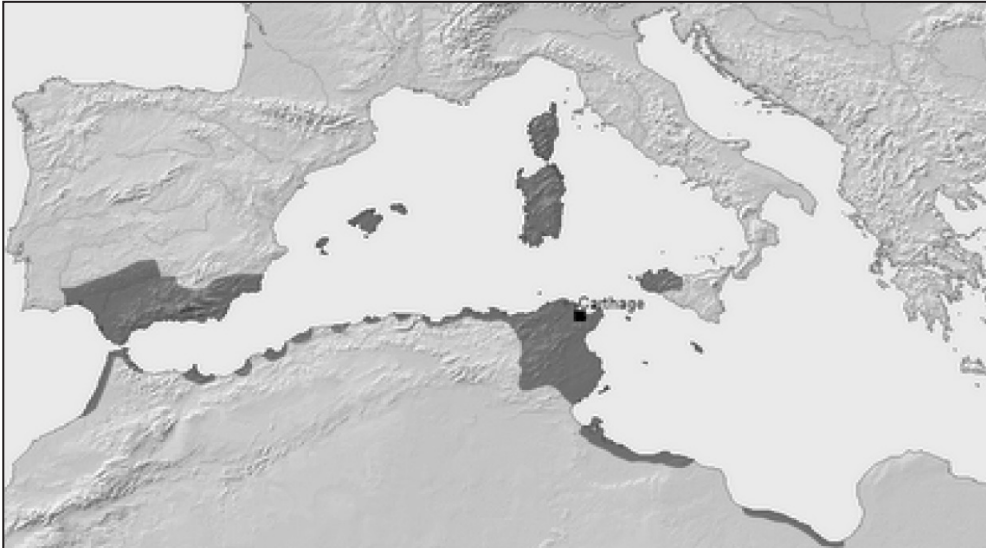
Carthaginian Empire

Carthage originated as a Phoenician settlement located strategically on the Sicilian channel, similar to Troy on the Dardanelles connecting to the Aegean and Black seas. Native to what is today Lebanon, the Phoenicians navigated superbly and thus flourished as traders. The French historian Fernand Braudel remarked in *The Perspective of the World* that Phoenicia exemplified early a “world-economy” surrounded by empires. Phoenician culture and sea power peaked during 1200–800 BCE. The Phoenicians sailed northward as far as England, where they traded for precious tin. Southward they explored the west African coast and perhaps even circumnavigated Africa.

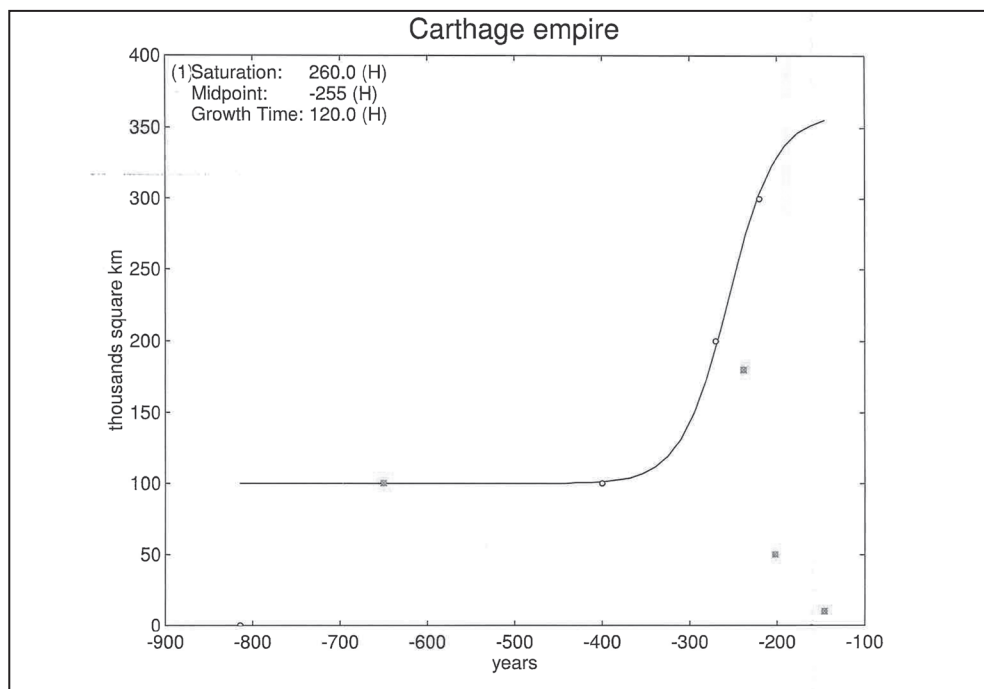
While Carthage began spawning its own colonies in the 7th century BCE, its turn at empire awaited the 4th century. Carthage then grew over about 120 years, five generations, to its peak around 220 BCE. Its fast collapse and shrinkage characterize many empires, as we shall see. Its successor, Rome, was a newcomer that had popped up as a power only around 500 BCE. While Rome started its own aggressive territorial expansion only around 150 BCE, bickering occurred much earlier, and in fact the decisive wrestling match came around 250 BCE with Carthage, a vital but aging empire, and Rome a small energetic one just emerging. The Carthaginian general Hannibal tried a final attack in Roman territory. He drove elephants through the Alps together with a mixed

breed of mercenary soldiers, including the famous Numidian cavalry and its archers. Rome kept losing and fighting until it could overcome the invader. It finally decided to cut the danger at the root. “*Cartago delenda est*” became the conclusion of the speech of Cato the Elder in the Senate. In 149 BCE Carthage finally fell under the attack of Scipio and was thoroughly destroyed, its inhabitants killed or sold as slaves. A brilliant city and civilization were butchered, more or less the beginning of the Roman expansion and cruelty.

A curiosity, Corsica, Sardinia and western Sicily conserved Punic (Carthaginian) laws applied through underground organizations. The populations never really submitted to Roman laws. In particular they had secret tribunals operating according to Punic laws. The origin of Mafia as we know it today can be traced back to these tribunals in western Sicily. History has long fingers.



-814	Carthage	0,00			0,00 Taagepera, 1979: 125
-650	Carthage	0.10+/-0.08	0,02	0,18	0,10 Taagepera, 1979: 125
-400	Carthage	0,10			0,10 Taagepera, 1979: 125
-270	Carthage	0,20			0,20 Taagepera, 1979: 125
-238	Carthage	0,18			0,18 Taagepera, 1979: 125
-220	Carthage	0,30			0,30 Taagepera, 1979: 125
-202	Carthage	0,05			0,05 Taagepera, 1979: 125
-146	Carthage	0,00			0,00 Taagepera, 1979: 125



Roman Empire

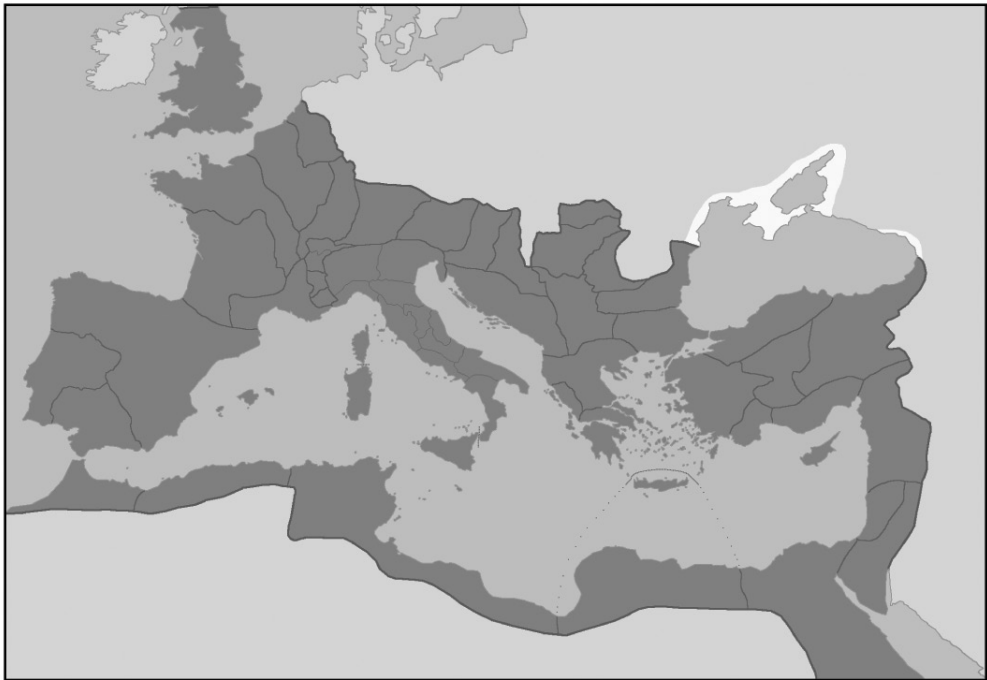
Rome perhaps best epitomizes empire. The Roman empire took long to build, 160 years, which probably contributed to its solidity, and expanded fully to the limits of the 14 days of travel. Rome paved the most remarkable network of roads in ancient history, about 90,000 km. Rome also disintegrated slowly. Its law and administrative rules remain in use today in many political systems. Modern China announced it will take Roman law as a reference to produce its own modern legal system.

Rome began as a small state covering only a tract of central Italy, but biting, consistent with its founding legend of Romulus and Remus fed by a shewolf. Rome finally won against Hannibal's invasion and brought the final destruction on the mainland of Carthage by hastily building a large fleet to bring its army there and reducing it to ashes and killing most of its inhabitants. As a popular general, Julius Caesar assumed control of a Republic and soon declared himself Dictator in Perpetuity and Imperator. A gang of senators murdered Caesar near the heated midpoint of Roman expansion, and other emperors completed the course.

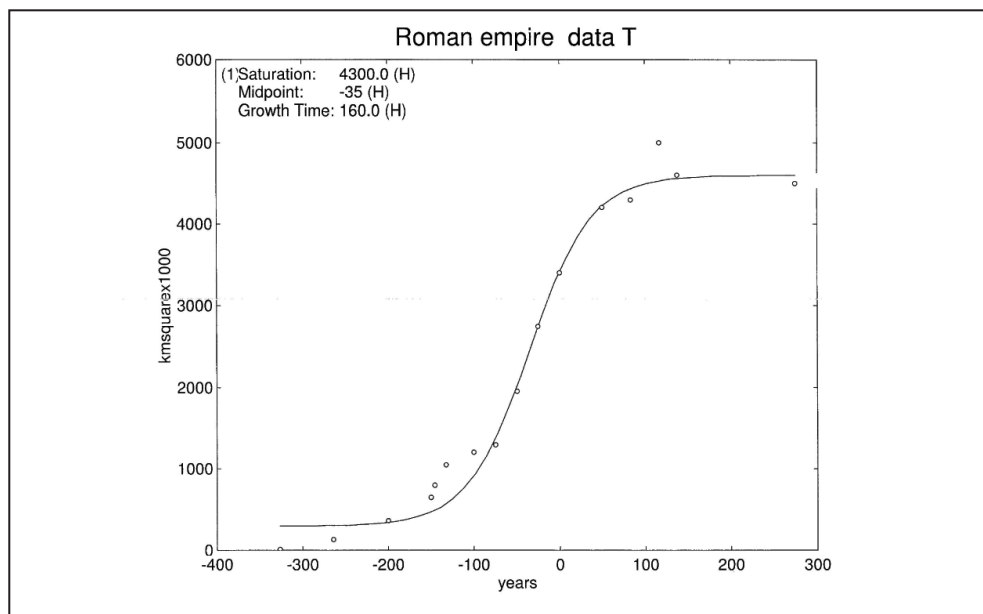
The Roman empire grew in a period that geographers define as a climatic optimum. A rise of a couple degrees in mean temperature effectively expanded vegetation time and agricultural productivity. The rise happened all along the Mediterranean latitudes, but it

was used in different ways. The Greeks built temples and nurtured intellectuals, providing the basis for our modern civilization. The Romans financed a professional army that built and kept the empire for a very long period of time after the logistic saturation had been reached.

The fall of Rome came in pieces. The first important act was the split between east and west that we reinterpret as due to the persistent presence of pirates. They even captured Caesar. The 14-day connection with Byzantium and the Black Sea depended on fast sea travel in triremes. When piracy caused risk averse functionaries to start choosing a land route that took almost a month, it precipitated split of the empire in two. Our interpretation differs from history books, but it rests on basic anthropology and would be easy to verify.



-500	Rome	0,001	0,00 Taagepera, 1979: 125
-326	Rome	0,01	0,01 Taagepera, 1979: 125
-264	Rome	0,13	0,13 Taagepera, 1979: 125
-200	Rome	0,36	0,36 Taagepera, 1979: 125
-150	Rome	0,65	0,65 Taagepera, 1979: 125
-146	Rome	0,80	0,80 Taagepera, 1979: 125
-133	Rome	1,05	1,05 Taagepera, 1979: 125
-100	Rome	1,20	1,20 Taagepera, 1979: 125
-75	Rome	1,30	1,30 Taagepera, 1979: 125
-50	Rome	1,95	1,95 Taagepera, 1979: 125
-25	Rome	2,75	2,75 Taagepera, 1979: 125
0	Rome	3,40	3,40 Taagepera, 1979: 125
50	Rome	4,20	4,20 Taagepera, 1979: 125
83	Rome	4,30	4,30 Taagepera, 1979: 125
117	Rome	5,00	5,00 Taagepera, 1979: 125
138	Rome	4,60	4,60 Taagepera, 1979: 125
275	Rome	4,50	4,50 Taagepera, 1979: 125
390	Rome	4,40	4,40 Taagepera, 1979: 125

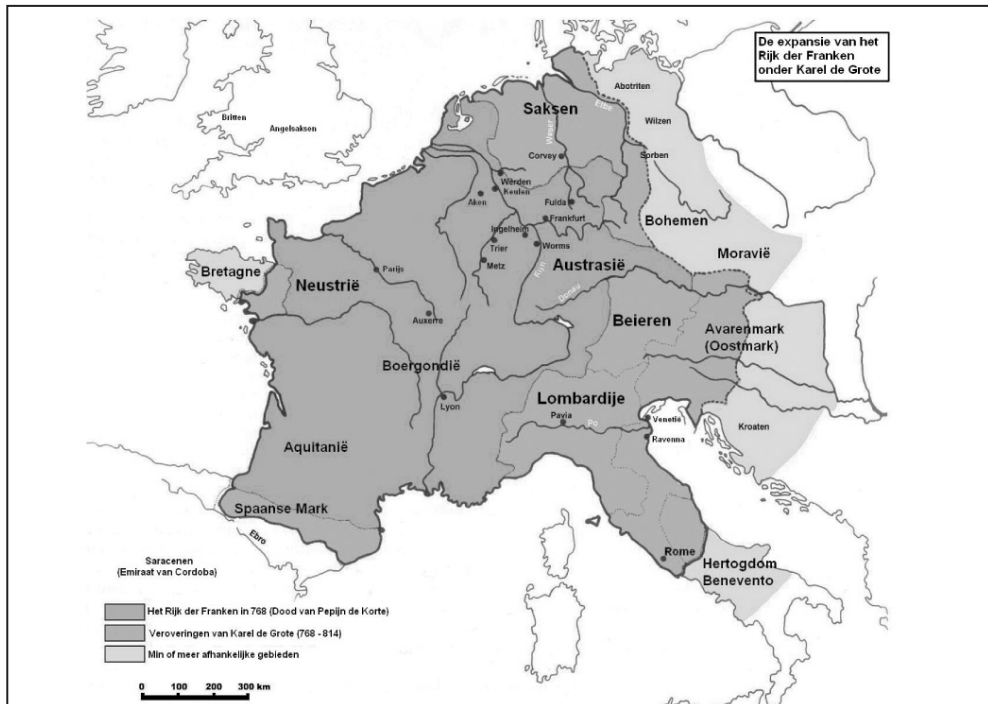


Frankish Empire

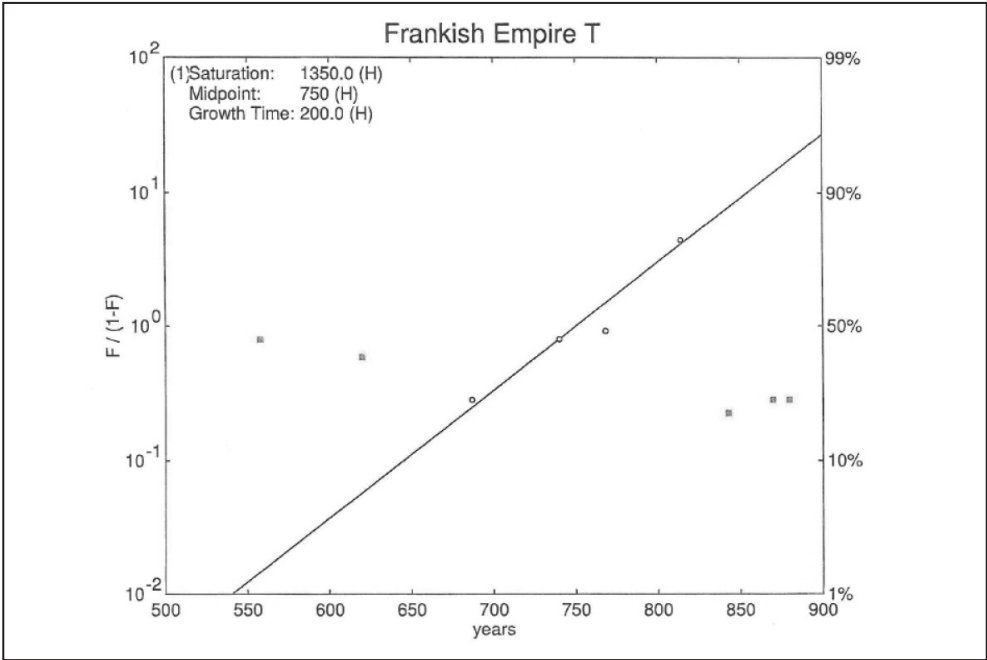
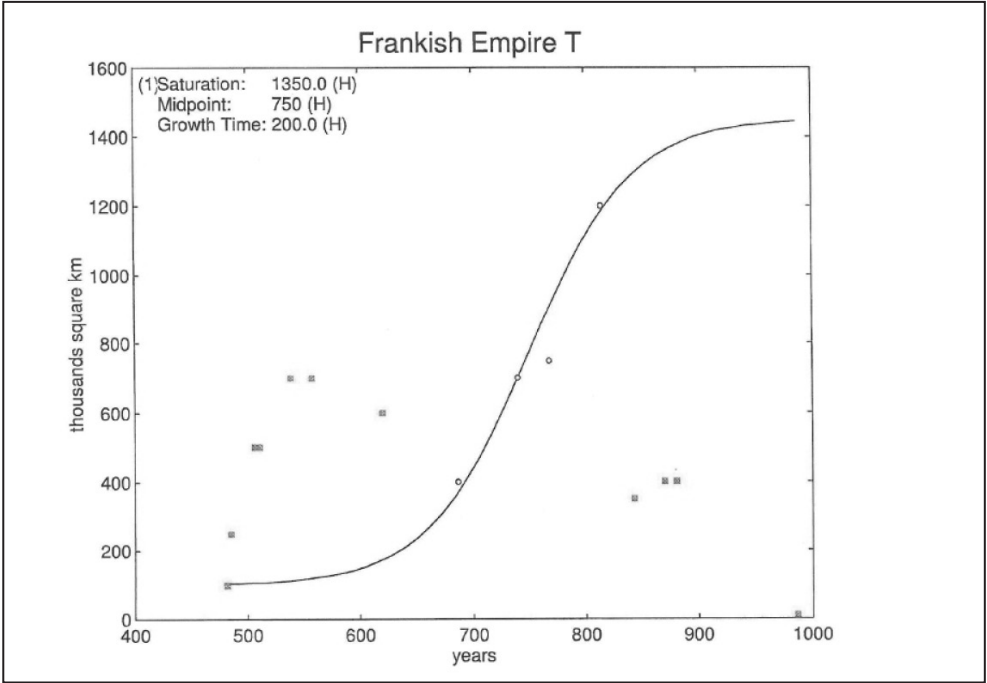
When the western Roman Empire dissolved definitively, around 476 CE, several relatively small regional organizations arose inside its borders, and the most vital of these, in particular the Franks in Austrasia, started fighting for growth. Finally an empire the size of western Europe was reassembled at the time of Charlemagne (768-814). The splendid monuments of the capital, Aquisgrana, and surviving gold and other artifacts show that little was lost with the fall of the Roman empire in culture and civilization. The Dark Ages appear to have been an invention of historians who perhaps simply lacked documents or other evidence. Notably, the transport system remained good enough to move architects and artists out of Byzantium, that magnificent haven of Roman and Mediterranean culture and technology. The logistic of the Frankish Empire centers on 750 CE with a time constant of 200 years, notwithstanding many subdivisions and reunions due to the splitting of inheritances and war. Testimony that the system was in high gear approaching the center point is the victory against the Ummayyad Caliphate at Poitiers (732), which marked the beginning of the European revival. Importantly, the Frankish Empire represents the core of modern Europe and has remained the core of its defense and revival.

Dedicated warriors, the Franks saw the military potential of the stirrup to weld the horseman to the horse. They developed the heavy armoured knights who were invincible for centuries, but very expensive, and necessitated confiscations of the land of religious orders to provide income. The huge horses developed for the knights had important fallout; they needed the oats which stimulated the serial cultivation of oats, beans, and turnips. The sequence increased land productivity and provided valuable protein in the beans. Innovations that followed, in particular the heavy plow, vastly increased agricultural productivity per working peasant and created important surpluses. Second-choice horses, but more efficient than oxen, were used in agriculture. The metaphysical expenses for building the gothic cathedrals testify to this agricultural wealth. From the Benedictine monasteries, where monks read the book of Nature in parallel with that of Scripture, a wealth of technological innovations emerged that would put Europe ahead of competing political systems. With these revolutions the seeds of the future European military, political, and economic dominance were thrown.

From a strictly political point of view, post-Roman Europe was the seat of continuous battles that favored the military culture necessary for its survival, squeezed as it was by Huns from the east, Arabs from Spain, Turks from the south east, and Vikings from the north. The new vitality was demonstrated when the Europeans started pushing back these converging forces and finally leapt out to conquer much of the world.



482	Frankish	0,10	0,10 Taagepera, 1997: 494
486	Frankish	0,25	0,25 Taagepera, 1997: 494
507	Frankish	0,50	0,50 Taagepera, 1997: 494
511	Frankish	[0.50]	0,50 Taagepera, 1997: 494
539	Frankish	[0.70]	0,70 Taagepera, 1997: 494
558	Frankish	0,70	0,70 Taagepera, 1997: 494
620	Frankish	0,60	0,60 Taagepera, 1997: 494
687	Frankish	0,40	0,40 Taagepera, 1997: 494
740	Frankish	0,70	0,70 Taagepera, 1997: 494
768	Frankish	0,75	0,75 Taagepera, 1997: 494
814	Frankish	1,20	1,20 Taagepera, 1997: 494
843	Frankish	0,35	0,35 Taagepera, 1997: 494
870	Frankish	0,40	0,40 Taagepera, 1997: 494
880	Frankish	0,40	0,40 Taagepera, 1997: 494
987	Frankish	0,00	0,00 Taagepera, 1997: 494



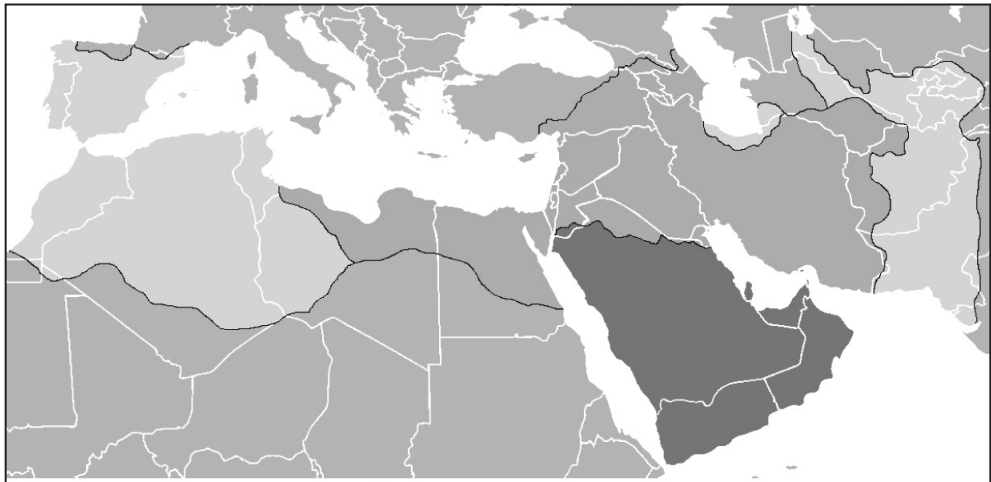
Empire of the Islamic Caliphate (Rashidun, Ummayyad, Abbasid)

Islamic religion supports conquering lands by war as a form of piety. Mohammed provided an example almost as vertical as a minaret, as the figures show. With the very short time constant of just 35 years and a mid-point of growth in about 650 CE, the early caliphs formed an empire more than twice the Roman and overlapping the oriental part of it. The Roman (and perhaps Persian) roads were an obvious attractor for the lines of expansion of the Caliphate, which in the end extended mainly West.

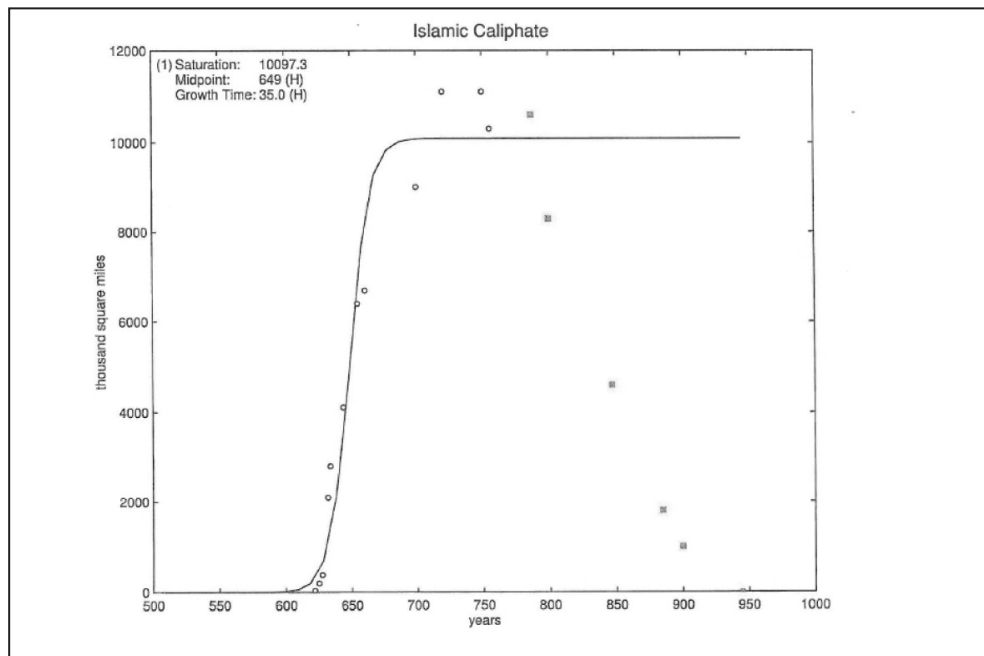
Islamic soldiers attacked in testosteroneic rage. Mohammed had stimulated them with the appreciated prize of 72 virgins in paradise, in case they died in battle. The ones that remained on Earth would marry, as a consolation, the widows of the dead soldiers.

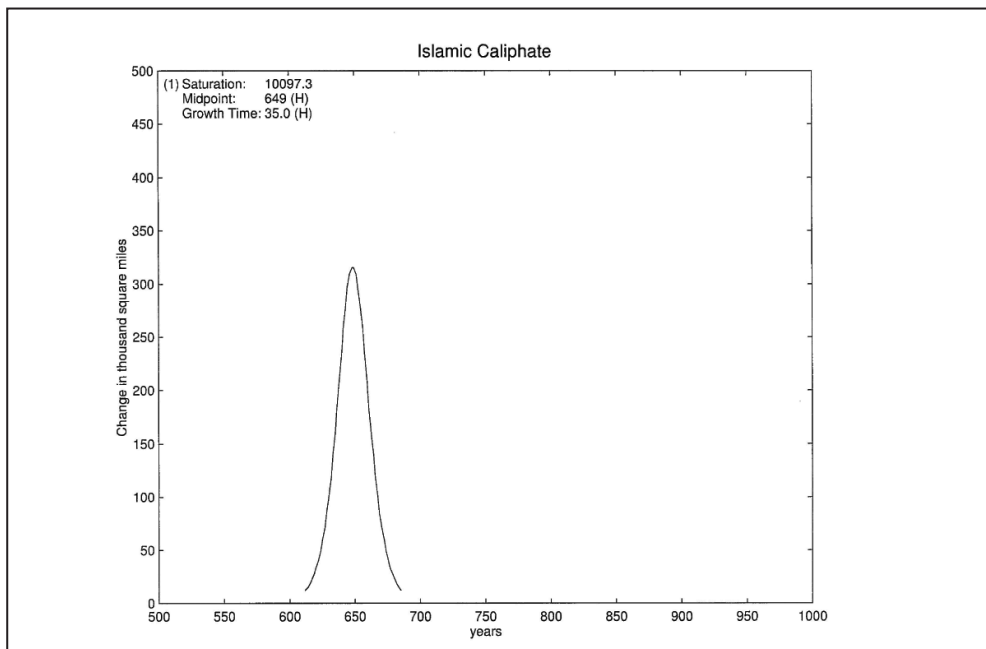
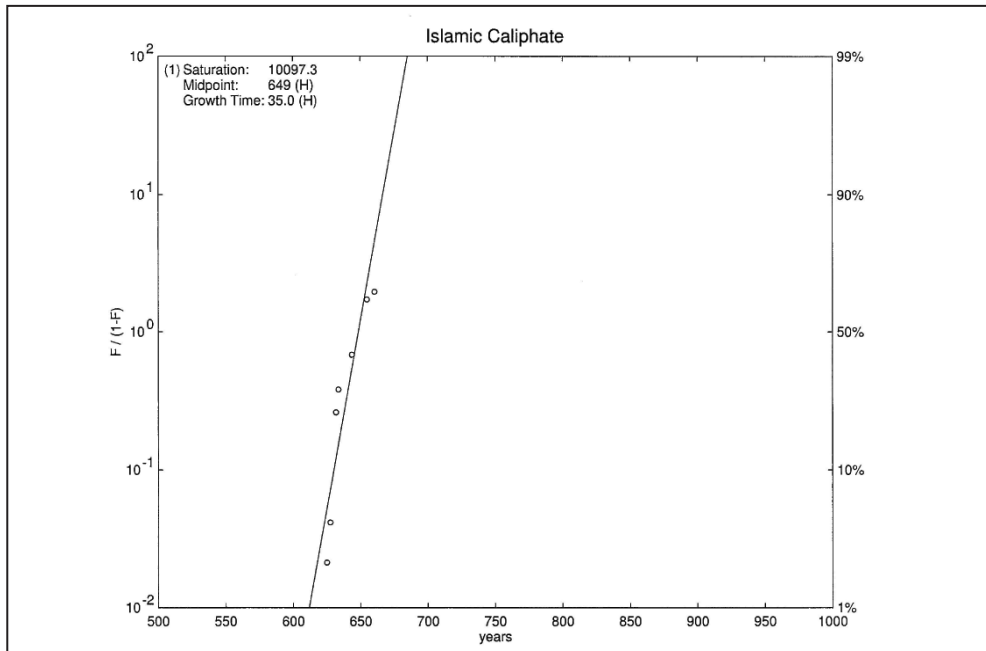
One of the last important aggressive operations was the crossing of the Pyrenees mountains to conquer France, but endangered and desperate Europe gave a deep bite to the Moslem invaders near Poitiers, not far from Paris, through the army of Charles Martel.

Having reached saturation, the Caliphate lasted about a century and a half, with strong oscillations in size, and finally crumbled due, as often, to internal instabilities that amplified external pressure.



622	Islamic Caliphate	0,05			0,05 Taagepera, 1997: 495
625	Islamic Caliphate	0.21+/-0.05	0,16	0,25	0,21 Taagepera, 1997: 495
628	Islamic Caliphate	0.40+/-0.10	0,30	0,50	0,40 Taagepera, 1997: 495
632	Islamic Caliphate	2.10+/-0.50	1,60	2,60	2,10 Taagepera, 1997: 495
634	Islamic Caliphate	2,80			2,80 Taagepera, 1997: 495
644	Islamic Caliphate	4,10			4,10 Taagepera, 1997: 495
655	Islamic Caliphate	6,40			6,40 Taagepera, 1997: 495
661	Islamic Caliphate	6,70			6,70 Taagepera, 1997: 495
700	Islamic Caliphate	9,00			9,00 Taagepera, 1997: 495
720	Islamic Caliphate	11,10			11,10 Taagepera, 1997: 496
750	Islamic Caliphate	11,10			11,10 Taagepera, 1997: 496
756	Islamic Caliphate	10,30			10,30 Taagepera, 1997: 496
787	Islamic Caliphate	10,60			10,60 Taagepera, 1997: 496
800	Islamic Caliphate	8,30			8,30 Taagepera, 1997: 496
847	Islamic Caliphate	4,60			4,60 Taagepera, 1997: 496
885	Islamic Caliphate	1,80			1,80 Taagepera, 1997: 496
900	Islamic Caliphate	1,00			1,00 Taagepera, 1997: 496
945	Islamic Caliphate	0,00			0,00 Taagepera, 1997: 496

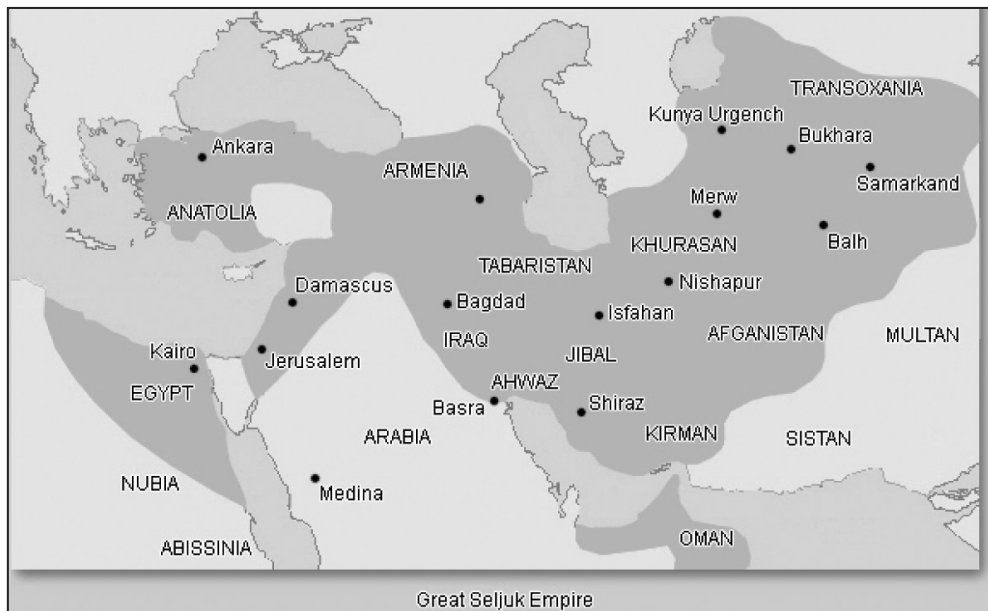




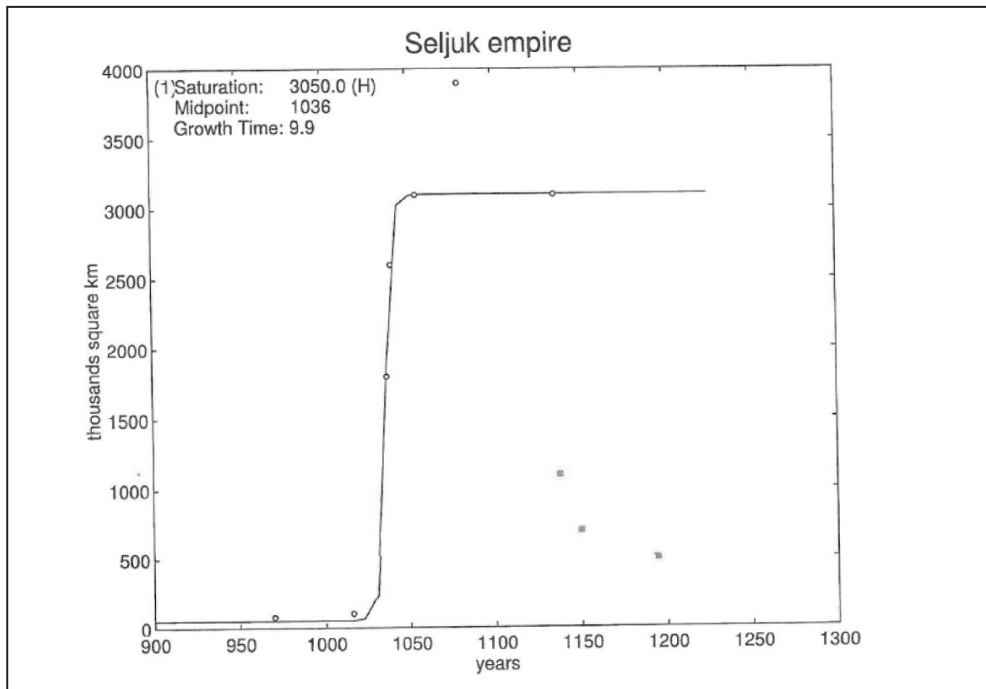
Seljuk Empire

Created shortly after the year one thousand, the Seljuk Empire had a time constant for its growth of only 10 years, although its final size was 4 million square km, similar to the Roman empire. The extraordinary speed of creation may be understood through the spirit of these Moslem conquerors, who fought non-stop. According to Seljuk commentators, they brought to the Muslims “fighting spirit and fanatical aggression.” As remarked earlier, dying in battle guaranteed enjoyment of 72 virgins, and survival the widows of the dead. How powerful the driving force in a sensuous society!

Originally educated in the service of Muslim courts as slaves or mercenaries, the Seljuk dynasty brought revival, energy, and reunion to Islamic civilization hither to dominated by Arabs and Persians. The potential of the transport system that coalesced various previous systems that ran from Turkey to China probably dictated the maximum size of the empire. In 1087, the Abbasid Caliph gave the Seljuk Sultan the title of “The Sultan of the East and West.” The relatively rapid end of the Seljuk Empire was linked to the usual power squabbles between different potential heirs over division of land, and the fall was almost as fast as the rise of the empire. Some contribution to the fall came from the crusades that battered the Seljuk western territories and resulted in establishment of islands of power linked to the Christian world.



970	Seljuk	0,08			0,08 Taagepera, 1997: 496
1016	Seljuk	0,10			0,10 Taagepera, 1997: 496
1037	Seljuk	1,80			1,80 Taagepera, 1997: 496
1040	Seljuk	2.60+/-0.50	2,10	3,10	2,60 Taagepera, 1997: 496
1055	Seljuk	3,10			3,10 Taagepera, 1997: 496
1080	Seljuk	3.90+/-0.30	3,60	4,20	3,90 Taagepera, 1997: 496
1136	Seljuk	3,10			3,10 Taagepera, 1997: 496
1138	Seljuk	1,10			1,10 Taagepera, 1997: 497
1150	Seljuk	0,70			0,70 Taagepera, 1997: 497
1194	Seljuk	0,50			0,50 Taagepera, 1997: 497



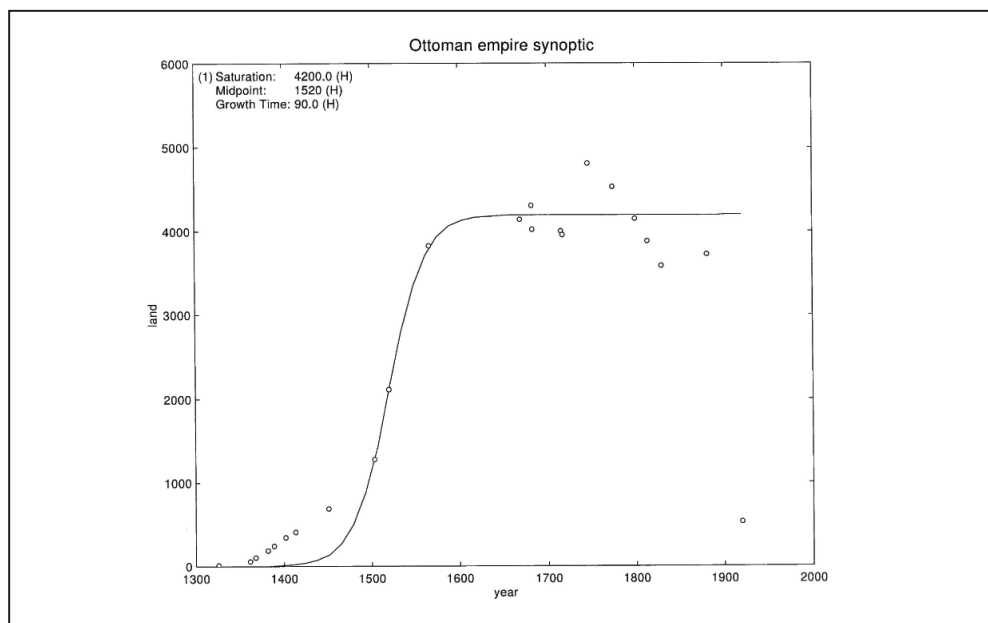
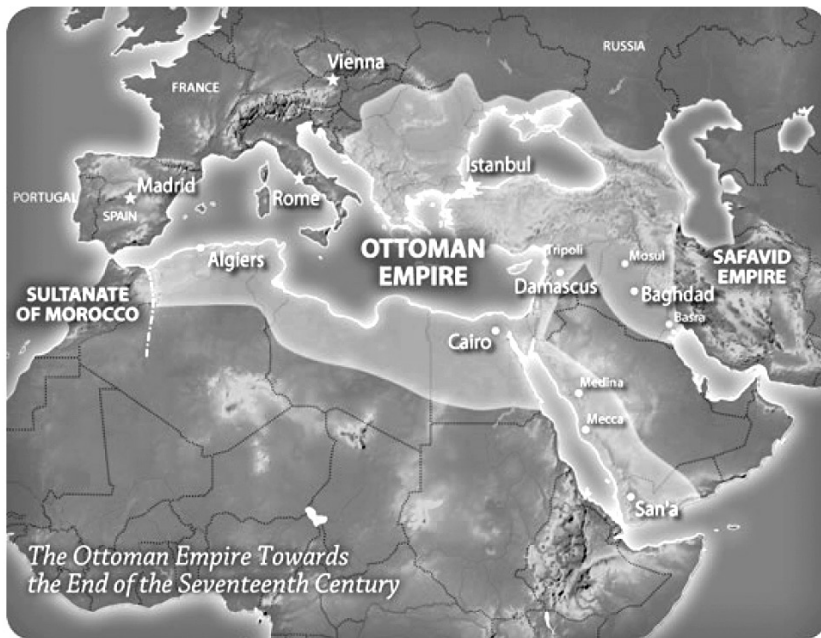
Ottoman Empire

The Ottoman empire grew as one of a sequence of Moslem empires centered on the Anatolian peninsula and spreading out from there. With Constantinople as its capital and vast lands around the eastern Mediterranean, the Ottoman Empire was, in many respects, an Islamic successor to the Eastern Roman or Byzantine Empire. The time constant of expansion was 90 years, deliberate by the standards of Islamic empires, and the calculated center point of the logistic part of its expansion is 1520, the year that Suleiman the Magnificent initiated his long reign. The saturation size was about 4 million square km, the now familiar number from the Roman Empire. The area was almost inevitable, as the speed of transport differed little, and the empire had direct control from Constantinople. After reaching the saturation point, its size oscillated somewhat. Formally, we may interpret the oscillations as efforts to expand followed by difficulties in control linked to inadequate messenger speed. Historical descriptions offer various causes, but the speed with which to assert authority consistently is subjacent and fundamental.

Interactions between the Eastern and Western worlds centered on the Ottoman Empire for six centuries. Vigorous and aggressive during the period of Suleiman, the empire dreamed explicitly to conquer Europe, and the Ottomans made various starts via the Balkans and Hungary. When they eventually tried to access the Danube causeway to Europe locked by the fortress at Vienna, they suffered defeat.

In fact, the period of renewed assertiveness came to a calamitous end in May 1683 when Grand Vizier Kara Mustafa Pasha led a huge army to attempt a second Ottoman siege of Vienna. Allied Habsburg, German, and Polish forces spearheaded by the Polish king Jan Sobieski swept away the Ottoman forces. The retreating army was almost destroyed in various battles by the new military star, the Italo-Austrian Prince Eugene of the Savoy family. In the final battle at Zenta Eugene inflicted approximately 25,000 casualties, including the new Grand Vizier. The alliance pressed the advantage, and 15 years of warfare culminated in the Treaty of Karlowitz (1699) which for the first time saw the Ottoman empire surrender control of significant European territories, including Hungary.

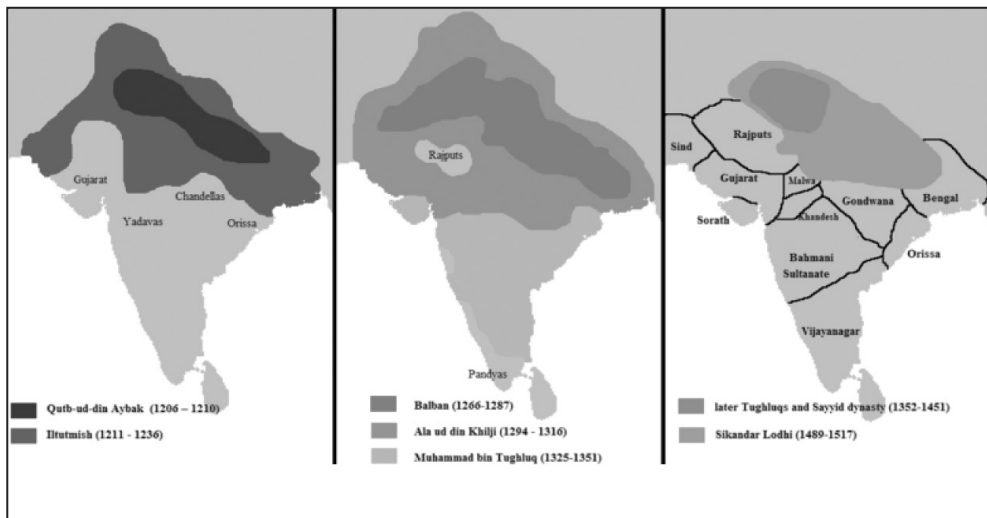
The Ottoman empire had reached the end of its ability to conduct an assertive, expansionist policy against European rivals and was forced from this time on to adopt an essentially defensive strategy. Clever management subdued the internal fighting and instability linked to situations of non-growth, and the empire persisted for an additional 200 years until an abrupt collapse around 1900.



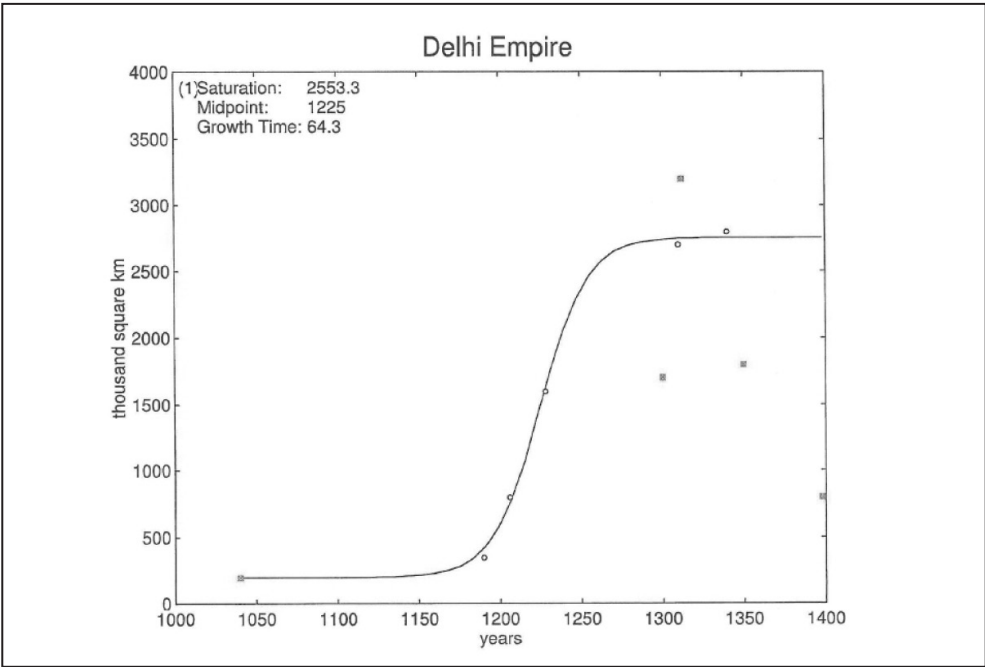
Delhi Sultanate

The second edition of Moslem occupation of the Indian subcontinent, the Delhi Sultanate began with an invasion led by Shahabuddin Ghori in 1175. It was expanded by the Mamluk, Albak, who together with three other Mamluks, inherited part of Ghori's possessions. Albak had testosterone and started fighting to enlarge his territory that at saturation reached 2.5 million square km. As usual with Moslem empires the time constant of the logistic is short, only about 60 years.

With a midpoint of growth in 1225 followed by just two-three generations at large scale, the Delhi Sultanate does not present any particularly remarkable aspects, but it boasted many monumental buildings in brick, some extant still today, in particular mosques, towers, and tombs, as well as elegant gardens. As for many empires, displaced stones are the legacy.



1040	Delhi	0.20?	0,20 Taagepera, 1997: 499
1190	Delhi	0,35	0,35 Taagepera, 1997: 499
1206	Delhi	0,80	0,80 Taagepera, 1997: 499
1228	Delhi	1,60	1,60 Taagepera, 1997: 499
1300	Delhi	1,70	1,70 Taagepera, 1997: 499
1310	Delhi	2,70	2,70 Taagepera, 1997: 499
1312	Delhi	3,20	3,20 Taagepera, 1997: 499
1340	Delhi	2,80	2,80 Taagepera, 1997: 499
1350	Delhi	1,80	1,80 Taagepera, 1997: 499
1398	Delhi	0.80?	0,80 Taagepera, 1997: 499



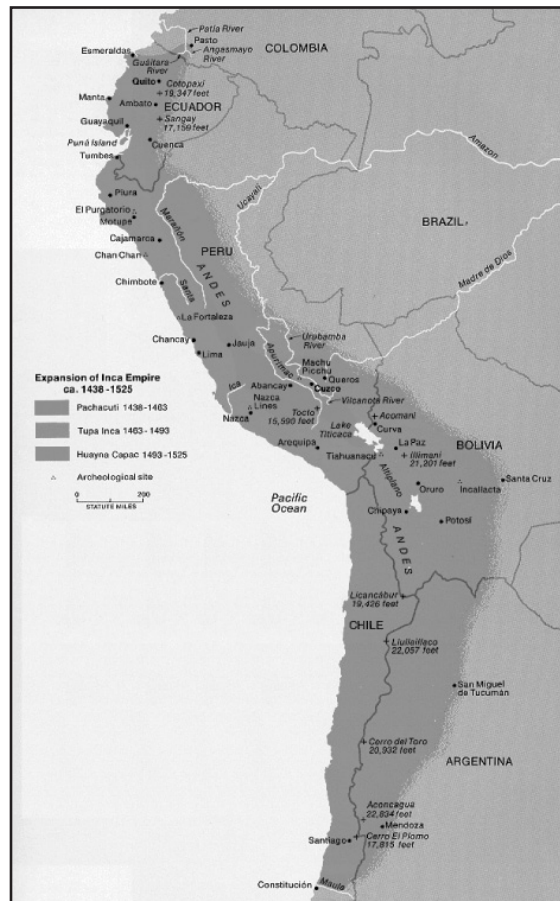
Inca Empire

The first traces of the Incas can be dated at about 1250, when they appear to have been shepherds living in the area of Cuzco in the Andean highlands. The explosion of their empire came in 1445 when Inca Yupanqui started subjugating his neighbours. Conquest continued non-stop until the empire saturated at 2 million square km, one half the size of the Roman empire. The core growth time spanned a mere 25 years, inflecting in 1480. The territory comprised a thin strip along the Andes, mostly at very high altitude. Amidst a chaos of indigenous idioms, the Incas managed to impose their language, an important unifying tool.

At the maximum expansion, a message from Cuzco to the farthest place in the empire took just 14 days to reach its target. Lacking horses, the Inca transmitted messages by runners, the chasquis, who could cover 250 km per day running day and night, in relay, aided by stone and rope bridges. The 40,000 km network of roads guaranteeing Inca communication included the Great Inca Road extending about 6000 km along the spine of the Andes and a 4000 km coastal road. Messages were coded in binary numbers represented by knots on a rope and encrypted by a password that the runner memorized and passed on to the next. The coded ropes were assembled in a sort of multifingered whip, the Quipu.

When Conquistador Francisco Pizarro arrived with his few hundred soldiers, the empire logistic had already reached saturation and was ready to collapse. The usual internal struggles had already begun, well represented by the fact two Incas were fighting for the throne. Atahualpa reportedly ordered that his brother be killed, and he himself was finally killed by Pizarro in 1533. While army discipline excelled, with driving accompaniment of banners and drums, as theorized by Sun-Tzu in 500 BCE in his treatise *On the Art of War*; the ferociously centralized organization was paralyzed. Moreover, the Inca army had poor weapons, as metal was in short supply, and that only bronze. The empire crumbled after resisting here and there in a sort of guerrilla style.

Attracted by precious metals, the Spaniards got enough of them to upset the economy of Spain and Europe, but the real treasure of the Inca empire was agricultural, especially highly productive plants including potatoes and maize that enriched the offering of staple foods in Europe and spurred its sprint to power.

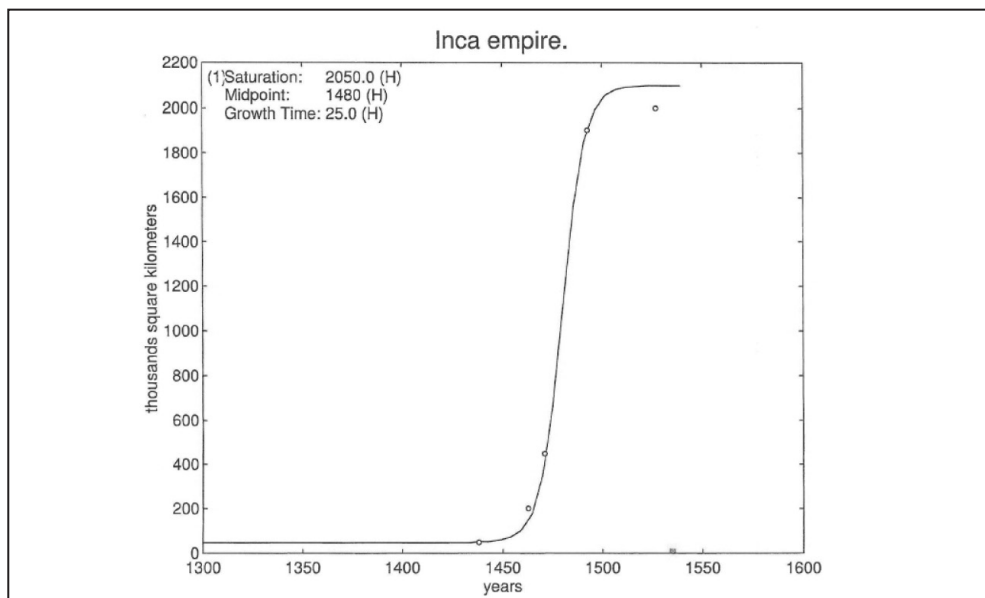


The **Chasquis** (also **Chaskis**) were agile and highly-trained runners that delivered messages, royal delicacies and other objects throughout the Inca Empire, principally in the service of the Sapa Inca. *Chasquis* were dispatched along thousands of miles, taking advantage of the vast Inca system of purpose-built roads and rope bridges in the Andes of Peru and Ecuador. *Chasqui* routes extended into further reaches of the empire into parts of what are now Colombia, Bolivia, Argentina and Chile.

Each *chasqui* carried a *pututu* (a trumpet made of a conch shell), a quipu in which information was stored, and a *qipi* on his back to hold objects to be delivered. *Chasquis* worked using a relay system which allowed them to convey messages over very long distances within a short period of time. *Chasquis* would start at one *tambo* and run to the next *tambo* where a rested *chasqui* was waiting to carry the message to the next *tambo*. Through the *chasqui* system a message could be delivered from Cusco to Quito within a week.



1250	Inca	0.005?	0,01 Taagepera, 1997: 497
1438	Inca	0,05	0,05 Taagepera, 1997: 497
1463	Inca	0,20	0,20 Taagepera, 1997: 497
1471	Inca	0,45	0,45 Taagepera, 1997: 497
1493	Inca	1,90	1,90 Taagepera, 1997: 497
1527	Inca	2,00	2,00 Taagepera, 1997: 497
1535	Inca	0,00	0,00 Taagepera, 1997: 497

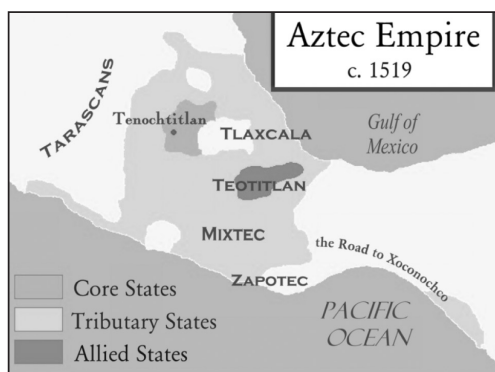


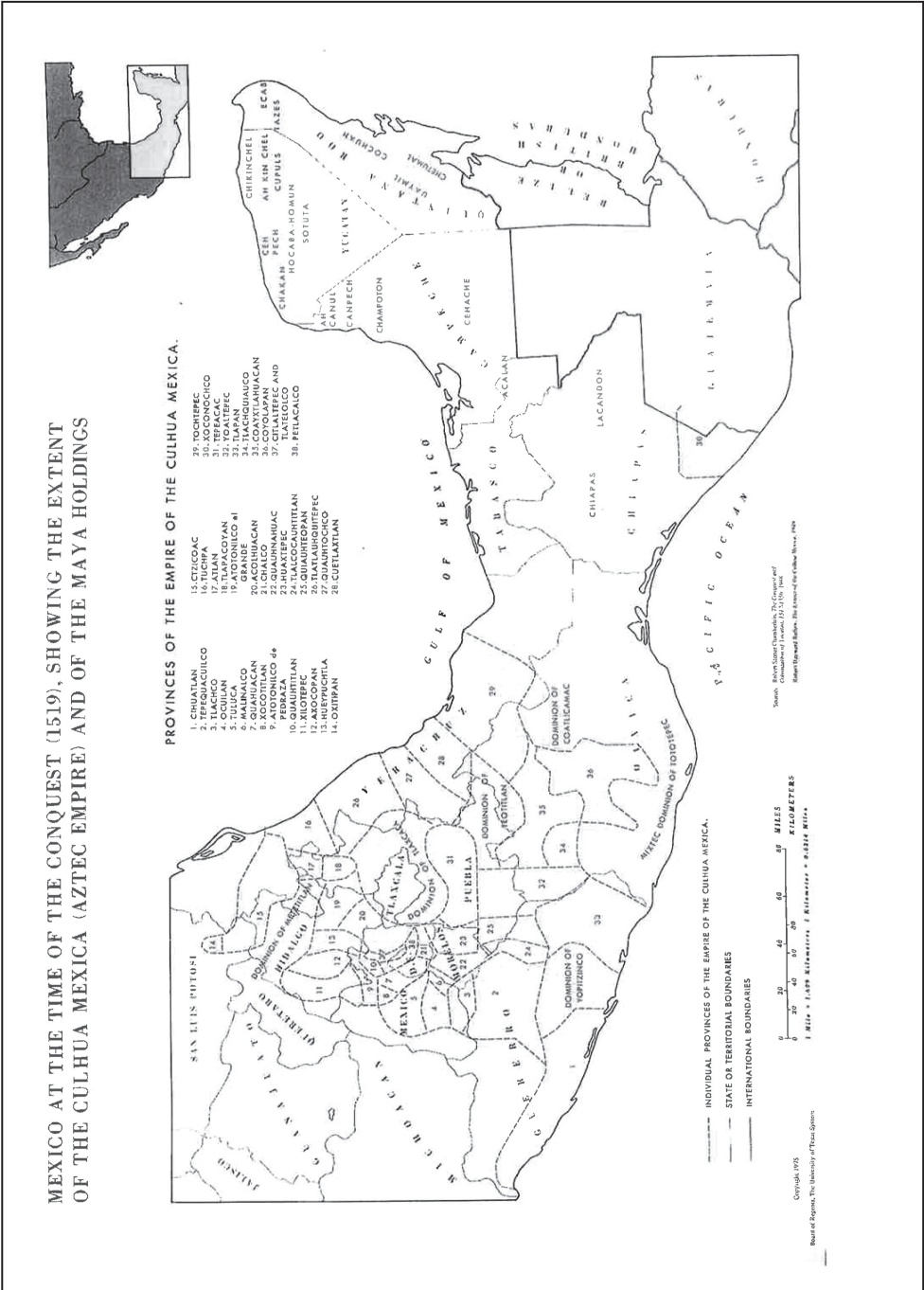
Aztec Empire

From the 13th century, the Valley of Mexico hosted the core of Aztec culture, the city of Tenochtitlan built on raised islets in Lake Texcoco. The military attitudes of this core population became manifest in 1400 with the onset of systematic, gradual conquest of surrounding states extending over 95 years with an inflection year of 1491, a year before Columbus. The dimensions of the empire finally saturated at about 275,000 square km, a relatively small empire. The empire built an excellent network of roads used by messengers who carried skins with hieroglyph messages or would communicate memorized messages. Although the Aztecs had messengers running at the same speed as the Inca chasquis, the Aztec messengers ran mostly at night because of the heat. When the Spaniards landed in 1519, Montezuma was informed the next day of the size and shape of the fleet in full details. Curiously, the Spaniards arrived when the empire neared saturation and was ready to crumble, as happened with the Inca empire.

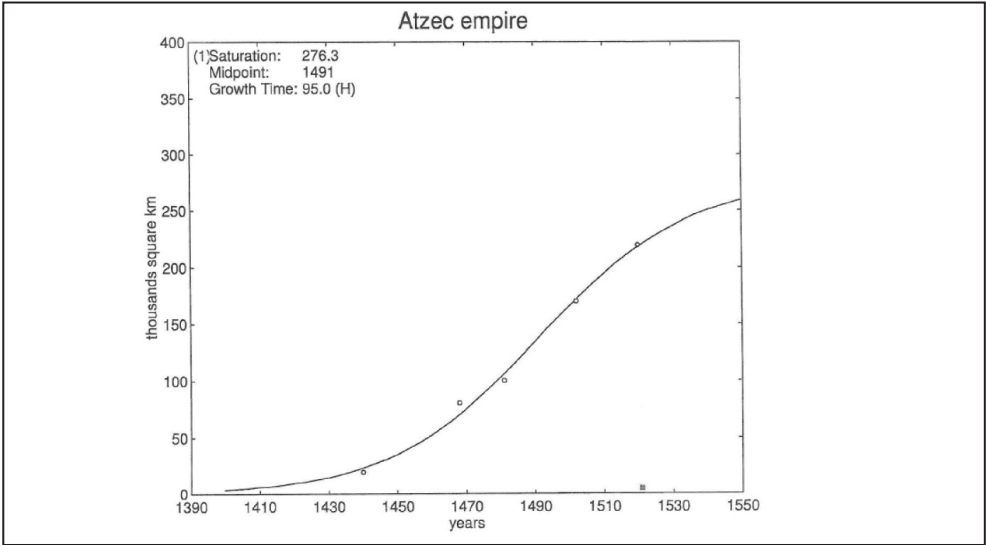
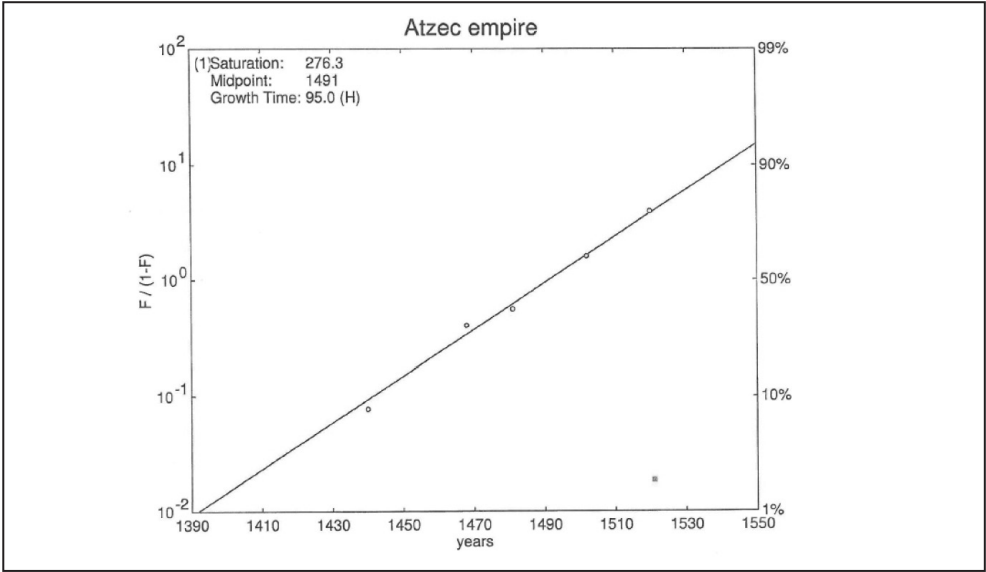
The Aztec state was based on taxes or tributes paid by the subjugated people who could keep their rulers and administrators provided they remained tranquil, a concept often applied also by the Romans. Unsurprisingly given this arrangement, the Aztecs also maintained an efficient network of spies. Aztec cruelty astonished arriving Europeans, for example, rituals in which hundreds of men were brutally killed and finally eaten. A benevolent interpretation of some anthropologists is that the Aztec diet lacked two important amino acids, lysine and tryptophan, that they obtained from various types of beans and meat when available. They also had amaranth, whose seeds rich in these two amino acids were consumed following complex rituals presumably underlining its importance.

A more political interpretation is that the Aztecs had to familiarize their population with cruelty, useful in conquering and maintaining empires. The Romans were also extremely cruel and kept the tendency alive with violent spectacles in their arenas. The famously dispassionate historian Edward Gibbon described the spectacles as blood-curdling, and they still capture the Hollywood imagination. Curiously, to most modern eyes the surviving Aztec monuments still exude violence whereas the Roman monuments project serene eternal beauty. Montezuma's own subjects stoned him to death, a little prematurely by our calculation of how long the Aztecs might have ruled.





1440	Aztec	0,02	0,02 Taagepera, 1997: 497
1468	Aztec	0,08	0,08 Taagepera, 1997: 497
1481	Aztec	0,10	0,10 Taagepera, 1997: 497
1502	Aztec	0,17	0,17 Taagepera, 1997: 497
1520	Aztec	0,22	0,22 Taagepera, 1997: 497



Spanish Empire

Spain generated an exceptionally large structure covering 14 million square km over a couple of centuries by a series of occasional conquests, principally in the Americas. Seen in a long time frame, the Spanish empire appears as the rebound of the reconquest or *reconquista* from the Moorish occupation that ended in 1492 with the establishment of a unified Spanish monarchy. The continuation of the spirit of expansion can be inferred from the financing of the expeditions of Christopher Columbus and other adventurers. In fact, Columbus was a safe bet, as he had spent some time in Iceland, where the existence of America had been known for centuries and probably neglected because of the excessive distance from Europe. The inflection point of 1639 came 50 years after the Spanish Armada sailed to invade England.

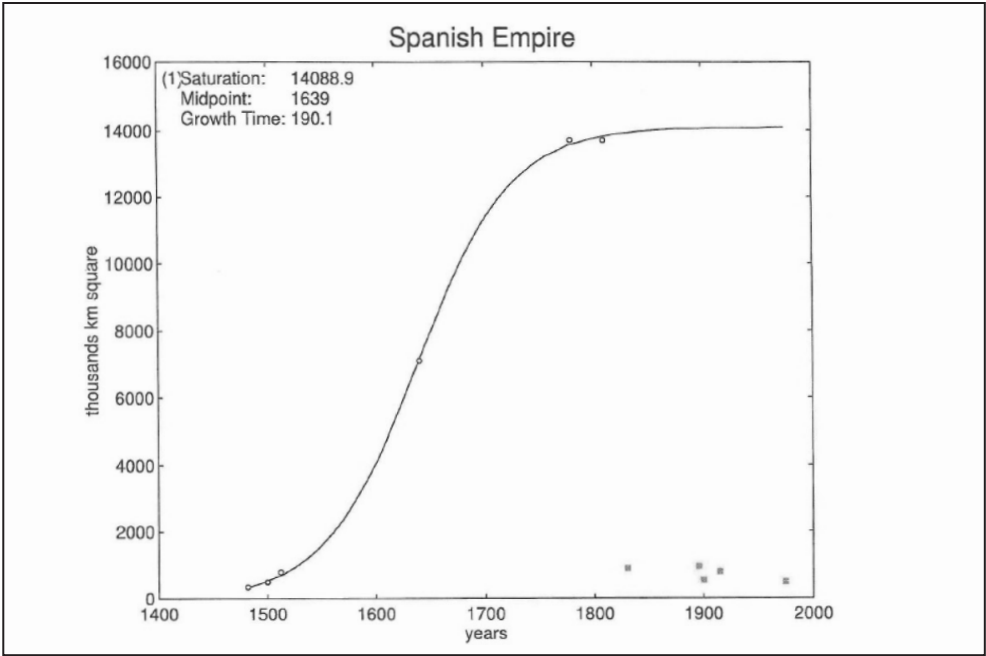
The Spanish empire included not only American land from Patagonia to California but the Philippines and various islands and other lands around the world, including in Africa. Because the speed of naval connections did not suffice for direct administration from Madrid, local governments were established. Consequently, this political structure stretches our definition of empire. As in the later cases of Portugal and England, it might be better to call it a commonwealth.

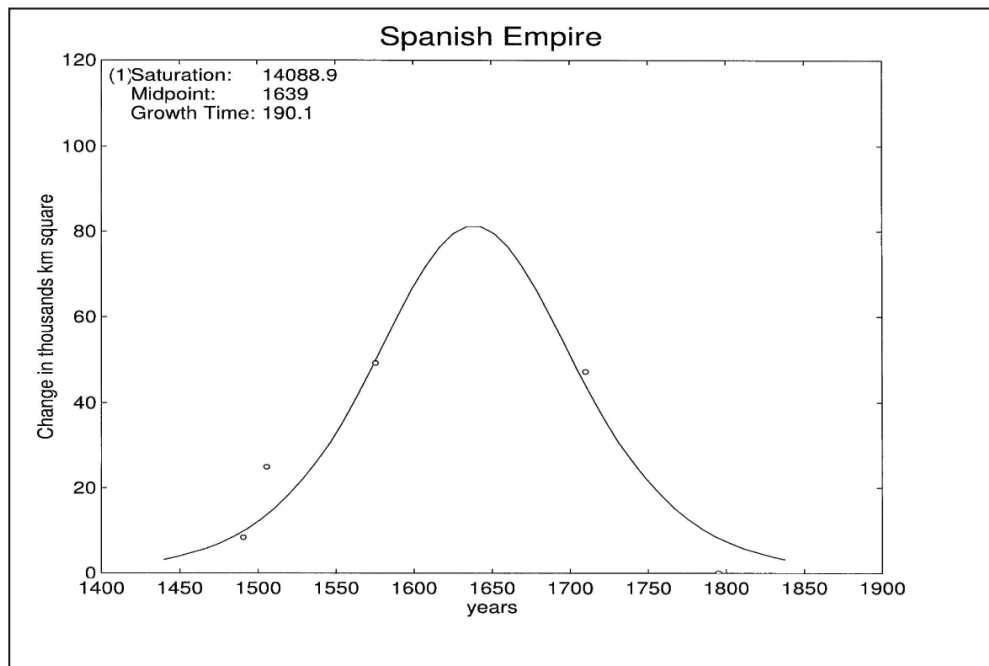
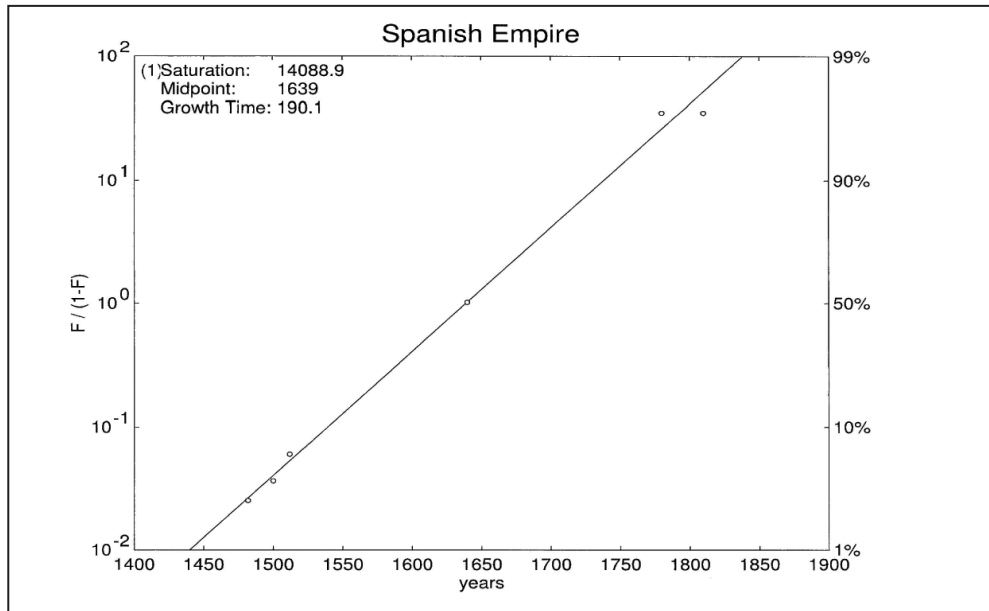
In the case of Spain, in the language of historians, the marriage of the Reyes Catolicos (Ferdinand II of Aragon and Isabella I of Castile) created a confederation of reigns, each with its own administration, but both formally ruled by a common monarchy. Due to this particular structure, occupation somehow differed from a colonization. Aiming to recreate something in the image of Spain, the aristocracy in power tried to build something civilized, efficient and aesthetic. This strategy did not impede the destruction of cultures that did not fit the Christian ideals of the time and their cultural artifacts, including books. Spanish laws prohibited slavery and allowed cohabitation and thus biological mixing with the local populations. In the long run, the mixing is helping preserve Spanish genes, in the *mestizos*, genes now being lost in Spain due to low fertility levels.

Three hundred years after the Moorish expulsion, the empire was ready to crumble, and did so rapidly when Napoleon's intrusion in European affairs upset the political situation. The confederated colonies had to defend themselves and realized they could also be fully independent. In just a few years the confederation disappeared as such and Spain was reduced to its European territories, a process with many parallels to Portugal and, a century later, to Britain.



1482	Spain	0,35	0,35 Taagepera, 1997: 499
1500	Spain	0,50	0,50 Taagepera, 1997: 499
1512	Spain	0,80	0,80 Taagepera, 1997: 499
1640	Spain	7,10	7,10 Taagepera, 1997: 499
1780	Spain	13,70	13,70 Taagepera, 1997: 499
1810	Spain	13,70	13,70 Taagepera, 1997: 499
1830	Spain	0,90	0,90 Taagepera, 1997: 499
1895	Spain	0,95	0,95 Taagepera, 1997: 499
1900	Spain	0,55	0,55 Taagepera, 1997: 499
1915	Spain	0,80	0,80 Taagepera, 1997: 499
1975	Spain	0,51	0,51 Taagepera, 1997: 499





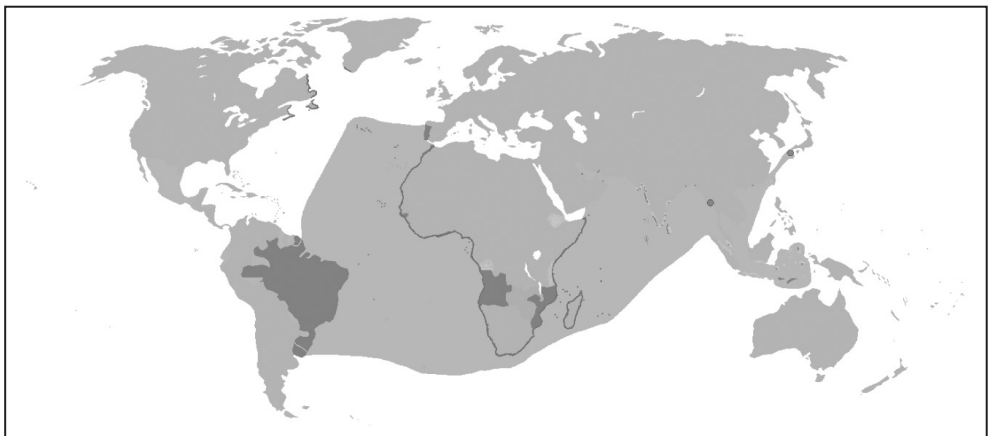
Portuguese Empire

Since the outset of the reconquista of Iberia, the Portuguese had been active seafarers. In the mid-15th century they developed a high-tech ship, the caravel, superior to all vessels of the time for oceanic navigation because it sailed closer to the wind. Using this new maritime technology, Portuguese navigators could sail anywhere in a profitable amount of time, circumnavigate Africa and establish trade posts in Asia.

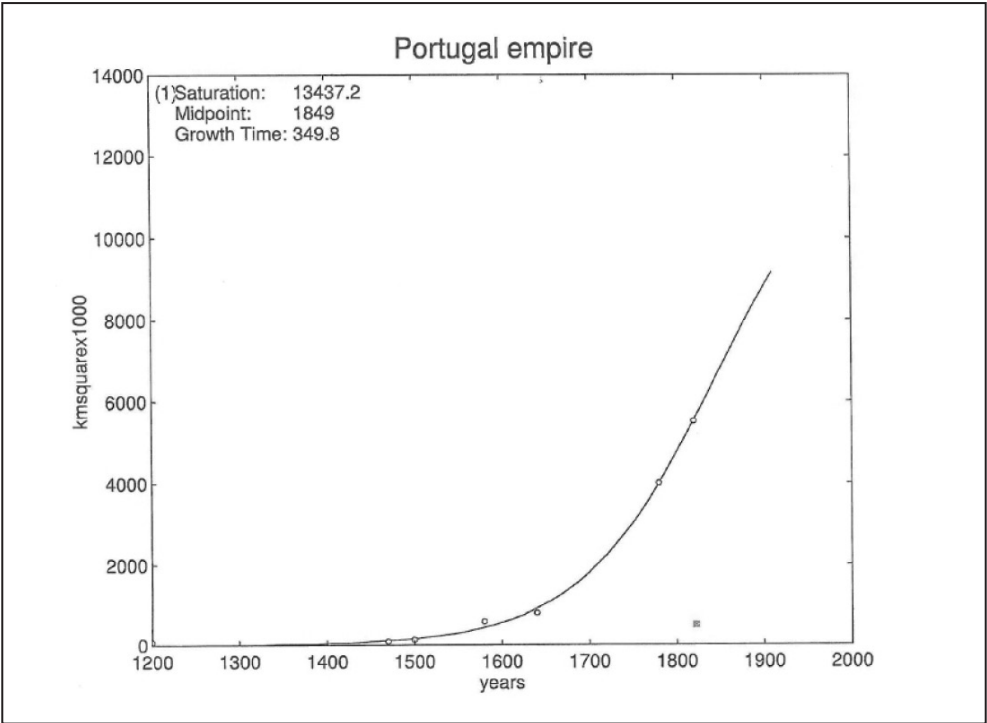
The exploration associated with the establishment of bases, sometimes just commercial posts and, when the opportunity presented, with the conquest of territories. Due to the European technical and military superiority, these conquests were relatively easy and sometimes huge, as in the case of Brazil. Mathematically, Portugal aimed for an empire as large as their more populous Spanish neighbors, and for a couple of hundred years stayed the course. However, in spite of their navigational skill, sailing speed did not comply with the 14-day travel rule necessary to establish a centrally administered Portuguese empire that extended to South America.

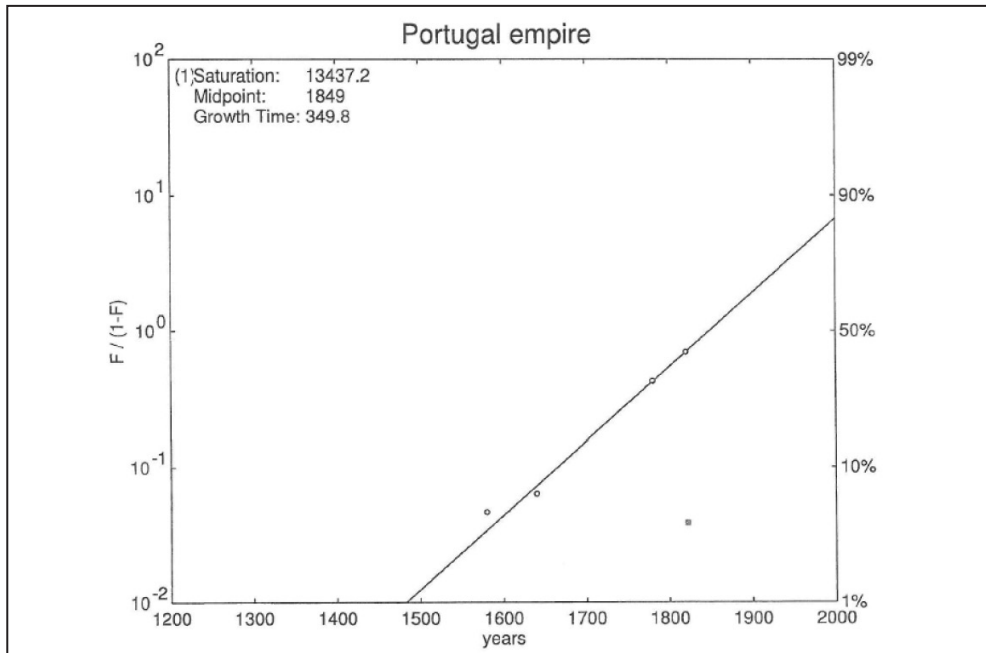
In 1808, Napoleon Bonaparte invaded Portugal, and Prince Regent Dom João ordered transfer of the royal court to Brazil. In 1815 the exiled Lusitanians elevated Brazil to the status of Kingdom, the Portuguese state officially becoming the United Kingdom of Portugal, Brazil and the Algarves, and they transferred the capital from Lisbon to Rio de Janeiro, the only example of a European country being ruled from one of its colonies. When Napoleon completed his career, the Portuguese government returned to Lisbon, a grave political mistake. Brazil was still too far away for direct rule but had tasted the glory of empire. The royal family's return to Portugal led to a growing desire for independence among Brazilians, and in 1822 Brazil proclaimed independence and crowned its own emperor.

The 19th century European colonial outburst brought in other territories, especially in southern Africa, finally in the 1880s two weeks by motor vessel from Lisbon. Viewed as one continuous process, Portugal's empire failed prematurely. Alternately, one might view the history as having two pulses, the larger cut short about 1820, and the second peaking about 1900. Mobility makes and breaks empire.



1200	Portugal	0,08	0,08 Taagepera, 1997: 502
1470	Portugal	0,10	0,10 Taagepera, 1997: 502
1500	Portugal	0.13?	0,13 Taagepera, 1997: 502
1580	Portugal	0.60?	0,60 Taagepera, 1997: 502
1581	Portugal	0,00	0,00 Taagepera, 1997: 502
1640	Portugal	0.80?	0,80 Taagepera, 1997: 502
1780	Portugal	4.00?	4,00 Taagepera, 1997: 502
1820	Portugal	5,50	5,50 Taagepera, 1997: 502
1822	Portugal	0,50	0,50 Taagepera, 1997: 502
1900	Portugal	2,10	2,10 Taagepera, 1997: 502
1975	Portugal	0,09	0,09 Taagepera, 1997: 502





Mongol Huan Empire

When Genghis Khan started his conquest around 1200, every soldier had a reserve of twenty-three horses. Nobody could resist the strength of the superb mounted army and the ability of the commander. The basic diktat was to destroy, and large swaths of Eurasia were definitively destroyed, all citizens killed and cities burned. This may be interpreted as Genghis' super-testosteronic drive leading to super-aggressiveness to the point of cruelty. Genghis reportedly had a harem of 2000 girls, and his Y gene can be found in millions of males in the areas he conquered.

Genghis' uninterrupted series of victories finally ended at a battle in the valley of Armageddon against the Mameluks, the Turkish professional slave soldiers. The first logistic of the Mongols and their Chinese branch, the Huan or Yuan, saturates in about 30 years at the mammoth size of 16 million square km, four times the area of the Roman Empire. The problem was to sustain the single rule. Such an empire spanned too much distance to cover in 14 days even with the finest horses. Consequently, it split into four smaller divisions, each the size of the Roman empire. Inevitably they started to fight among themselves, and fragmented further.

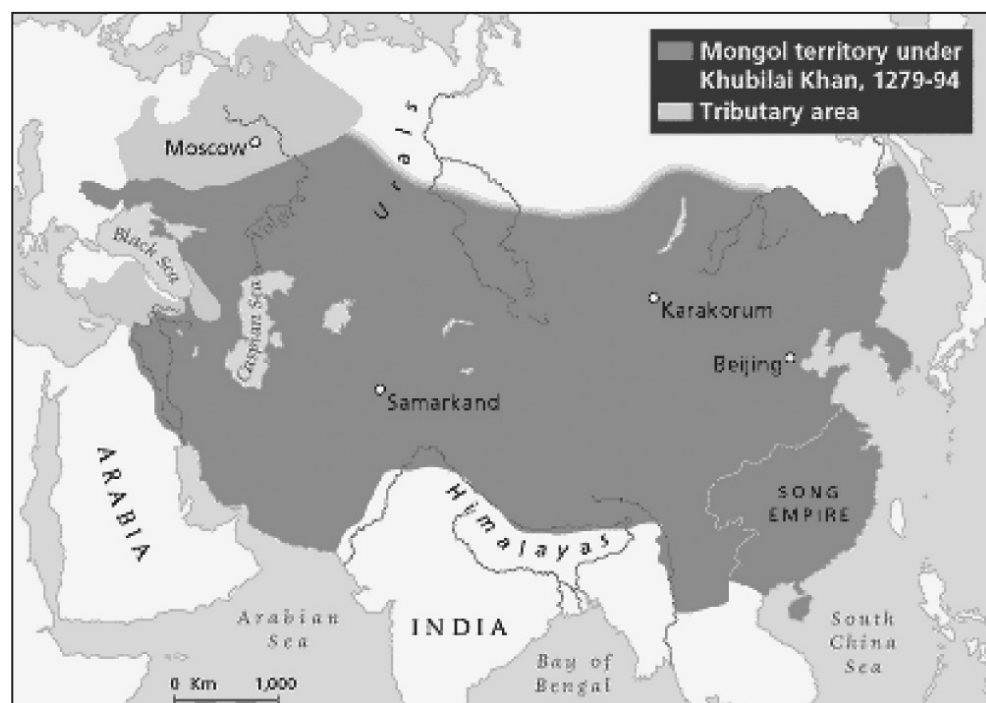
When Genghis conquered Beijing, he found it interesting for a capital. Curiously, Beijing increased in size to 5 km x 10 km at a time when no other city had ever exceeded the dimension a person could walk in one hour, 5 km. In fact Beijing formed a rectangle

composed of two square cities, adjacent but separated by a sort of external wall with guards and few doors. Han Chinese inhabited one city and Mongols the other, each group keeping its languages and customs. This pattern would often define the Chinese empire, comprised of subject groups that conserved various degrees of autonomy.

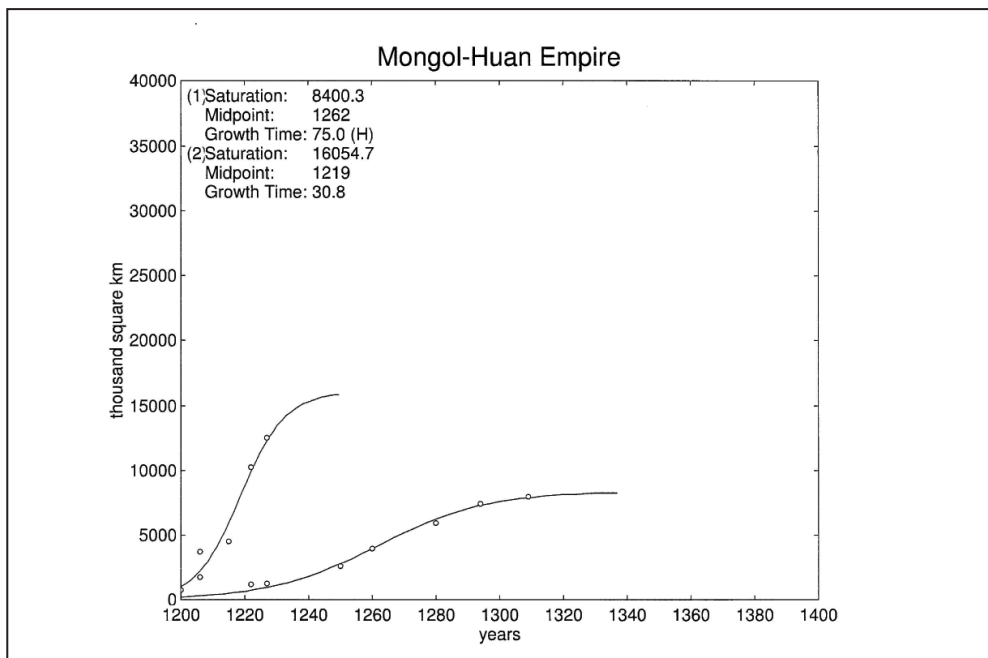
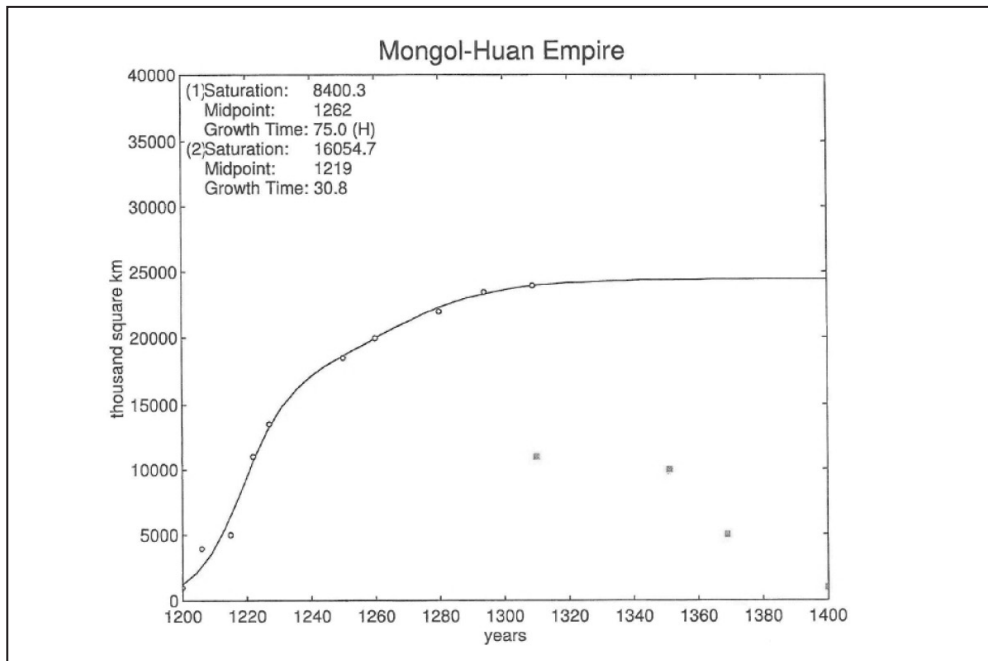
Genghis' grandson Kublai Khan (1215-1294) built a magnificent palace complex for himself, the Forbidden City, in Beijing. Containing elements of Arabic, western Asian, and Chinese architectural styles, it also contained a vast area of Mongolian nomadic tents and a playing field for Mongolian horsemanship. Kublai earned his place as formal initiator of the Mongol-Huan dynasty by building special relays for high officials as well as ordinary relays and hostels. During the reign of Kublai, the communication system consisted of some 1,400 postal stations, which used 50,000 horses, 8,400 oxen, 6,700 mules, 4,000 carts, and 6,000 boats. The Yam, a system of relay stations maintained by the Mongol army, extended from Eastern Europe to the Pacific separated by an average day's journey on horse. In parts of Manchuria and southern Siberia, the Mongols used dogsled relays for the Yam. The Mongol riders regularly covered 200 km per day, faster than the fastest record set by the Pony Express some 600 years later.

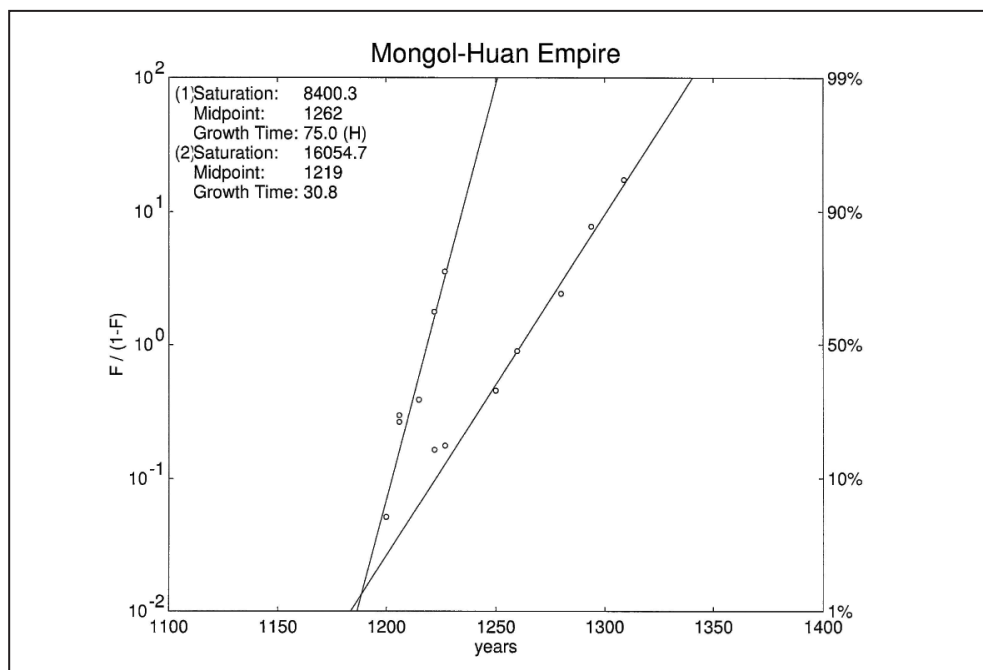
A crucial structure within the empire was the efficient postal system that in a couple of weeks could reach any locale with precisely set timing written on the envelopes. Any delay led to investigation into the causes, and the culprit was fined up to one year of salary. Chinese wisdom, efficiency and cruelty worked.

Analytically, the Mongol-Huan empire reveals itself as a pair of superposed pulses, the first initiated about 1200 and lasting about 30 years and the second initiated about 1230 and lasting about 75 years. Together, they form the shortest lived of the major Chinese dynasties. As the charts show, less than a century separates the surge about 1220 from the first collapse about 1310. The official date of the fall of the dynasty is 1368. Later Huan emperors could not stop the slide into powerlessness. On the one hand, the Beijing Khans lost legitimacy among the Mongols still in Mongolia who thought they had become too Chinese; on the other hand, the Chinese never accepted the Yuan as a legitimate dynasty, but regarded them as bandits, or at best an occupying army who failed to learn Chinese and integrate themselves into Chinese culture. Officials attributed the downfall to nature, as the Yellow River changed course and flooded irrigation canals and so brought on massive famine in the 1340's. However, we would say the context was ripe for the testosteroneic peasant, monk, and bandit Chu Yuan-Chang, who led a rebel army that took Beijing in 1368 and declared himself the founder of a new dynasty: the Ming (1369-1644).



1200	Mongol-Yuan	1.00+/-0.70	0,30	1,70	1,00	Taagepera, 1997: 499
1206	Mongol-Yuan	4,00			4,00	Taagepera, 1997: 499
1215	Mongol-Yuan	5,00			5,00	Taagepera, 1997: 499
1222	Mongol-Yuan	11,00			11,00	Taagepera, 1997: 499
1227	Mongol-Yuan	13.50+/-1.50	12,00	15,00	13,50	Taagepera, 1997: 494
1250	Mongol-Yuan	18,50			18,50	Taagepera, 1997: 499
1260	Mongol-Yuan	20,00			20,00	Taagepera, 1997: 499
1280	Mongol-Yuan	22.00+/-0.50	21,50	22,50	22,00	Taagepera, 1997: 499
1294	Mongol-Yuan	23.50+/-0.30	23,20	23,80	23,50	Taagepera, 1997: 499
1309	Mongol-Yuan	24.00+/-1.00	23,00	25,00	24,00	Taagepera, 1997: 499
1310	Mongol-Yuan	11.00+/-0.70	10,30	11,70	11,00	Taagepera, 1997: 499
1351	Mongol-Yuan	10.00+/-1.50	8,50	11,50	10,00	Taagepera, 1997: 499
1369	Mongol-Yuan	5,00			5,00	Taagepera, 1997: 499
1400	Mongol-Yuan	1.00+/-1.00	0,00	2,00	1,00	Taagepera, 1997: 499





Manchu-Qing Empire

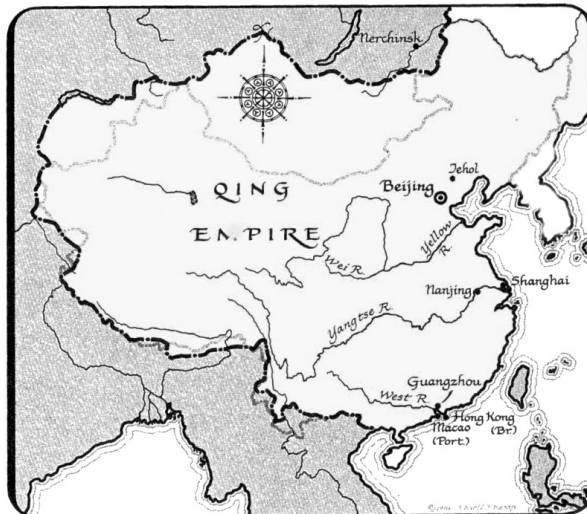
Chinese empires have tended to cover the entire continent or region, so forces to topple them have come from internal revolution with a couple of exceptions. Genghis Khan came from outside, carried by the immense vigor of the newly united Mongol tribes. He was finally entangled in the complex and very evolved structures created by the Hans, such that the empire he established actually had a double body as we have seen, with a double logistic growth and a double capital, evocative of the famous double head of European imperial eagles.

The Manchus were a population living in Northern China near the Great Wall, and thus linked biologically and culturally to the Mongols of Genghis. At the beginning of the 1700s, the Ming dynasty, centered on the Han populations, had been brilliant for centuries, but was succumbing to the internal instabilities characteristic of empires sometime after they have reached saturation. Peasants revolted and fiefdoms quarreled, problems that the central government had to settle. When the pressure of authority starts to wane, newcomers try their wits.

A Manchu leader Nurhaci, originally a vassal of the Ming, in 1582 initiated an intertribal campaign to reunify the Jurchen tribes that finally involved him in the internal squabbles of the empire. Mostly victorious, he kept expanding into the Ming realm with the essential contribution of the Mongol cavalry as his ally. Nurhaci was actually defeat-

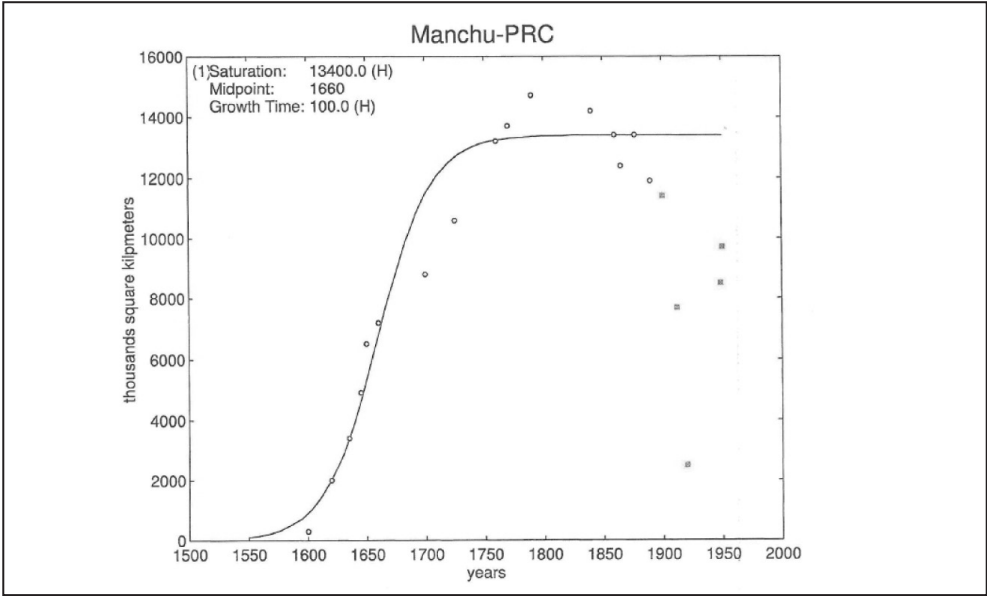
ed in 1626 by a Ming army equipped with modern Portuguese cannons, and died, and his son was defeated in 1627 by the same Ming general, but the son had learned the lesson, and his reorganized army had no truly valid competitors. Seen from a distance, a weakening authority was substituted by a vigorous new one. The immensity and complexity of the imperial organization had to be taken wholesale and the numerical superiority of the Hans accepted. In a sense the Qing were a refreshed version of the Ming. It took the Manchus one hundred years to restore the full empire of more than 13 million sq km, manageable only with the superb infrastructure they inherited.

We follow Taagepera in referring to the empire as the Manchu-PRC because in the chart the collapse around 1920 appears as an aberration. The present area of the People's Republic of China remains about 9.6 million square km, so the empire may "feel" too small. Inclusion of Mongolia and some of the Russian Far East would restore it to full dimensions.



Qing Dynasty Empire (1644–1911)

1600	Manchu-PRC	0,30			0,30 Taagepera, 1997: 500
1620	Manchu-PRC	2,00			2,00 Taagepera, 1997: 500
1635	Manchu-PRC	3,40			3,40 Taagepera, 1997: 500
1645	Manchu-PRC	4,90			4,90 Taagepera, 1997: 500
1650	Manchu-PRC	6,50			6,50 Taagepera, 1997: 500
1660	Manchu-PRC	7,20			7,20 Taagepera, 1997: 500
1700	Manchu-PRC	8,80			8,80 Taagepera, 1997: 500
1725	Manchu-PRC	10,60			10,60 Taagepera, 1997: 500
1760	Manchu-PRC	13,20			13,20 Taagepera, 1997: 500
1770	Manchu-PRC	13,70			13,70 Taagepera, 1997: 500
1790	Manchu-PRC	14.70+/-0.30	14,40	15,00	14,70 Taagepera, 1997: 500
1840	Manchu-PRC	14,20			14,20 Taagepera, 1997: 500
1860	Manchu-PRC	13.40+/-0.50	12,90	13,90	13,40 Taagepera, 1997: 500
1865	Manchu-PRC	12,40			12,40 Taagepera, 1997: 500
1877	Manchu-PRC	13,40			13,40 Taagepera, 1997: 500
1890	Manchu-PRC	11,90			11,90 Taagepera, 1997: 500
1900	Manchu-PRC	11.40+/-0.30	11,10	11,70	11,40 Taagepera, 1997: 500
1912	Manchu-PRC	7,70			7,70 Taagepera, 1997: 500
1920	Manchu-PRC	2.50?			2,50 Taagepera, 1997: 501
1949	Manchu-PRC	8,50			8,50 Taagepera, 1997: 501
1950	Manchu-PRC	9,70			9,70 Taagepera, 1997: 501



Mogul Empire

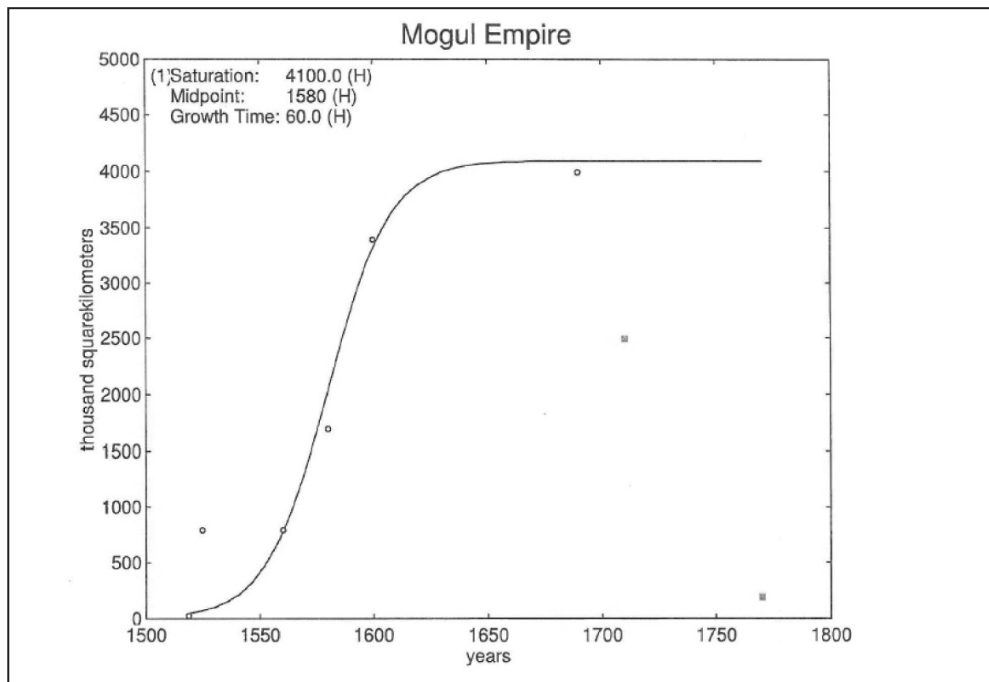
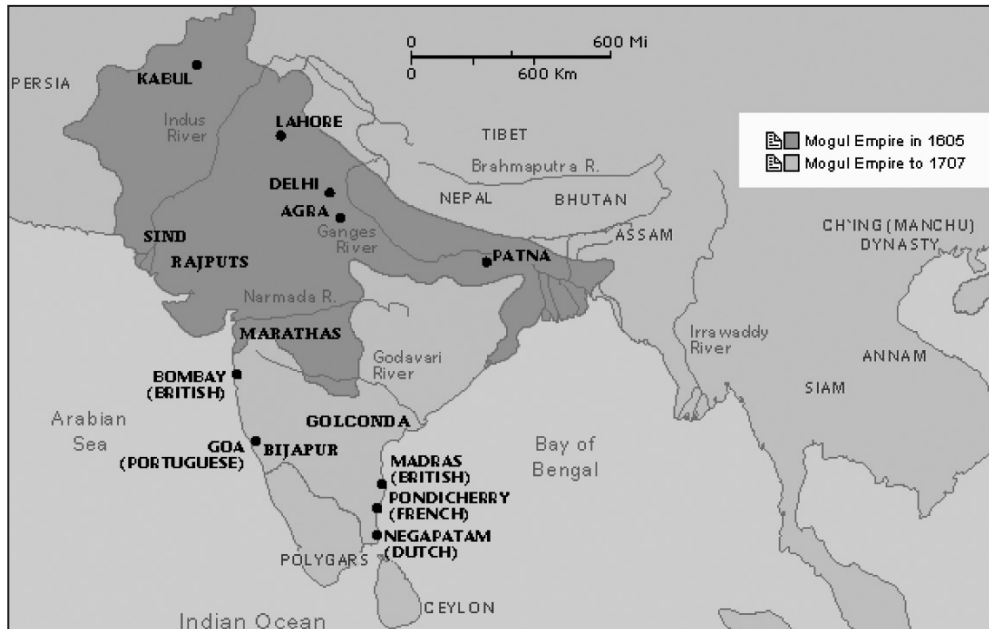
Genghis Khan’s invasion left some vital bits and pieces of Mongol genetics in Europe and western Asia. As mentioned earlier, Genghis played the role of the great stud. He created millions of genetically recognizable descendants. The Moguls intermingled Mongols with Turks, both aggressive. The militant conqueror Timor or Tamerlane in the 14th century started a conquest that ultimately extended to the whole of northern India, Pakistan, and Afghanistan with the noteworthy exception of the Pashtun populations of Afghanistan that now make life so difficult for the western occupants.

If the genetics were crucially Mongol, the culture was Persian and the religion Moslem. This imparted the empire the characteristic speed of Moslem conquests, about 60 years, with the midpoint of growth in 1580. Led most famously by Akbar (1556-1605), who is said to have won his 18th military victory by age 21 or 22, the empire covered finally 4 million square km, the Roman size, dictated by the speed of horses. The empire lasted at its maximum size about 100 years, time enough to build the Taj Mahal.

The Mogul Empire was culturally alert, fostering arts, architecture, and science. The 16th and 17th centuries saw a fruitful synthesis between Islamic and Indian astronomy, where Islamic observational techniques and instruments were combined with Hindu computational techniques. The Indian bent for software may be genetic. Inevitably, the empire developed a road system and provided a single currency.

The end came by succession crises and attrition, rather symmetrically with growth. The new invaders, the English East India Company, arrived by sail. During its first century of operation, the Company focused on trade with the Indian subcontinent, as it could not challenge the powerful Moguls, who had granted it trading rights in 1617. In the 18th century, as the Moguls’ power declined, the East India Company struggled with its French counterpart, the Compagnie francaise des Indes orientales. The British defeated the French and their Indian allies in 1757, leaving the Company in control of Bengal and establishing it as the major military and political power in India.

1519	Mogul	0.03?	0,03 Taagepera, 1997: 500
1525	Mogul	0.80?	0,80 Taagepera, 1997: 500
1560	Mogul	0,80	0,80 Taagepera, 1997: 500
1580	Mogul	1,70	1,70 Taagepera, 1997: 500
1600	Mogul	3,40	3,40 Taagepera, 1997: 500
1690	Mogul	4,00	4,00 Taagepera, 1997: 500
1710	Mogul	2.50?	2,50 Taagepera, 1997: 500
1770	Mogul	0.20?	0,20 Taagepera, 1997: 500
1798	Mogul	0,00	0,00 Taagepera, 1997: 500



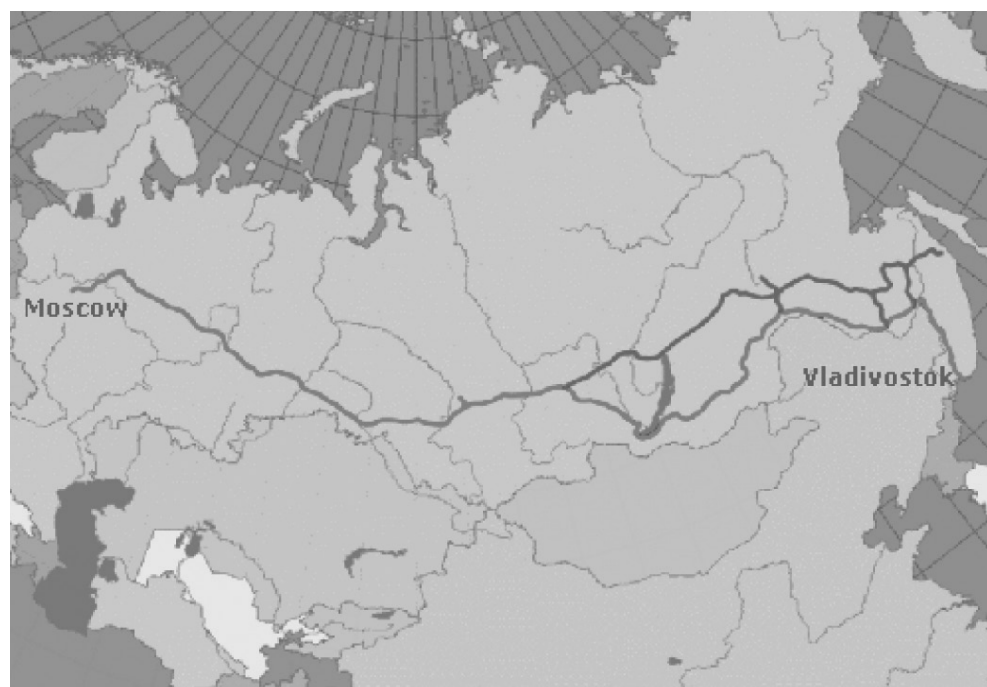
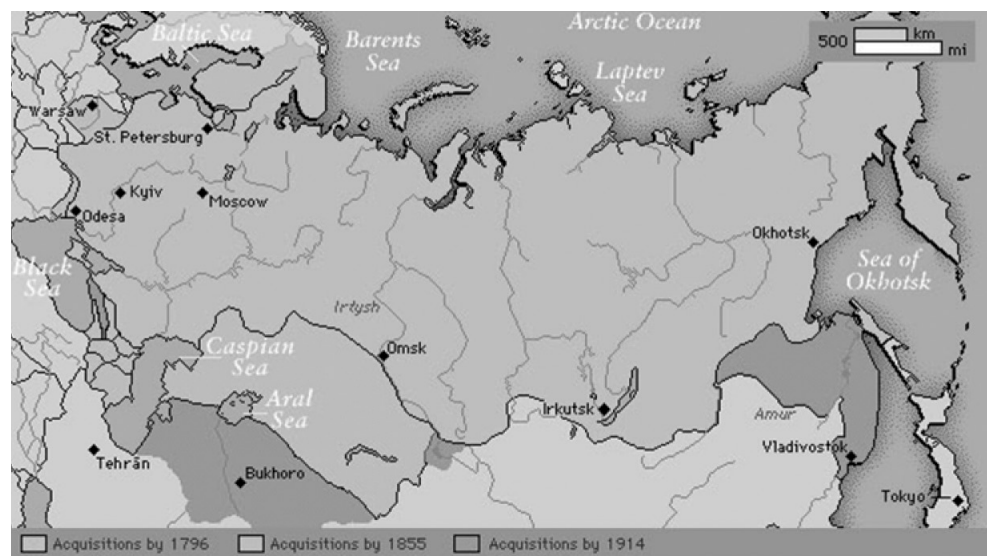
Russian Empire

The vast and fertile plains of today's Russia have hosted a series of populations, agricultural and nomadic or invaders like the Mongols. A self-consistent history begins with the Czars, who provided political continuity from the middle of the 15th century, systematically expanding the territories under their rule, in tune with the definition of a vital empire. The growth of these territories has been gradual, with a time constant of 220 years, but the final size was huge, 17 million square km. Most of the land, however, depended only nominally on the central ruler, as the 14-day feedback control was absent due to the immense distances lacking appropriate infrastructure.

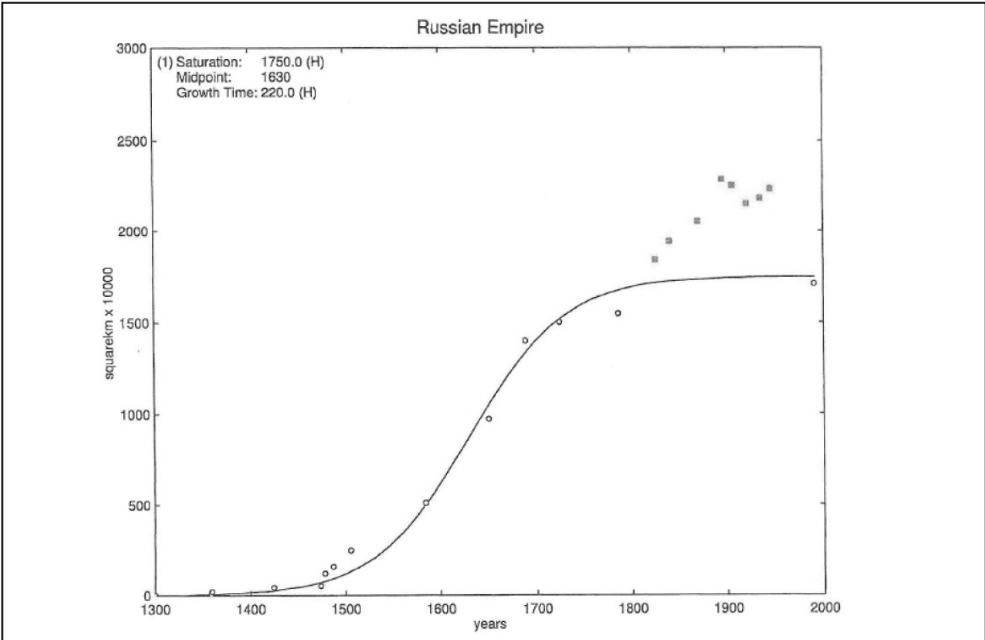
The Czars started as rulers of the Moscow area and proudly declared Moscow as the third Rome and the seat of the Russian Orthodox Church. Indeed, after Ivan III's marriage in 1472 to Sophia Palaiologina, the niece of the last Byzantine emperor, the Moscow court adopted Byzantine terms, rituals, titles, and emblems, including the double-headed eagle, which survives on the Russian coat of arms. Muscovy's conquests grew unabated, according to the logistic that marks the destiny of an empire. In 1800 the logistic of Russian territory had reached its natural saturation, but the Czars, now emperors, still had much energy and aggressiveness. The expansion continued with such vigor that even the sale of Alaska to the United States in 1867 made no dent in the bubbling overgrowth of the Russian territory. One has to wait for Gorbachev for the downloading of the extras. Gorbachev trimmed Russian size precisely to the saturation value of the imperial logistic as defined by the 300 years of Czarist conquest.

The stimulus to comply came from the emergence of Japan as a military power. At the end of the 19th century, having absorbed western technology, Japan started rattling the saber and menacing the Russian eastern territories, and conquered big chunks of nearby Korea and China. The Czarist army reacted as well as possible, but the Japanese kept gaining territories, in particular Port Arthur, considered strategic because it was operative the year round. Russia sent its large Baltic fleet to the Sea of Japan to tame the newcomer, but Japan sank most of the Russian fleet in the Battle of Tsushima, a great victory for this new entry on the world political and military scene. The Czar then made the right decision. He ordered acceleration of the construction of the trans-Siberian military railway that would finally link Moscow to Vladivostok in just fourteen days of travel time, not only to carry orders from the center like the Persian horsemen so admired by Herodotus, but also to transport military forces. Incidentally, the cost of the railway that penetrated the Siberian wilderness approximated that borne by Russia in military support during World War 1.

Russia is now a power in search of a role. It is too large to join Europe and too small to play an imperial role. Furthermore, a low birthrate saps Russia, like Europe, by diverting the energy of the system toward maintenance of an increasingly large percentage of non-productive persons.



1300	Muscovy-Russia-USSR	0,02	0,02 Taagepera, 1997: 498
1359	Muscovy-Russia-USSR	0,05	0,05 Taagepera, 1997: 498
1360	Muscovy-Russia-USSR	0,19	0,19 Taagepera, 1997: 498
1425	Muscovy-Russia-USSR	0,43	0,43 Taagepera, 1997: 498
1474	Muscovy-Russia-USSR	0,52	0,52 Taagepera, 1997: 498
1478	Muscovy-Russia-USSR	1,24	1,24 Taagepera, 1997: 498
1487	Muscovy-Russia-USSR	1,57	1,57 Taagepera, 1997: 498
1505	Muscovy-Russia-USSR	2,50	2,50 Taagepera, 1997: 498
1584	Muscovy-Russia-USSR	5,10	5,10 Taagepera, 1997: 498
1650	Muscovy-Russia-USSR	9,70	9,70 Taagepera, 1997: 498
1689	Muscovy-Russia-USSR	14,00	14,00 Taagepera, 1997: 498
1725	Muscovy-Russia-USSR	15,00	15,00 Taagepera, 1997: 498
1796	Muscovy-Russia-USSR	15,50	15,50 Taagepera, 1997: 498
1825	Muscovy-Russia-USSR	18,40	18,40 Taagepera, 1997: 498
1840	Muscovy-Russia-USSR	19,40	19,40 Taagepera, 1997: 498
1870	Muscovy-Russia-USSR	20,50	20,50 Taagepera, 1997: 498
1895	Muscovy-Russia-USSR	22,80	22,80 Taagepera, 1997: 498
1906	Muscovy-Russia-USSR	22,50	22,50 Taagepera, 1997: 498
1921	Muscovy-Russia-USSR	21,60	21,60 Taagepera, 1997: 498
1935	Muscovy-Russia-USSR	21,80	21,80 Taagepera, 1997: 498
1945	Muscovy-Russia-USSR	22,30	22,30 Taagepera, 1997: 498
1991	Muscovy-Russia-USSR	17,10	17,10 Taagepera, 1997: 498

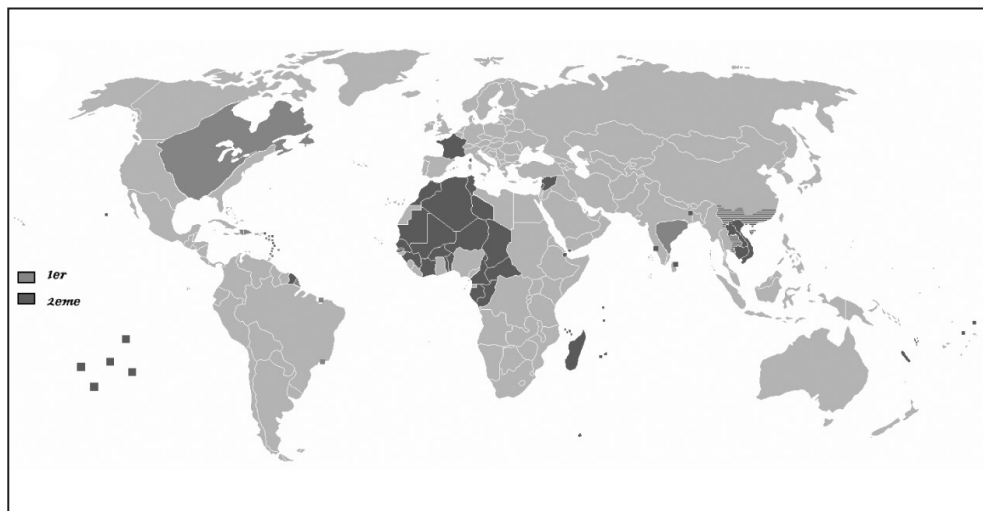


French Colonial Empire

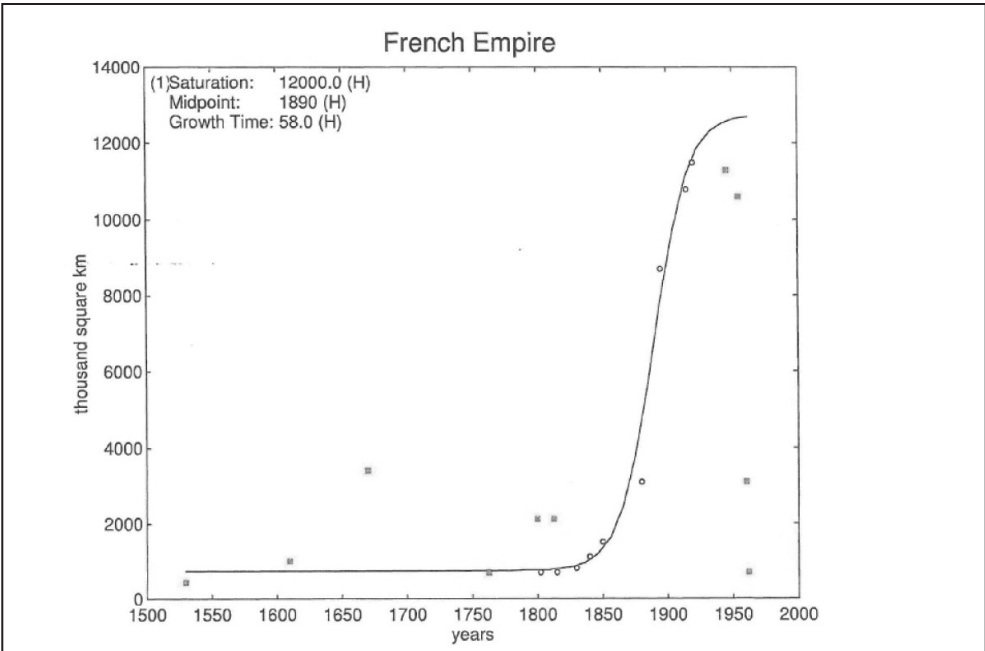
Historically France always had a tendency to expand, in Europe itself and in North America, but here we deal with the colonial empire mostly created after 1800. At that time European powers rushed to fetch bits of land here and there, mostly in Africa but also in the Far and Middle East. The rationale was power and profit, but in fact neither was evident *a posteriori*. Even with her Commonwealth, Britain went broke, and the others did not get rich. For France the largest part of the colonial empire was in Africa, north and west, acquired over about 60 years with a midpoint of 1890. The area grew with an orderliness one might associate with Prussia rather than France. In terms of maximum territory in 1945 the empire was huge, 11 million square km, comparable to the British Commonwealth.

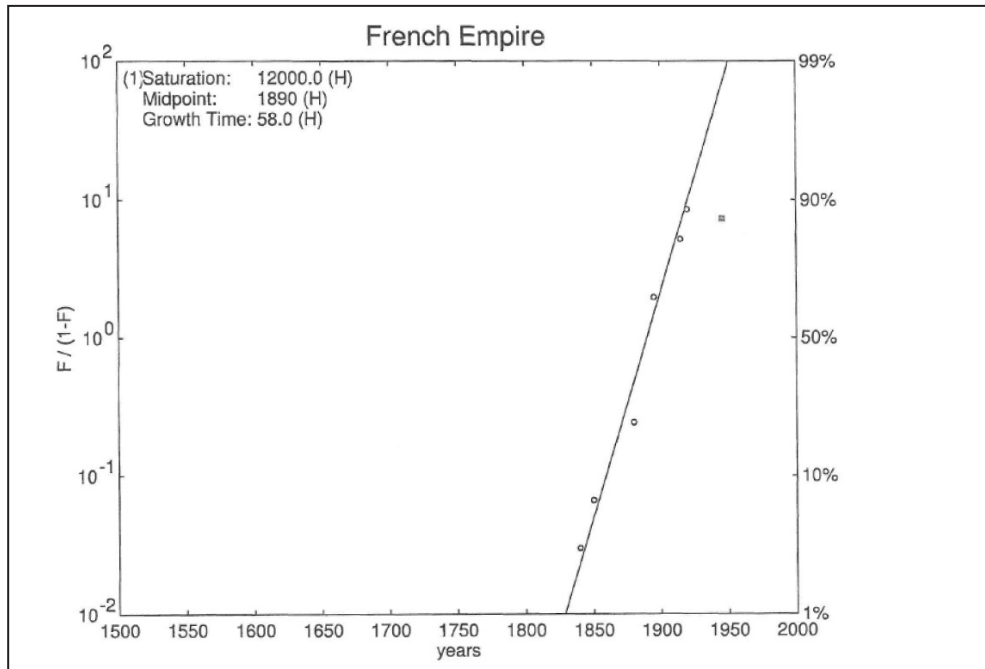
Most of the empire, especially inland, was beyond 14 days travel, even with steam ships, and consequently local administrations operated in the style of the British Commonwealth, but with more assimilation in the spirit of the French revolution. Local chiefs administered the territories, with hierarchical organization ending in a Minister of Colonies with finally tenuous influence on the local chieftains. Many areas remained poor and rebellious. As in many cases, the empire collapsed abruptly: What took about 60 years to build crumbled in about a decade.

A characteristic of the colonies was the large number of French citizens that migrated into them, especially in North Africa. These populations created big problems when finally they were expelled when the colonial territories gained independence after World War II. Altogether the French colonial adventure did not provide the gains France could expect. Our guess is that emulation and testosterone were the prime movers.



1530	France	0,45	0,45 Taagepera, 1997: 501
1610	France	1,00	1,00 Taagepera, 1997: 501
1670	France	3,40	3,40 Taagepera, 1997: 501
1763	France	0,70	0,70 Taagepera, 1997: 501
1800	France	2,10	2,10 Taagepera, 1997: 501
1803	France	0,70	0,70 Taagepera, 1997: 501
1813	France	2,10	2,10 Taagepera, 1997: 501
1815	France	0,70	0,70 Taagepera, 1997: 501
1830	France	0,80	0,80 Taagepera, 1997: 501
1840	France	1,10	1,10 Taagepera, 1997: 501
1850	France	1,50	1,50 Taagepera, 1997: 501
1880	France	3,10	3,10 Taagepera, 1997: 502
1895	France	8,70	8,70 Taagepera, 1997: 502
1915	France	10,80	10,80 Taagepera, 1997: 502
1920	France	11,50	11,50 Taagepera, 1997: 502
1946	France	11,30	11,30 Taagepera, 1997: 502
1955	France	10,60	10,60 Taagepera, 1997: 502
1960	France	3,10	3,10 Taagepera, 1997: 502
1962	France	0,70	0,70 Taagepera, 1997: 502





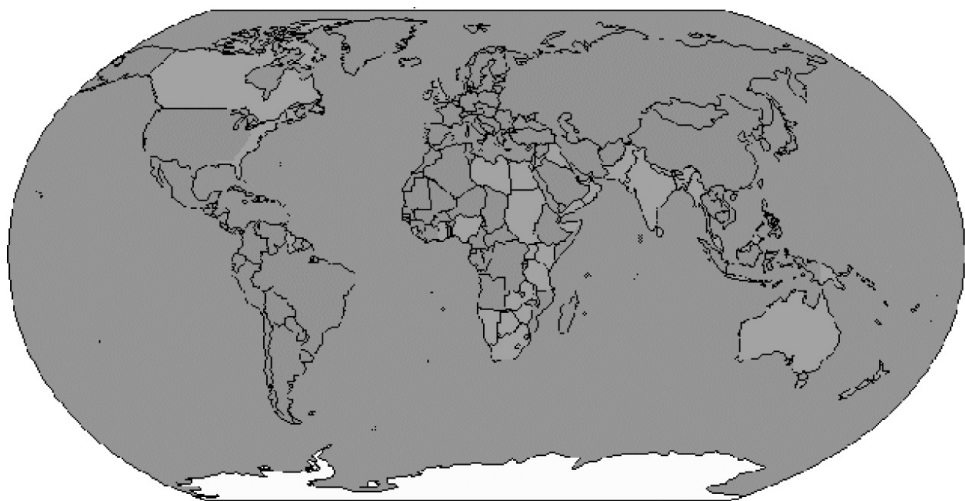
British Empire

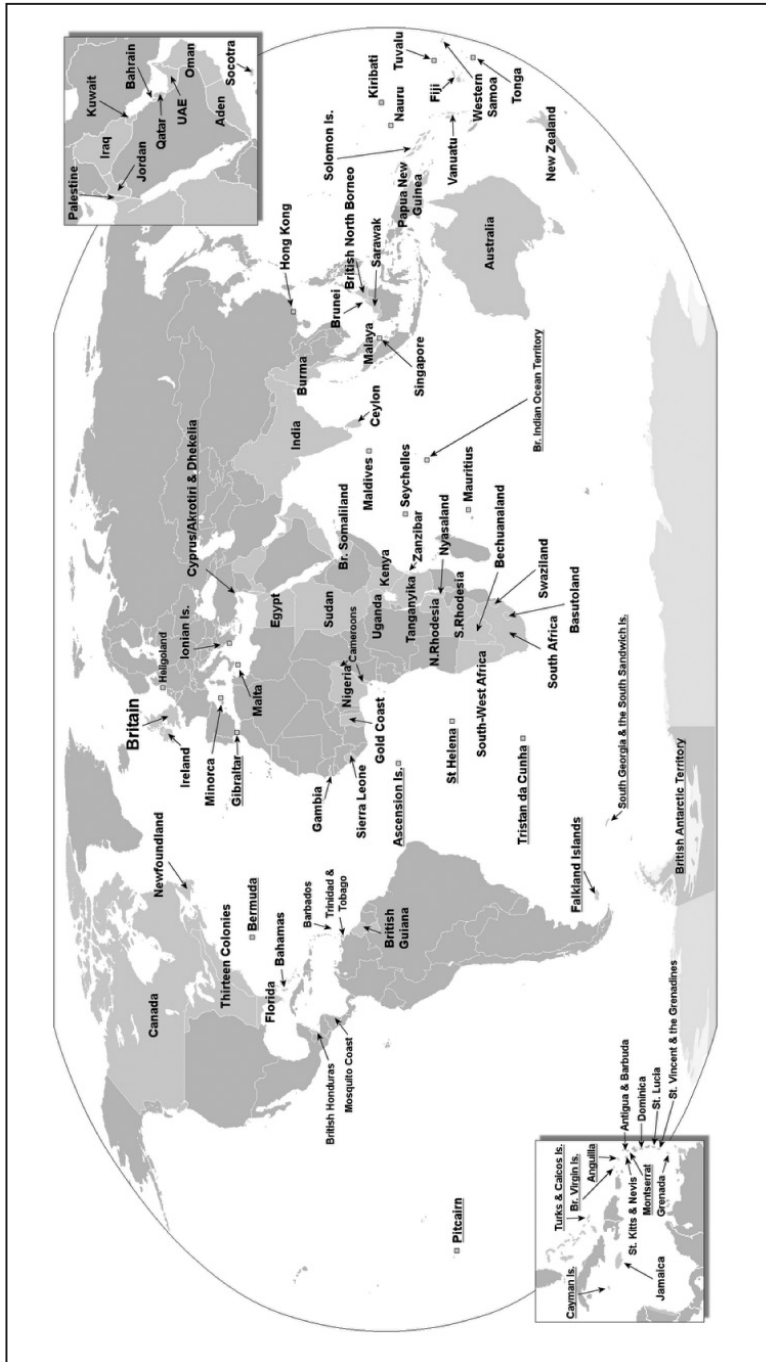
The British Empire had all the characteristics of a solid construction. Like the Roman empire, it grew slowly, had a robust administration, and patriotic drive. However, it had a basic flaw: it grew to a size ten times that of the Roman empire, with territories in various parts of the world and speeds of transportation not much faster than those of Rome. Consequently the administration had to split geographically and risk the dangers implicit in appointment of Viceroys and other forms of aggregation much weaker than a centralized command.

Britain put in place a number of rules to preserve its dominant position notwithstanding the time lags in the chain of command. According to our definitions Britain did not run an empire but was dominant in an association of countries or regions linked to Britain in a sort of league appropriately named the British Commonwealth. The communication gap was acutely felt, and the remedy was put into action as soon as technology provided it. From 1850 the telegraph connected more and more members, and finally in 1902 a single network of telegraph cables, the so-called All Red Line, linked the entire Commonwealth. The integration came too late. The two World Wars, beginning in 1914 and ending in 1945, brought on the final breakup of the Commonwealth and the substitution of the USA as the predominant world power.

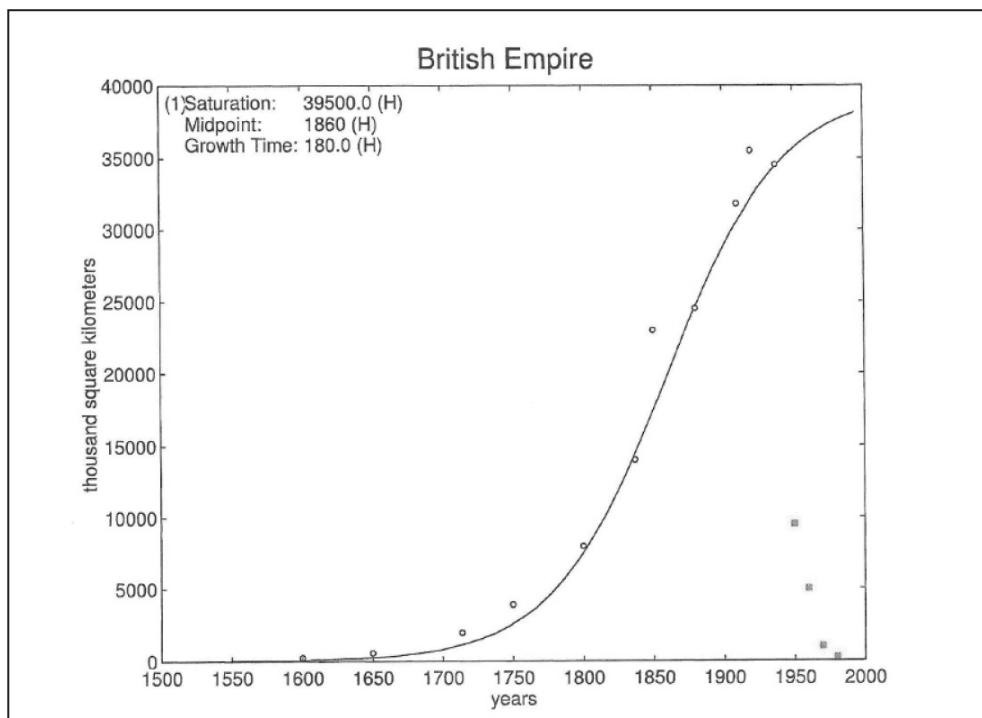
The naval fleet formed the backbone of British power, and the analysis of its evolution casts light on the internal pulse of the empire. A treasure trove of data in the Admiralty was unearthed by the research of an American historian, George Modelski. He prepared a list of the British battle ships from 1480 on, the so-called men of war, by birth and death so that we know the constitution of the fleet at any time. The number goes up and down presumably due to the extreme cost, but for long-term analysis one can use the cumulative number per year or cumulative cost. The result is a line that can be split in a sum of seven logistic equations as reported in the chart of British Warships.

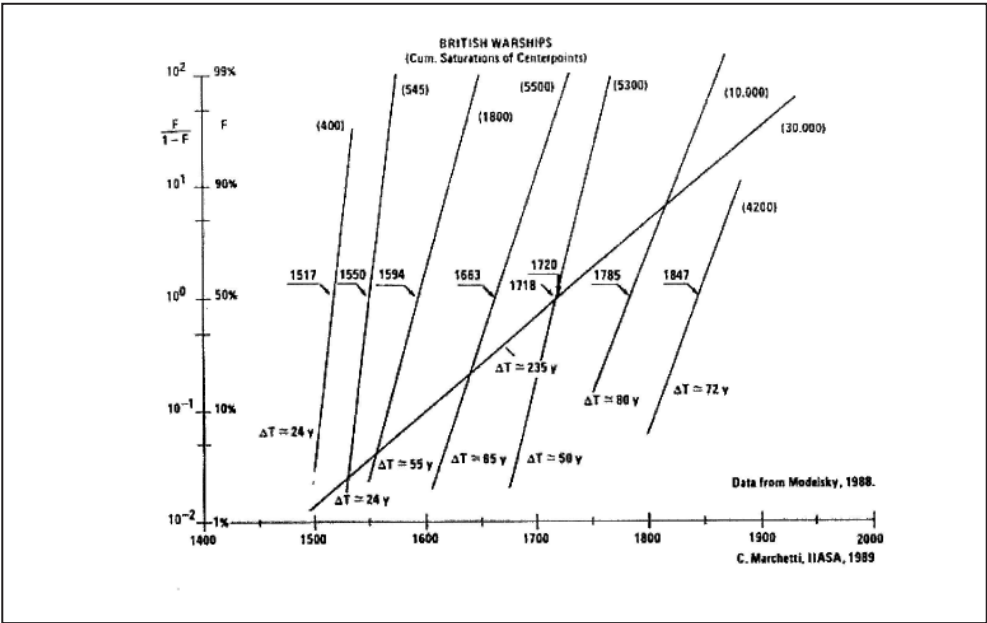
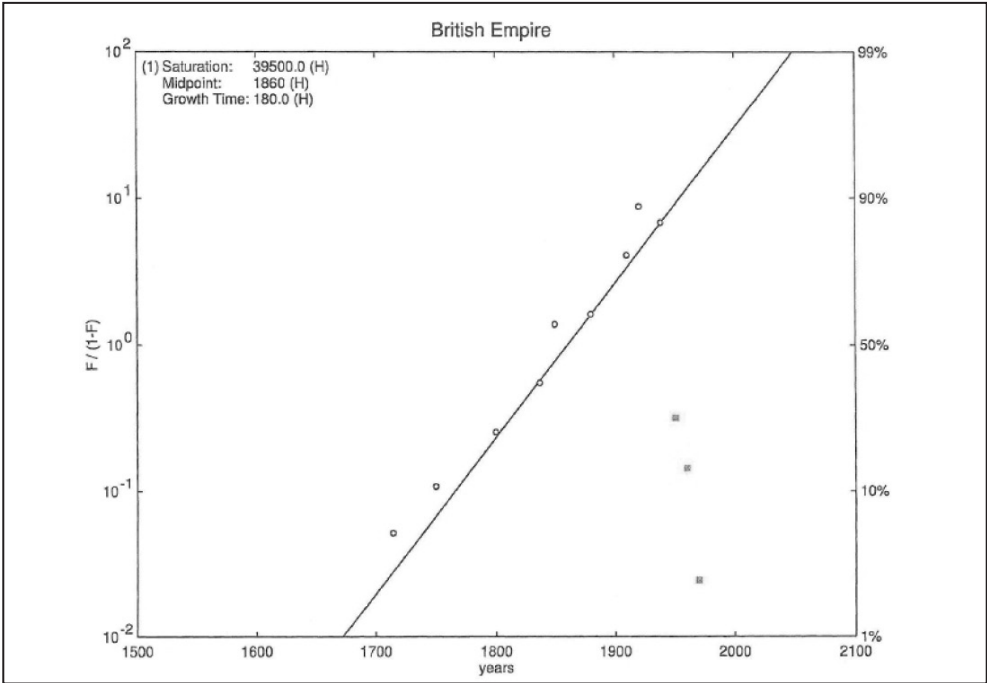
The search for a general outline of the history of the British fleet succeeded when the saturation levels of the various curves, i.e., the total number of ship-years in the curve, were put on the center date, the inflection point, of each curve. A logistic fitting of the seven center points loaded with the respective ship-years provides a single logistic that covers the 500 years (from 1% of the process to 99%) and fits snugly. The midpoint of the British Navy from this perspective was about 1720, when the Royal Marines beheaded Blackbeard, the most infamous pirate of the Caribbean. More remarkably, the logistic saturates around 1940-1950, a good date for defining the end of the naval dominance of Britain and the empire based on this dominance. This point could have been calculated 100 years before and betrays the undercover automatic mechanisms of human affairs. It also underlines the potential the mechanisms provide for long-term forecasting when appropriate observations are recorded.

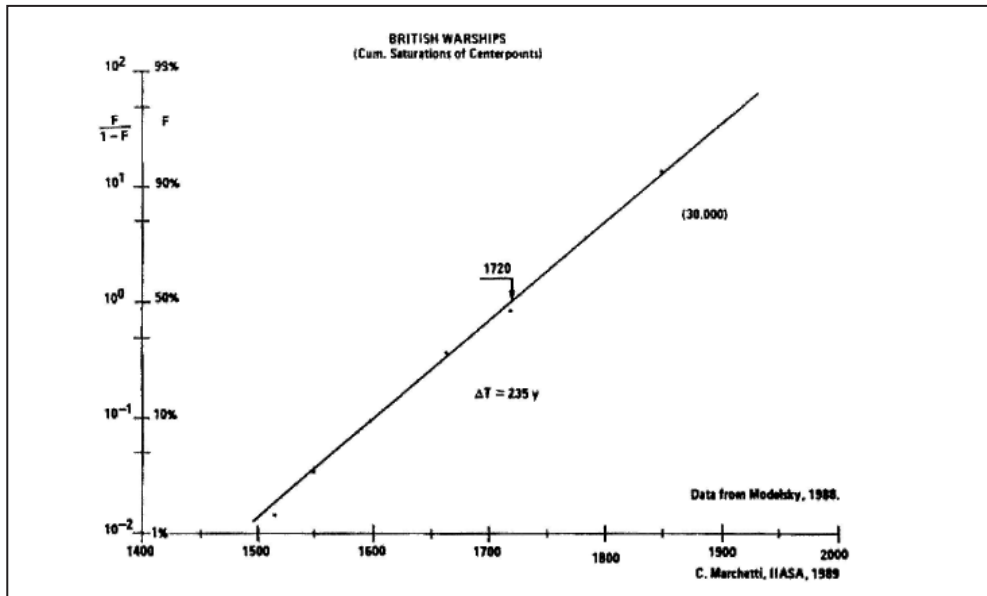




1600	Britain	0,30	0,30 Taagepera, 1997: 502
1650	Britain	0,60	0,60 Taagepera, 1997: 502
1714	Britain	2,00	2,00 Taagepera, 1997: 502
1750	Britain	3,90	3,90 Taagepera, 1997: 502
1800	Britain	8,00	8,00 Taagepera, 1997: 502
1837	Britain	14,00	14,00 Taagepera, 1997: 502
1850	Britain	23,00	23,00 Taagepera, 1997: 502
1880	Britain	24,50	24,50 Taagepera, 1997: 502
1910	Britain	31,80	31,80 Taagepera, 1997: 502
1920	Britain	35,50	35,50 Taagepera, 1997: 502
1936	Britain	34,50	34,50 Taagepera, 1997: 502
1950	Britain	9,50	9,50 Taagepera, 1997: 502
1960	Britain	5,00	5,00 Taagepera, 1997: 502
1970	Britain	1,00	1,00 Taagepera, 1997: 502
1980	Britain	0,30	0,30 Taagepera, 1997: 502







USA Empire

We first look at the USA in our now familiar way, growing as an S-curve within North America, and the fit is beautiful, with a midpoint of 1820, growth time of 105 years, and saturation around 10,000 square km, sustainable with the intercontinental railroads that diffused throughout the territory.

But let us take now take a look at the USA as a global empire as well. World visions tend to persist in individual cultures. When the Europeans arrived in North America, it was already settled by an indigenous population, not dense but numerous enough to fill the territory and ready to defend it. Thus, from the very beginning, penetration involved entry into hostile territory. A key idea for occupying a hostile region with a limited force was the fort, the equivalent of the medieval castle, with a military garrison inside and a fortified wall of defense. The idea succeeded in terms of keeping the Indians in check and protecting the penetration of European populations. When the United States started vigorously expanding outside North America in the 1940's, this basic idea remained the same. The forts became military bases with similar functions. For reasons unrelated to military conquest certain territories that came under the control of the USA, for example, the Philippines, were eventually given their independence, although they permitted establishment of USA bases on their territory or nearby.

Consequently, instead of taking territory as proxy of USA global imperial expansion, we used the number of military bases publicly reported by the US Department of Defense. The overall S-curve in the upper panel is most accurately viewed as the sum of

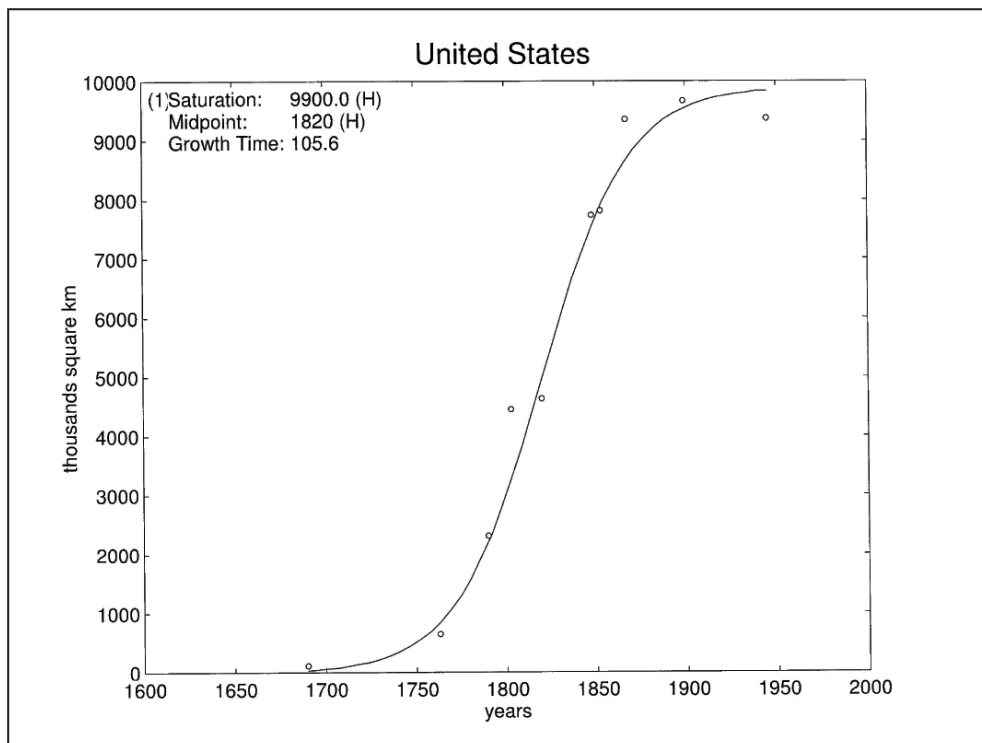
two logistics shown in the lower panel. The first logistic has a time constant of 140 years and involves 150 bases, while the second is an 8-year flash involving 85 bases. Both have the year 1940 as midpoint.

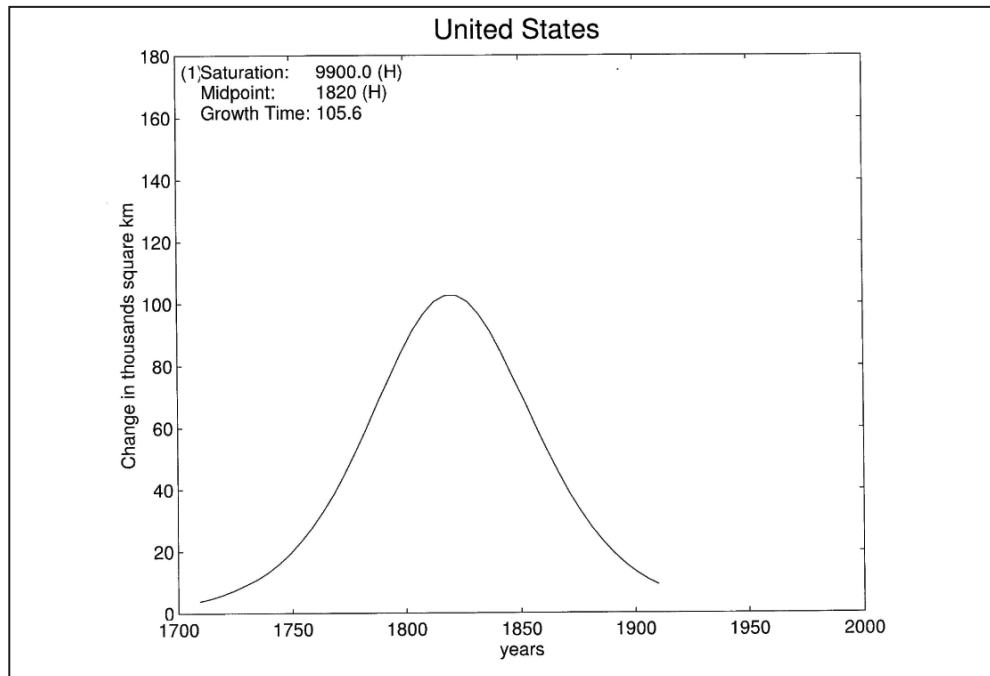
Top powers always dream of becoming #1. According to a theory of long cycles in world history, associated with the Russian economist Nikolai Kondratiev and described by Modelski, basically every 50-55 years contenders struggle, more or less directly and violently, for the crown. Britain, #1 at the beginning of World War I, was already declining, but still #1 at the end of that war. Although Britain favored the USA as successor, USA readiness was not 100%, and the war ended without a clear candidate for the succession. We interpret the intricate events taking place between the two World Wars as a long truce to gain energy for the decisive run at the conclusion of World War II. As Winston Churchill and some others have done, the entire period 1914-1945 could be more precisely described as a single 30-year war.

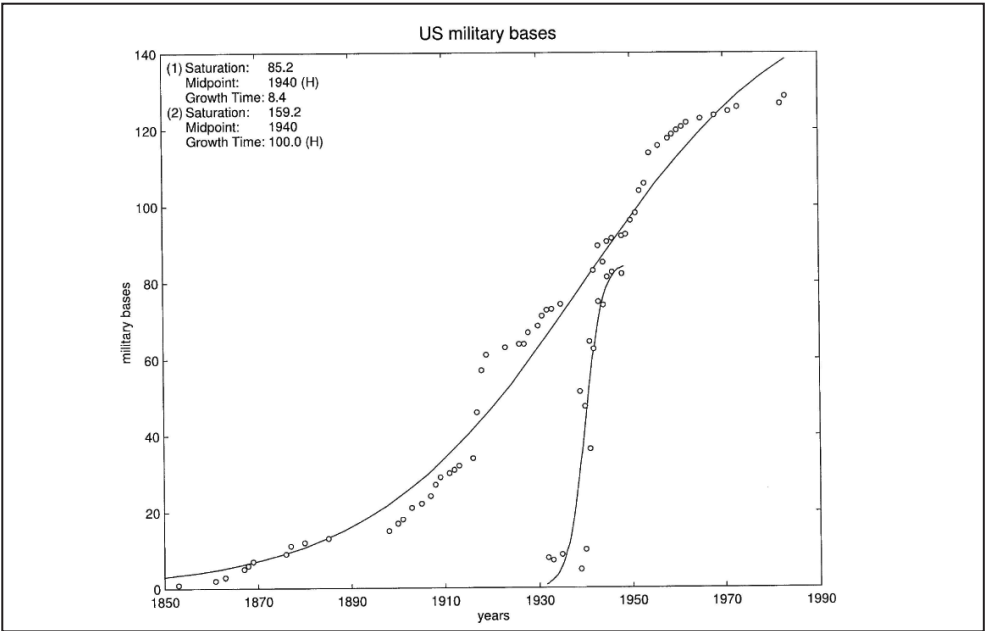
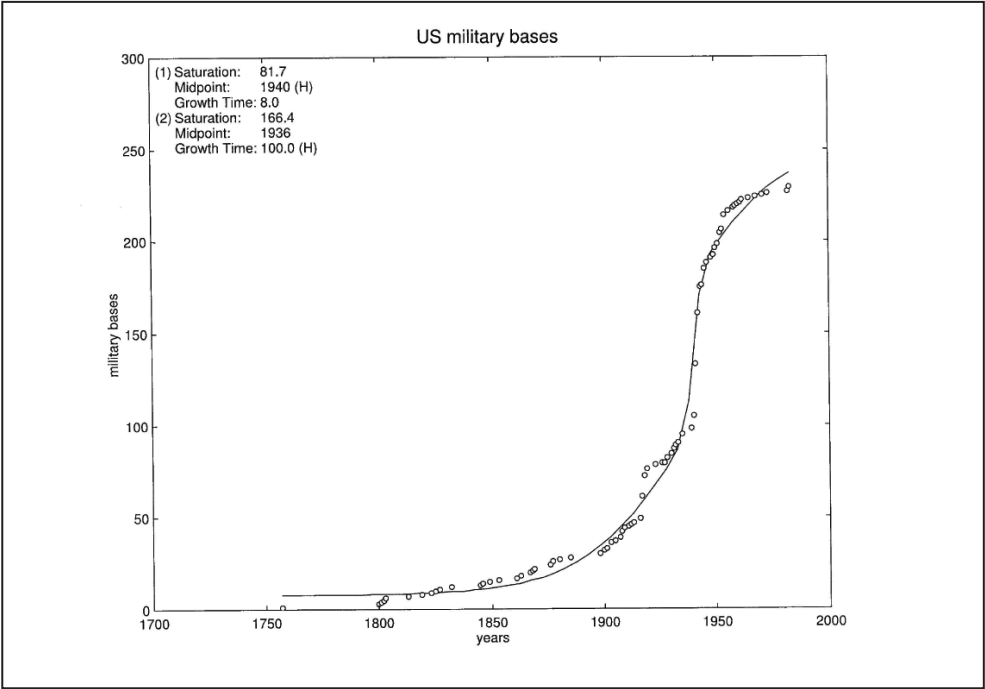
The explosion in the number of bases starting from 1930 clearly indicates that the USA was taking seriously the task of becoming world political power #1, and it fought World War II with no holds barred, just as a future dominating power should. The flex in 1940 signals maximum power drive, not incidentally coincident for the two logistics.

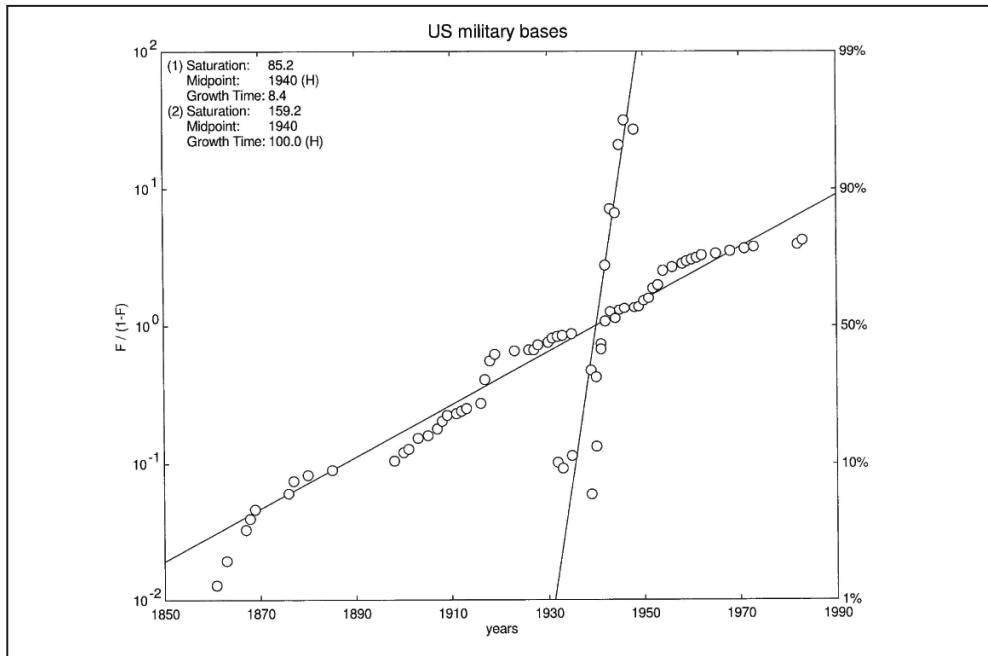


1690	USA	0,11+/-0,02	0,09	0,13	0,11 Taagepera, 1997: 501
1763	USA	0,65			0,65 Taagepera, 1997: 501
1790	USA	2,31			2,31 Taagepera, 1997: 501
1803	USA	4,46			4,46 Taagepera, 1997: 501
1820	USA	4,64			4,64 Taagepera, 1997: 501
1848	USA	7,75			7,75 Taagepera, 1997: 501
1853	USA	7,83			7,83 Taagepera, 1997: 501
1867	USA	9,36			9,36 Taagepera, 1997: 501
1899	USA	9,67			9,67 Taagepera, 1997: 501
1945	USA	9,37			9,37 Taagepera, 1997: 501









European Empire

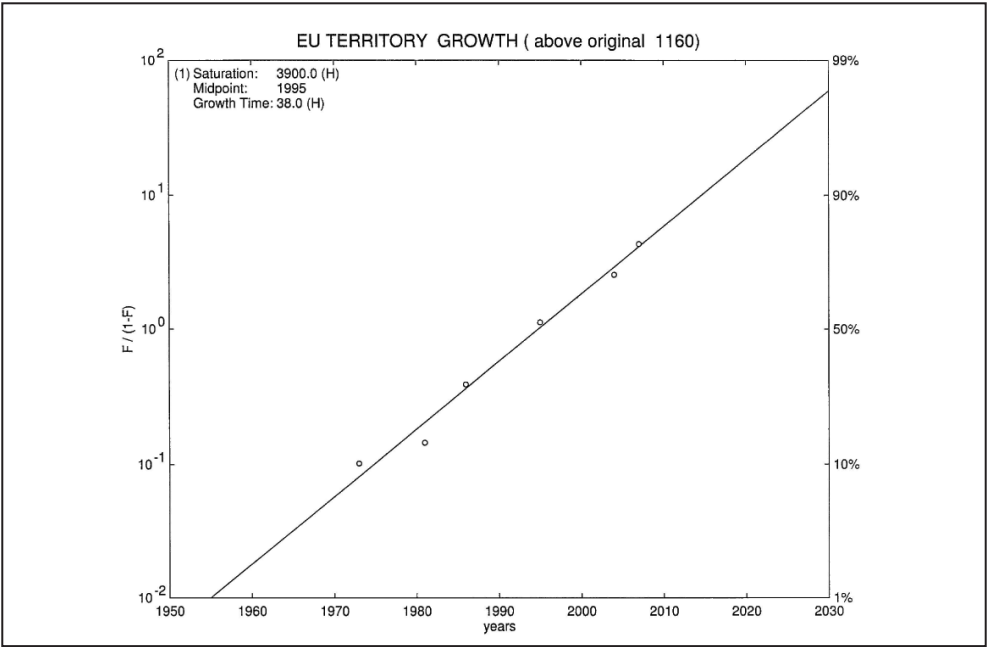
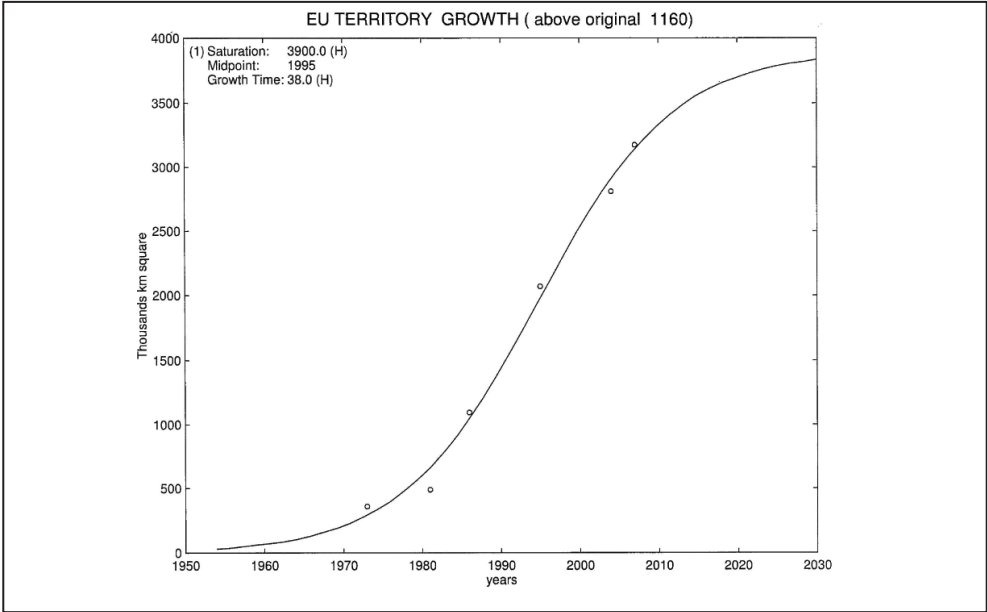
After World War II, a strong movement for unification of the European states that for centuries had fought among themselves, almost to the point of destroying each other, started in a primitive format reminiscent of the German customs union or *Zollverein* that prefigured the unification of Germany. A core block of states, Belgium, France, Italy, Luxembourg, the Netherlands, and West Germany initially created by treaty a steel and coal community to which progressively others states could be added. This original core grew in functional scope and numbers and now comprises 27 member states and an area of about 5 million square km, roughly the size of the Roman empire, and a population of a half billion people, less than either China or India, but more than the USA.

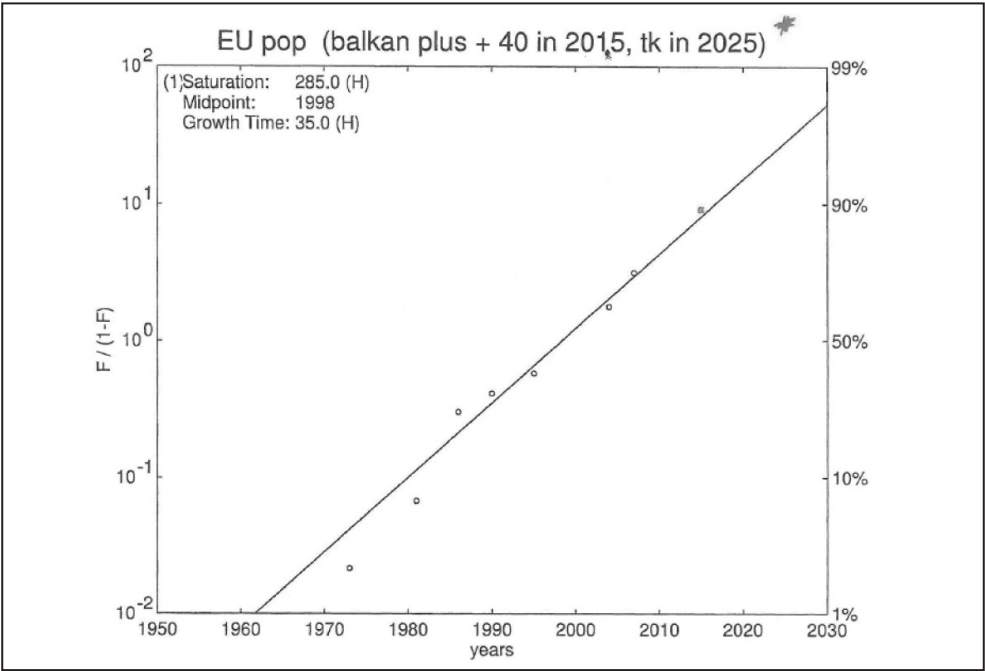
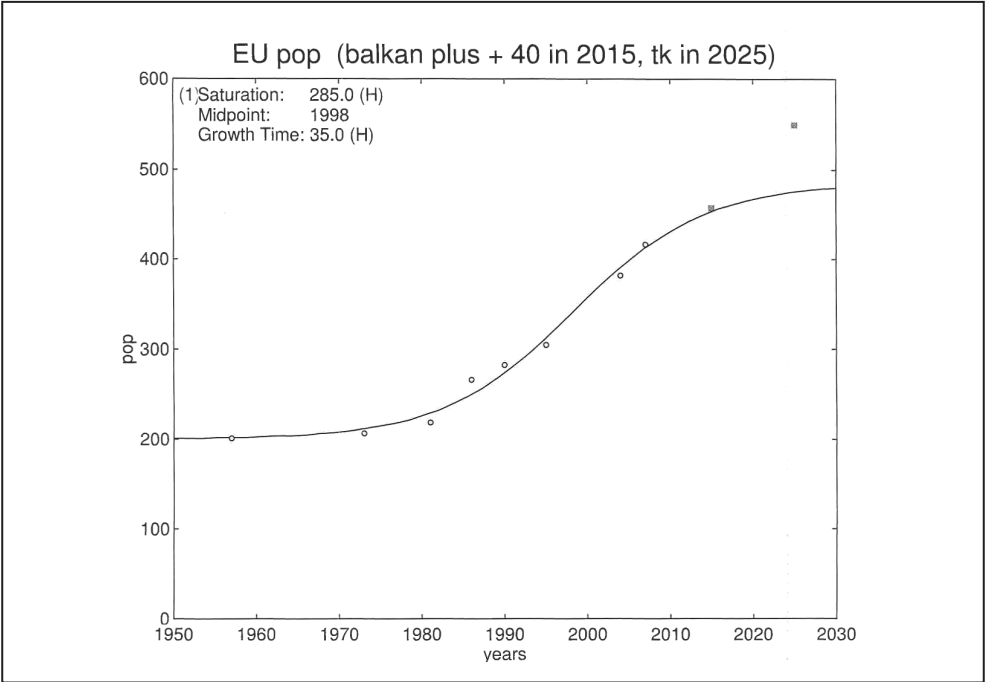
More than 50 years after the signing of the original treaty, Europe cannot be compared to a state or any form of empire, given the fragmentation within its power system. But the population of half a billion, in many ways interconnected, fits the mechanisms of an empire. Progress has been made in unifying finance and realizing free trade, especially through the introduction of the Euro, but the armed forces, powerful or at least expensive if viewed synoptically, remain fragmented. The European military costs around 200 trillion Euros per year, second only to that of the USA, 450 trillion, but notwithstanding the many collaboration agreements, the various national armies are still very much on the scene.

With the partial exception of the Balkans, the European Union involves no conquest in the military sense, just seduction, to join. Thus, the rate of agglomeration of the various countries may follow any rule. We tested the logistics of empires in terms of territorial expansion on the European community, and the final figures show it works. Moreover, once the last small fragments of the Balkans and Norway have joined, the saturation point will be near. We repeat the exercise using population instead of land area, and the result is practically the same.

Importantly, the fit for saturation excludes Turkey. The goodness of fit may mean that Turkey with its large territory and large population may not have the chance to enter Europe, a notable result as the entry of Turkey is a much debated problem with many ifs. The result, however, is not a proof; on various occasions empires and their testosterone leaders overshot the calculated saturation level, although usually with a more or less rapid adjustment for the deviation. Earlier we showed the example of the Soviet Union that due to the greed of the communist party incorporated a number of states beyond the saturation line of Czarist logistics. When Gorbachev reset the game, several states were released, and the land area of Russia once again became exactly that of the saturation level at the time of the Czars.







Conclusions and Speculations

The tour of twenty empires gives us confidence in a firm anthropological basis of empires. Over almost three thousand years monthly reassertion of social hierarchy has driven and limited empires. If we looked at Assyrians, Egyptians, Japanese, and Germans, we expect they would fit too. Basically, progesterone and testosterone make history, including empires.

Accordingly, we are willing to speculate about the future. By the rules of the Kondratiev cycles, a new #1 challenger should have appeared in 1914 +54 years or in 1968, and in fact Russia presented itself as a pretender for the throne. The presence of tens of thousands of atomic weapons on each side discouraged direct confrontation, but a bitter war that actually produced millions of casualties was fought by proxy. Assuming that the Kondratiev cycle remains valid, the next competition should take place around 1968 +54 years or in 2022. This date is a general reference position; a stronger conviction about timing requires specific indicators.

One such indicator may come from the fact that world power #1 often ends by going broke. Being #1 cures pride and brings benefits of various kinds, but ultimately it is extremely expensive. The previous #1, Great Britain, toward the end used much of the taxes raised to service its debt. The USA may find itself in a similar position in the next twenty years. Another sign is reinvigorated interest and loud grumbling of nations where, or near, the bases of the #1 power. If bases start being evacuated, the end is usually in sight. Also the formation of a possible new #1 starts evolving when the possibility of a changeover is perceived.

Europe is a rich political entity with great technological and industrial skills that could be material in the next resetting of the world power system. However, Europe's weak demography makes the long-term outlook hazy. Russia and Japan suffer similarly from few testosterone youth.

Meanwhile, both China and India are rethinking their military power. The occupation of Tibet and the construction of a military railway into Tibet indicate foresight. Throwing dice, we see China more powerful, but its demography is also very leaky, and India would more likely receive USA support. However, the inevitable solution for the successor to the USA empire might be a global solution, with the rule of a supranational organization, the Holy Roman Empire serving as a conceptual archetype. However, the political system is slow and does not appear to focus in that direction, the troubled unification of Europe being a sad example. Thus, we may eventually witness a confrontation between China or India, on one side, and the USA allied with Britain (as in the two World Wars), on the other. The USA empire has points of contact with the British in terms of exercising power not by direct administration, but through a network of military points of strength, the military bases, to show its presence in important parts of the world, an evolution of the habit used in taking possession of the USA of peppering the continent with forts and garrisons.

Nevertheless, because airplanes can go anywhere in one day, the global empire is now technically possible. In fact, multinational companies can be considered de facto global empires, in some cases more powerful than small and even middle-sized countries. Thanks to their global reach they can escape political control, a serious problem awaiting solution. For the moment the political system tries to solve the fiscal aspects and some of the environmental. A fully functional UN with an independent army that exercises global power seems beyond reach, still a dream or a nightmare, depending on point of view. Conquering the world piece by piece the old way remains technically impossible, as certain showpiece local wars have well demonstrated. Whatever empire dominates the next phase of world history, its leaders will meet monthly.

ACKNOWLEDGEMENTS — This work was supported by OSD Studies division project Control of Historical and Natural Systems Explored with a Darwinian Logic, contract HQ0034-100C-0034. Taagepera datasets are available at: irows.ucr.edu/research/citemp/data/empsizes.xls

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