Social Behaviors of Modern and Indigenous Peoples Impacting the Ecology of the Amazon Rain Forest in Brazil

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Abstract

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Human induced disruption of the environment is prevalent in every culture. In Brazil, the effects of massive deforestation have become apparent since the nineteen eighties. However, along with deforestation, and a coinciding loss in an economic resource for the country, is a significant loss of natural habitat and species extinction. The Amazon in Brazil contains a large proportion of the world's species diversity that is threatened by the socio-economic activities of modern Brazilian culture. Historically and presently, indigenous groups have contributed to insignificant levels of ecological disruption and are themselves threatened by the activities of modern Brazilians. The effects of ecological disruption range from shifting climate patterns, degradation of soils, loss of floral and faunal species, displacement of indigenous cultures, and the loss of many unknown resources. The preservation of this unique environment is vital to the continued viability of the region.

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Introduction

The world consists of a diverse set of complex systems. All systems are important in regulating and balancing the others. A complex system, like the Earth, has experienced three point seven billion years with life adapting to various climatic, geologic, solar, and chemical shifts. Through these shifts life has thrived, died, and thrived again. These events have been driven by volcanic emissions, plate tectonics, asteroid and comet impacts, solar fluctuations, and the influence of life on atmospheric composition.

In the face of these climatic events a mechanism has naturally been developed by life allowing for survival on this planet; this mechanism is diversity. Great biological diversity has created the abundance of life allowing for at least a percentage to survive through cataclysms in the past. The most recent mass extinction occurred approximately sixty-five million years ago at the Cretaceous-Tertiary boundary. This resulted in the loss of sixty-three percent of marine life and eighteen percent of land vertebrates. The worst mass extinction was at the Permian-Triassic boundary approximately two hundred fifty-one million years ago. This event led to the extinction of ninety-five percent of Earth's marine and terrestrial life. Extinctions have occurred globally since life began on earth. The influence of man has led to extinctions as well, but not to a comparable magnitude as the history of the world has shown us. For all of life on earth now, ninety-nine percent of species have come and gone before the time of man.

These facts about mass extinctions should not be used to compare and trivialize the effect mankind has had on the planet. Certainly the human species has developed

into a significant force of change in affecting the ecological systems present on the Earth. Mankind as a geologic force now moves more sand, silt, and gravel per annum than do all the natural erosional and sediment transport mechanisms existing today. Dams constructed in river valleys block and store more water than in all the free flowing rivers of the planet. These have been some of our greatest cultural achievements as a species, but they are accompanied by negative impacts. The human race has done a thorough job of conquering, altering, and destroying ecosystems to meet their needs.

A characteristic unique to human beings is a natural born desire compelling us to force the world to change rather than to chance our fate by adapting our needs to the offerings of the Earth's natural systems. This is unique in the sense that all other organisms on Earth find a balance between their populations and the resources present in the environment. The human desire to alter and control has resulted in the countless loss of numerous species of plants and animals across the millennia. Survival, meaning the actions taken to ensure propagation of one's genetic material, is supported by Charles Darwin's theory "survival of the fittest." His theory supports the survival concept in that the most genetically fit, the most capable of surviving, will find the means to adapt to changing environmental conditions. All species have a desire to survive, yet *Homo sapiens* have developed the mental faculty to survive and propagate their populations more effectively.

However, it seems we have reached a critical point in our evolution. The social and cultural norms we have utilized to become as successful as we have been are out of date. If we continue in the manner we have, there will be little left for our progeny to live on. We are now facing a situation in which there are too many of us, and too few

resources, to allow every member of our species to live as affluently as the most modern and most successful. However, as our species has advanced and grown in technological sophistication, we have gained greater control over our environment, and greater power with which to destroy it. There is a fine line between knowing how to utilize power gifted to you, and knowing too little about destroying oneself with that power.

The last ten millennia have seen the rise and fall of sixteen great empires. The rise of these great states was built upon the resources their environment had to offer. Their fall was a direct consequence of their abuse of power and mismanagement of resources. These empires fell primarily to ecological destruction on their own behalf, and usually not to outside forcings. This is not to say natural oscillations in the Earth's climate never had an effect on the success or fail of a state, but the main point is that these states still did not adapt to the conditions they created or experienced, they lived beyond their means. Each of these great empires was greater than the last, and each one made the same mistakes but with greater power. As we come into the modern age, wielding terrific power and technology within our society, we are faced with ever increasing costs to the environment through abuse.

Every human population in the modern world is living with the same biological requirements of survival as all other human beings before us. Each individual is attempting to maximize one's own worth in the society even beyond what is necessary to survive. To correlate the trends apparent in human behaviors and to show they are nearly identical today as they were in the past, a certain understanding of modern and pre-modern societies is necessary. However, due to the expansion of our particular

society, the assimilation of competing and less advanced cultures, and the propagation of modern technologies and social values, it is becoming increasingly difficult to identify social values and cultural norms of “pre-modern” peoples. One such geographical location in which a good comparison can be made is in the Amazon rainforest of Brazil. Here there are at least a few surviving indigenous tribes living in nearly the same manner as they have for thousands of years. Also there is a modern society that lays claim to the territory of Brazil and nearly everything within its borders. One aspect to take note of is that while a member of the Brazilian government might consider everyone living in the territory of Brazil as a Brazilian, not everyone living in Brazil would consider themselves as such. Therefore we see a contrast in the perceptions and perspectives of the people living in a common region, with greatly differing social values, technologies, and exposure to the modern world. This contrast can be used to formulate a model for understanding human behaviors and how those behaviors affect the environment.

Long before any European vessels sailed the shores of South America there have been people living within its forests and on its mountains. The people indigenous to South America can all nearly be traced back to a modern ancestor that walked the Bering Land Bridge into the Americas as recently as 15,000 B.C.E. This was during the end of the last ice age when glaciers were retreating due to atmospheric warming at the end of the Pleistocene. This transition marks the start of the Holocene, and the first period in which *Homo sapiens* occupied every landmass on Earth save Antarctica. These pre-modern peoples altered their environment to suit their cultural and survival needs, yet their populations were not of such a magnitude as to do any lasting harm to

the local ecology. Devastating ecological impacts in the Americas coincided with the great empires of the Aztec, Inca, and the Maya. Two of those three states are included in the list of historical societies that destroyed themselves through ecological abuse. Of these three, only one rose to significance in South America before its untimely destruction at the hands of Spanish steel and disease.

The Incan empire was the only society in South America to develop into a state level society. States establish social complexities such as social stratification, centralized government, professional armies, and full-time religious figures. With the Incan empire being the only state level society on the continent, we can look into the heart of the Amazon in Brazil to find good examples of pre-modern societies that do not function in a similar manner to our modern states. These indigenous populations are descendents of the people that settled the continent. Their way of life, save for how the particular resources present in their environment affect their culture, should be nearly identical to the way those people of antiquity lived thousands of years before when there were no great states. Thus we can use the indigenous cultures of Brazil for the basis of comparison with the human behaviors presently operating in the modern Brazilian culture. This comparison will be used to examine how the indigenous and modern populations of Brazil are affecting the ecology of the Amazon rain forest and the relative consequences of their environmental relationships.

Ecology of the Amazon in Brazil

Brazil is located on the North Eastern half of the South American continent and is the largest country in the southern hemisphere. This territory is the largest political body in South America and covers roughly eight and a half million square kilometers, larger than Australia and smaller than the United States (Figure 1). In Brazil, there are five hundred fifty seven million hectares of rain forest, the largest in the world. This equates to a region over five and a half million square kilometers in size approximately sixty-five percent of Brazil's land area. Tropical regions are biologically rich, forming an impressively resilient ecosystem and are considered the most ecologically diverse terrestrial biomes (Moran, "Development" 3). In any given hectare of tropical rainforest there is approximately forty to one hundred tree species, whereas temperate forest areas may only have around ten to thirty different types. This significant contrast in species diversity is also found in animal, bacterial, insect, and plant populations (McKinney, Schoch, and Yonavjak 72).

The majority of the tropical rain forest in the Amazon is at a late seral stage, with most of the environmental nutrients contained as organic matter in vegetation and wildlife with a low level of nutrients remaining in the soil. Nutrients are absorbed quickly by fast growing plants in competition with one another, and any fallen or dead plant material is quickly decomposed by bacteria and insects (McKinney, Schoch, and Yonavjak 104). This climax stage of ecological development is associated with high diversity and high stability (Preston). These late stages are additionally characterized by low productivity and a large weight of biomass (McKinney, Schoch, and Yonavjak 75). The fundamental nature of ecosystems is to progress to higher seral levels thus

granting them resilience to climate fluctuations or invasive species of insect, fungi, or bacteria. Whatever natural global or regional event that may befall an ecosystem in a late stage of development it is likely that there will be continued functionality and survival of species within the region. However, depending on the severity of the event forcing ecological disruption, there may be a significant period of time, up to hundreds if not thousands of years, for the ecology in a disrupted environment to regain its former diversity (Preston). However, tropical rain forests have shown a characteristic, unique only to them, within eight to ten years they can achieve ninety percent of their maximum biomass after forest clearing (Moran, "Development" 24).

The high productivity of species and their fantastic biodiversity in the Amazon can be explained by two global features; seasonal consistency and a long period of isolation without environmental disruption. The tropics maintain fairly constant temperatures, around twenty-five degrees Celsius with daily and seasonal fluctuations varying approximately five degrees Celsius. Annual rainfall ranges from two hundred to four hundred fifty centimeters (McKinney, Schoch, and Yonavjak 103-104). Relative humidity ranges from seventy-five to one hundred percent. These mild climatic fluctuations are the result of direct and nearly continuous incoming solar radiation. The sun provides the greatest amount of energy at the equator and a considerable amount between the Tropic of Cancer and the Tropic of Capricorn. According to Moran, "the area receives two point five times more solar radiation than the poles ("Development" 24)." Equatorial terrestrial regions support the growth of tropical rain forests for the main reason that there is the greatest amount of energy available for photosynthesis. This provides for year round seasonal stability of climatic features.

The Amazon rain forest has been an evolving and highly productive region of the planet for thousands of years. This region was relatively unaffected by the advancing ice sheets that scoured away ecosystems during the Pleistocene and was able to continue on an evolutionary path with little large scale disruption. This geographical and latitudinal isolation combined with seasonal stability created a system where a whole host of diverse organisms could compete and evolve in a relatively stable ecosystem (Figure 2). As evidenced by McKinney, Schoch, and Yonavjak, "In most ecosystems, there is a strong correlation between the diversity of plant species and the diversity of animal species…," showing that there is a rich animal population coinciding with this region of abundant plant life.

Where there is an abundance of plant life there also will be abundant animals and insects. Interspecies competition would have necessitated evolutionary traits within populations to adapt to utilizing different plant resources for survival. In a region with such great plant diversity, it would have been evolutionarily simpler to adapt to a new resource not being exploited by another species than to continue competing for a certain resource. Evolution granted survival to species that found their niche within an ecological community and exploited it. The abundance of species diversity in rain forests worldwide is estimated at fifty percent of the world total. To emphasize the ecological importance of tropical rain forests, this high percentage of species is located in an area totaling seven percent of the Earth's surface (McKinney, Schoch, and Yonavjak 290). However, according to Preston, since deforestation has escalated within the last three decades, this abundant number of species is located in a region now totaling only three and a half percent of the Earth's surface.

Estimates of species diversity in the Amazon are hindered by the shear vastness of the region. Comprehensive studies are lacking, but scientists have begun to get some basic ideas about the species diversity in tropical rain forests. There are two fundamental types of populations to identify, the floral populations and the faunal populations. Both of these consist as part of the total diversity present in the Amazon (Figure 3). It is important to note that all figures are estimates and true numbers are unknown. According to Moran, however, "the clear trend has been to increase earlier estimates of species diversity" ("Development" 27). This statement means that for whatever figures we may calculate, it is safe to say there are many species not included in the calculation.

When one examines the tropical rain forests of the Amazon the most prominent feature is the floral populations. Upon inspection it can be noted that there is a terrific array of species with very few individuals of a species present in any given hectare (Moran, "Development" 27). An excerpt from Moran states,

> Research on species diversity suggests that sample plot size is a significant factor in predicting species diversity. Whereas samples in one hectare plots yielded sixty to seventy-nine species in the Amazon, the number of species is more than ninety in one point five hectares, one hundred seventy-three with two hectares, and continues to increase. Studies are too limited in number to predict at what plot size the diversity of species identified levels off ("Development" 27-28).

Rain forests develop into complex multi-layered ecosystems defined by three distinct levels. The canopy is the uppermost level and the forest floor forms the lowest

level. Each level contains floral and faunal species specifically adapted to survive in that tier. The uppermost level is suited for direct sunlight and contains species that are tall enough to form the canopy or are suited to live within the canopy to gain access to direct sunlight. Middle and forest floor level species are adapted to low-light conditions and have evolved dark green pigmented chlorophylls and broad leafs for maximum light absorption (McKinney, Schoch, and Yonavjak 104). The uppermost layers can reach a height of ninety meters, though this is the maximum extent. Trees are characterized as having thin trunks and thin bark, with relatively small crowns near the top (Figure 3). Most vegetation lacks deep roots, with sixty-five to eighty percent of species achieving a root depth in the topsoil of up to thirty centimeters; the remainder can achieve deeper soil depths (Moran, "Development" 25). An advantage of biodiversity is that floral stands tend to be relatively isolated from other stands or individuals which promote species survival against invasive pests or disease. This relative isolation seems to be a contributing factor to the presence of diversity in that if a particular region is affected by blight, other populations of the same species will remain unaffected due to their separation by other plant species (Fearnside 40-41).

Amongst the vegetation, and in coevolution with the rest of the ecosystem, are active populations of faunal species. As noted previously, there can be just as many types of animals and insects as there are plants to feed and harbor them. However, there presence is somewhat insignificant in the total allocation of biomass present in the tropical rain forest (Moran, "Development" 29). Still, they are an integral part of the ecosystem. They do not amount to any significant threat to the vegetation as their populations in comparison to plants is dwarfed. It has been reported that in any given

hectare of the *terra firme* region, to be discussed below, there is over nine hundred metric tons of floral biomass for every zero point two tons of faunal species (Moran, "Development" 29-30). Even though they live upon what is provided by the environment, whatever may be consumed is ultimately returned to the cycle of vegetative growth either through excrement or bodily decay in death. The considerable diversity of faunal species is directly linked to the diversity of floral species, and explains why there is such faunal diversity. Supporting this is data reflecting that faunal species show minimal overlap in resource niches, thus producing exceptional ecospecialists. Many faunal species have also developed a mutualistic relationship with plant species that proves beneficial to the entire ecosystem by increased interaction and development (Moran, "Development" 30). One such relationship is characterized by large and diverse communities of faunal and litter populations that provide rapid and efficient nutrient recycling for uptake by growing plants (Fearnside 40).

Tropical rain forests the world over are not perfectly similar. Latitude and altitude will affect the specific climate conditions and thus the types of organisms present and the process by which they interact with the environment. The Amazon tropical rain forest is not a homogenous unit (Moran, "Development" 3). Regions are characterized by differing floral species as well as particular faunal diversity that are supported by the vegetation. There are three primary regions that can be classified as part of the rain forest (Figure 4). One particular zone, *cerrado* or scrub savanna makes up the Central Brazilian Plateau. This plateau region is characterized by savanna grassland with low scrubby xerophytic trees, meaning the ecology here is suited to lower levels of rainfall (Fearnside 232). The remaining three regions are dominated by *terra firme*, or the non-

flooded highlands; *varzea*, or floodplains; and *igapo*, or swamp forest (Fearnside 235, 238-239). Excluding the *cerrado* region, *terra firme* accounts for seventy percent of the total forest area in the Brazilian Amazon (Fearnside 35)

The unique environmental setting of the Amazon has led to an abundance of organisms, paralleled by other tropical rain forests and unmatched by any other region on Earth. By gaining an understanding of the fundamentals of the environmental aspects present, and also an understanding of the diversity of life present, we can utilize this information to understand the importance of such an ecosystem, its strengths and weaknesses, and the consequences that may be associated with its loss.

Human Cultures in Brazil and Their Ecological Footprint

The human species is a powerful force of change. For over two million years our species has been exploiting the ecology and geography of the world for survival. Every change we have made to our environment was with the specific intent to make a living. This living was made by extracting from the environment. The techniques we have used to extract resources has changed over time, though our operational motivation has always been to gather water for drinking, collecting from plants and hunting game for sustenance, gathering wood for fire, and seeking shelter for protection. Extracting resources from the environment for survival is not a trait unique to humans; every species, and every individual within that species, has performed in this manner. This is the interaction of life and the earth.

Humans, however, have taken this one step further, we have learned over time to extract more from the earth than it can naturally sustainably provide. Most species will adapt to the resources they need and essentially "settle in" without having a significant ecological impact on the environment; they will form a natural balance. Our species has essentially operated under this same principle for the majority of the last two and a half million years, although we have been unique in having caused some ecological disruption over time. To compare the time spent in the lifestyles of pre-modern to modern age people, if one hour on a twenty-four-hour clock represents one hundred thousand years then the historical course of human beings as hunter-gatherers is represented by twenty-three hours and fifty-four minutes. Only at six minutes to midnight did we invent agriculture (Diamond 191).

Intentional alterations, with foreseen and unforeseen consequences, have been made to the environment since our early ancestors were hunting and gathering. Our primary motivation, survival, has led to indirect consequences. We have, over time, acquired new means by which to impact the environment with greater force; because of our expanding populations and technologies we are doing so to a greater degree. Historically, the impacts have been small scale and not resulted in many major ecological changes. One example of such an activity has been the use of fire to force ecosystems into earlier seral stages resulting in greater ecological productivity. This technique resulted in forcing forest ecosystems into earlier stages defined by shrubs, grasses, and small fruit bearing trees. A human population could acquire these productive plants; hunt the animals attracted to the vegetation, and move on to richer areas. This type of ecological disruption was not so severe. A region could reestablish higher seral stages relatively quickly if left alone for a few decades (Preston). Typically, a hunter-gatherer band would cycle through regions collecting resources they needed as they followed game, and may not have returned to a previously visited region for some time.

Another method of overusing natural productive capacity has been through agriculture. This is the modern system upon which our most recent ancestors have developed and our current culture is founded upon. There were at least three cultural hearths that gave birth to agriculture and they each initiated between twelve and eight thousand years ago (Preston). Two of these regions were on the Asian continent, and one, which will be the brief focus of interest here, was in Central America. The American hearth led to three great empires, the Aztec, the Maya, and the Inca.

However, all three of these are late comers in great world empires. The original settlers of the Americas did not bring agriculture with them. Approximately twenty to fifteen thousand B.C.E. hunter-gatherers, following herds of animals, crossed the Bering Land Bridge from Asia into the Americas. Their descendents spread across both North and South America. Indigenous people living in the Brazilian Amazon today still live in a similar manner to the way their ancient ancestors lived. This is not to say that once they arrived in the Americas they ceased their cultural creativity, but similarities are especially apparent when compared with modern Brazilian culture. The indigenous groups in the Brazilian Amazon have their unique methods of altering and affecting the ecology of the rainforest for their own benefit, but it is not to the same magnitude compared to modern methods.

Modern Brazil originated out of the Portuguese colonies established first on the eastern coast of the country. The capital, Brasília, is located in the Central-West region. Brazil's total population, which includes indigenous populations as well, is over one hundred ninety-seven million, ranking it as the fifth most populous country in the world (CIA). However, because of Brazil's geographic expanse, it ranks one hundred eighty second in population density which is around twenty-two people per square kilometer. Intensive agriculture and the modern dominate socio-economic system grounded in agriculture has achieved and sustains this large population. Modern populations have a significant impact upon the environment because of their large numbers and their technological capacity, something indigenous groups have neither of. Depending on environment, figures for pre-modern societies, hunter-gatherers for example, show population densities around one person per several square kilometers. As will be

evidenced later, indigenous populations in the Amazon operate effectively at carrying capacity. This means that with population densities being over seven times larger within the modern population than the pre-modern population the balance of the environment is in jeopardy.

The geography and numbers of indigenous people in Brazil is diminishing. A principal group is the Yanomamö. These people do not form one collective entity, but are the product of over two hundred different tribal groups. Their total population is estimated at approximately twenty thousand people with only thirty percent of that living in Brazil, the remainder is in Venezuela. The Yanomamö are one of the last major primitive people left in the Amazon (Chagnon Preface). It is sad to say, with this being the largest tribal population left and their total only accounting for five percent of the five hundred thousand indigenous peoples left in Brazil, that the state of other tribal populations of differing cultures is comparatively worse. Over the last fifty years the attitude of the Brazilians has shown neglect and contempt for indigenous tribes. Economic forces drive the destruction of the rain forest with no regard for the habitat populated by indigenous groups who have lived there for thousands of years. Land rights of natives are typically ignored as they are pushed from their lands by colonists. This has resulted in serious conflicts (Moran, “Growth” 9).

The power indigenous groups can wield to alter the ecology of the Brazilian Rainforest is substantially smaller in comparison to modern Brazilian society. The five hundred thousand native people only represent four tenths of one percent of Brazil’s total population. The Yanomamö as a cultural example affect the forest in very minute ways. Their principal food is cultivated in small gardens and the men hunt daily for

game. However, in the appropriate seasons, when fruits and plants are abundant in the surrounding rainforest they collect the local flora, relying less on their gardens. Accessing the abundance of foods available in the jungle surrounding their villages greatly supplements their diets. Because of such low population densities, human impact on the environment by all indigenous people is very low compared to modern cultures.

The people here supplement their diets from what the land provides, and the land is generous providing hundreds of species of plants and animals in surrounding regions for the villagers. Still, eighty to ninety percent of the food consumed in Yanomamö villages is produced in their gardens (Chagnon 75-79). However, a distinction must be made; the Yanomamö as well as all the other indigenous cultures in the Amazon are not agriculturalists; instead they can be referred to as horticulturalists. They do intentionally cultivate a few plants but they do not rely on this method to establish a permanent sedentary society; in fact, their method of cultivation is merely a concentration of resources already present. Their gardens are made up of seasonal produce and are not in the same location every year. It is still true they are not always horticulturalist nor are they always hunters and gatherers; however, the populations of indigenous groups in the Amazon depend upon the abundance of resources varying season to season.

This region is also unique in its diversity which allows these mobile bands and temporary villages to overcome environmental obstacles that hunters and gatherers would face in other regions of the world. Before the advent of agriculture, almost twelve thousand years ago at its earliest, human populations were clustered in family groups no larger than fifty or sixty people. This is similar to the tribes living within the Amazon

rainforest, however, with the abundance of resources from the diverse species present; a rainforest is capable of providing adequate resources for larger groups. Horticultural practices allow for the concentration of food to feed relatively sedentary populations (Chagnon 75). The advantage of gardening while still collecting a great variety of wild plants, over intensive agriculture, such as practiced today, is that the health of individuals is significantly better. Malnutrition rates amongst early agricultural communities are very high (Diamond 184).

The Yanomamö are the last unacculturated Native American group left (Chagnon 242). Every other pre-contact Native American culture has been assimilated, acculturated, or annihilated. There still remain indigenous groups of people that have adopted modern lifestyles or tools and still practice some of their cultural traditions. With agriculture as the base for development, human societies have developed into a powerful force of change. We have demonstrated the capacity to alter ecological and cultural systems to the point we have almost completely overcome traditional cultures and the environments they depend upon. The preservation of Amazonian experts, within the indigenous population is critical. With hopes of creating a sustainable and economically sound development market in the Amazon Moran states, “native expertise can be used to improve experimental research and to select rare plants for economic uses” (“Growth” 10). Instead of trying to overrun the Amazon with traditional agricultural and economic models, we should study the Amazon for the unique environment it is, and treat it accordingly. We shouldn’t think it is feasible to try using a hammer to pound in a screw; instead we should learn to use the screwdriver. The same principal applies with respect to Amazonian development.

Consequences of Ecological Disruption

For two million years man has been acquiring resources from nature as a means to live. Humans have used their mental faculty and their developed culture to transform nature for human use. In relation to man's desire to transform nature Karl Marx put, "by changing it, he at the same time changes his own nature" (Wolf 73). This states, whatever changes our species bring about ecologically on this planet, we will, and have, unavoidably changed our own nature.

Our technological capacity has grown exponentially since we first used stone tools two and one-half million years ago. The rate at which progress was made was initially slow, for instance, by one hundred thousand years ago the Neanderthal's in Europe were the only population consistently using fire (Diamond 364). Agriculture was developed ten thousand years ago and the rate of progress has increased into modern times. With this progress comes great responsibility, as each age has granted more power to human cultures. According to Diamond,

> Our harnessing of much of the Earth's productivity, our extermination of species, and our damage to our environment is accelerating at a rate that cannot be sustained for even another century (365).

Diamond argues that without a socio-cultural change in attitudes about how our species harnesses resources on Earth, then the global population will inevitably face catastrophe (Diamond 365-366). Historically our species has managed to find a way to inhabit the Earth without significant disruption. The problem lies in some of the methods used to make a living, and also in how many people are utilizing those methods. Should we have a smaller population then our impact would not be as significant; yet we

still need to strive for a system less disruptive to ecological processes. However, there is no turning back from our course, and we must find a way to sustainably manage our populations without the destruction of Earth's ecosystems.

The dilemma in the Brazilian Amazon is one of man versus ecology. In the long run the greatest benefit to human cultures would be the preservation of diversity. However, Brazil's attitude towards development is one in which natural systems are being replaced by human systems. These human systems are focused on logging and commercial agriculture, principally opening rain forest for peasant farming, and cattle ranching. An understanding that this region is not suited for long-term agricultural or ranching practices will preserve the Amazon. To determine how the Amazon should be managed we should be aware of its carrying capacity, which is defined by the total number of people that can be sustainably supported to a measure of social acceptability. Fearnside states, "Exceeding carrying capacity can lead to failure to maintain an acceptable standard of living and to environmental degradation in many forms" (1). As Diamond was suggesting earlier, our current society is very powerful in respect to our ability to alter ecosystems. Fearnside supports this claim implying that our society is operating at a level at which we expect unlimited return from the environment. He further suggests our society has an "incompatibility of infinite demands with finite resources" (1). This attitude comes from assuming that the Amazon is a stable system. Climate reports indicate a long-term instability for the region over the last five thousand years. The floral species, susceptible to climate variation, would be impacted directly. All associated fauna, including humans, would be impacted subsequently (Meggers 16).

The abundant diversity of the tropical rain forest is essentially what has protected the entire system from fluctuations. Our disruption of the Amazon rain forest is creating an ecological instability which may poise the system for a total collapse should future climatic variations occur. This collapse would lead to a fundamental break down of one of Brazil's premium economic resources and a significant loss of the world's total biological diversity. Furthermore, if our disruptions continue then we will ultimately face the consequences of environmental degradation and an impact reaching global scales. This would lead to the point where our current means of survival may become obsolete.

Examples of the degeneration that can occur can be found among tribes in the *terra firme* region of Brazil (Tropical rain forest, Figure 4). Here climatic forcing caused cultural replacements during alternating periods of severe drought and flooding across Amazonia between fifteen hundred B.C.E. and seven hundred B.C.E. leading to devastating impacts on local subsistence resources (Meggers 30). There have also been cultural changes due to disruption by the introduction of epidemic diseases and the subsequent loss of population in the seventeenth and eighteenth centuries. Anthropologists, one being Donald Lathrap, have deduced from language and settlement patterns that many tribes in Brazil affected by disease used to practice horticulture, and today can be found as foragers. However, a few tribes have since established themselves as agriculturalists due to acculturation through contact with modern society. Some groups have even become horticulturalists on their own after a period of nomadic foraging. This could prove to be too little too late as these tribes are now threatened with habitat loss due to total destruction of rain forest through Brazil's efforts to expand logging, ranching, and intensive agriculture (Balée 98-100).

The same effects occurred during periods of severe climatic conditions. Populations were forced to emigrate, regionally dispersing and having to adopt foraging as a means of survival (Meggers 30). This example correlates cultural disruption with severe climatic variation and the changes that can occur within societies when the ecology collapses. However, instead of the effects being felt by a few thousand people secreted away in the Amazon, the loss of the Amazon may be of significant importance on the global scale. Concerning the carrying capacity of the Amazon, both archaeological and climatological evidence referenced from Betty J. Meggers work indicates the rain forest is not equipped with the appropriate resources to sustain large populations of humans (35).

Deforestation of the Amazon will lead to societal impacts. History correlates the collapse of ancient civilizations with intense deforestation. Even before the fall of ancient empires, the regions which had been deforested saw a dramatic change in climate with the removal of their forests. The intensity at which forests have been cleared has only accelerated since that time, chiefly recorded by the expanding influence of the European powers during the colonial era. The Europeans began clearing forested land on the Brazilian coast beginning in the eighteenth and nineteenth centuries. We have seen deforestation accelerated in tropical rain forests within the last forty years. The effects of deforestation locally can result in more extreme climates, physical and chemical deterioration of soils, and imbalances in the hydrology. On a global scale, the effects of a change in albedo and regional atmospheric water content could result in a change of weather patterns (Sayer and Whitmore 1). With the disruption of the hydrologic cycle we would find increased aridity locally and abroad as

the majority of the water that falls is cycled through the ecosystem. Rainfall on exposed soils would lead to massive erosion and siltation of rivers (Sponsel, 266). This siltation would affect not only the local fish and aquatic populations, but would have consequences for agricultural opportunities. The loss in aquatic species, particularly fish would amount to an economic loss for people who rely on fishing as their chief source of income or food. Additionally, with the removal of forests there would be a net loss of carbon dioxide uptake associated with the loss. The increase of carbon dioxide in the atmosphere will lead to global temperature increases (Preston).

Deforestation is such a chief concern because with the loss of the forests, the entire ecological system collapses (Figure 5). Sponsel states, “The consequences of deforestation are manifold - evolutionary, genetic, environmental, social, economic, medical, political, and aesthetic” (266). We do not only harm the environment; we are risking future species, medical advances, and economic activities. When we lose the ecology the effects are felt beyond the immediate habitat. Every loss amounts to an irreplaceable unit, both in knowledge and in opportunity. Additional associated losses through deforestation include habitat destruction and loss of species. The background extinction rate is one species per one hundred to one thousand years. At the time W.V. Reid’s article was published in 1991 approximately seven hundred twenty-four recorded species had become extinct through human induced habitat destruction and disturbance since 1600. This represents only a fraction of the total lost (Reid 56). Presently, the number of species existing on the Earth is unknown. It is nearly impossible to calculate the loss of species diversity through destruction of rain forests other than to assume the count would be very high.

The primary forest type in the Brazilian Amazon amongst the *terra firme* region is termed closed forest (Figure 2). This type is defined by having total ground cover by the tree canopy; also this forest type supports the large majority of tropical species types (Reid 59). In 1980 there were over three hundred and fifty million hectares of closed forest in Brazil. From August 1988 to August 1989 the average annual loss of rain forest was two million six hundred sixty-six hectares (Reid 72). Given the 1981 calculation by Moran that the extent of the Amazon in Brazil was five hundred fifty seven million hectares of rain forest, then from 1981 to 1988, two hundred seven million hectares of forest were lost in seven years. This correlates well with deforestation rates having risen exponentially in Brazil from 1975 through 1985 (Reid 60-61).

This sort of ecological depletion has not been experienced in the Amazon during prior history. With this disruption and the loss of species the balance of the ecosystem is threatened. When indigenous populations were disrupted by hostile climate conditions they could adapt by relying on secondary resources and moving to other regions for subsistence. However, with the spread of European society during colonial times, and the contemporary expansion of permanent agricultural communities in Brazil the indigenous populations do not have room to adapt; nor does the modern society as it continues to deplete the resources of the rain forest. According to Meggers, "Accelerating disruption of the complex interactions on which the survival of the ecosystem depends threatens its permanent degradation (36)." This states that the level of disruption being perpetrated by the modern society is to a degree as to be unsustainable and entirely disruptive to the future of the ecosystem. Whether or not our society will be able to reverse our course before the damage becomes permanent is a

matter of debate. Both economic and political forces are principally aligned against policy change concerning the future of the Amazon. We have examples within Brazil, of indigenous groups that have survived outside forces and have demonstrated sustainable long-term use of the resources (Meggers 36).

Over the course of the last twelve thousand years as human cultures have developed we have seen the loss of species through direct and indirect methods. This includes, and is not limited to, "entire and irreplaceable biological units, including species and even orders, have disappeared forever from natural systems" (Brown Jr. and Brown 119). Perhaps Daniel Quinn put it best in the words of Ishmael's disciple,

> We were never meant to be the only players on this stage. Apparently the gods intend this planet to be a garden filled with creatures that are self-aware and intelligent… [Man's] destiny is to be the first to learn that creatures like man have a choice: they can try to thwart the gods and perish in the attempt or they can stand aside and make some room for all the rest… His destiny is to be the father of them all… By giving all the rest their chance… He becomes in some sense their progenitor… In a billion years… whoever is around then, says, 'Man? Oh yes, man! What a wonderful creature he was! It was within his grasp to destroy the entire world and to trample all our futures into the dust but he saw the light before it was too late and pulled back… and gave the rest of us a chance. He showed us all how it had to be done if the world was to go on being a garden forever. Man was the role model for us all. (242)

We must learn from the examples our predecessors have shown us. The history of environmental abuse need not be repeated on a grander scale in every new technological age. If we are to have a future on this planet, as well as preserving a future for all life, we must assume the responsibility of stewardship in protecting and promoting a healthy environment rich in diversity.

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Appendix

Figure 1: Political Map of Brazil in South America.

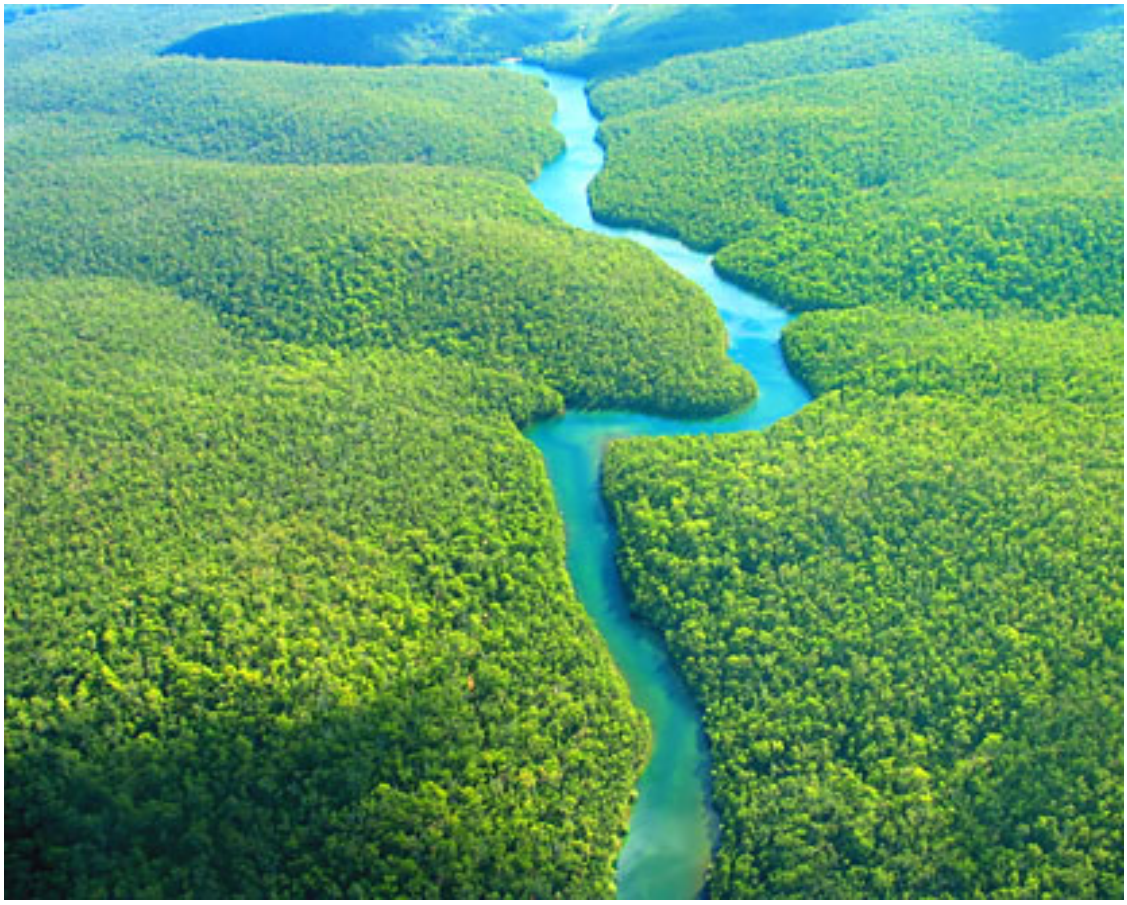

Figure 2: Diverse and Stable Ecosystem.

Figure 3: Floral Density and Species Diversity in the Rain Forest.

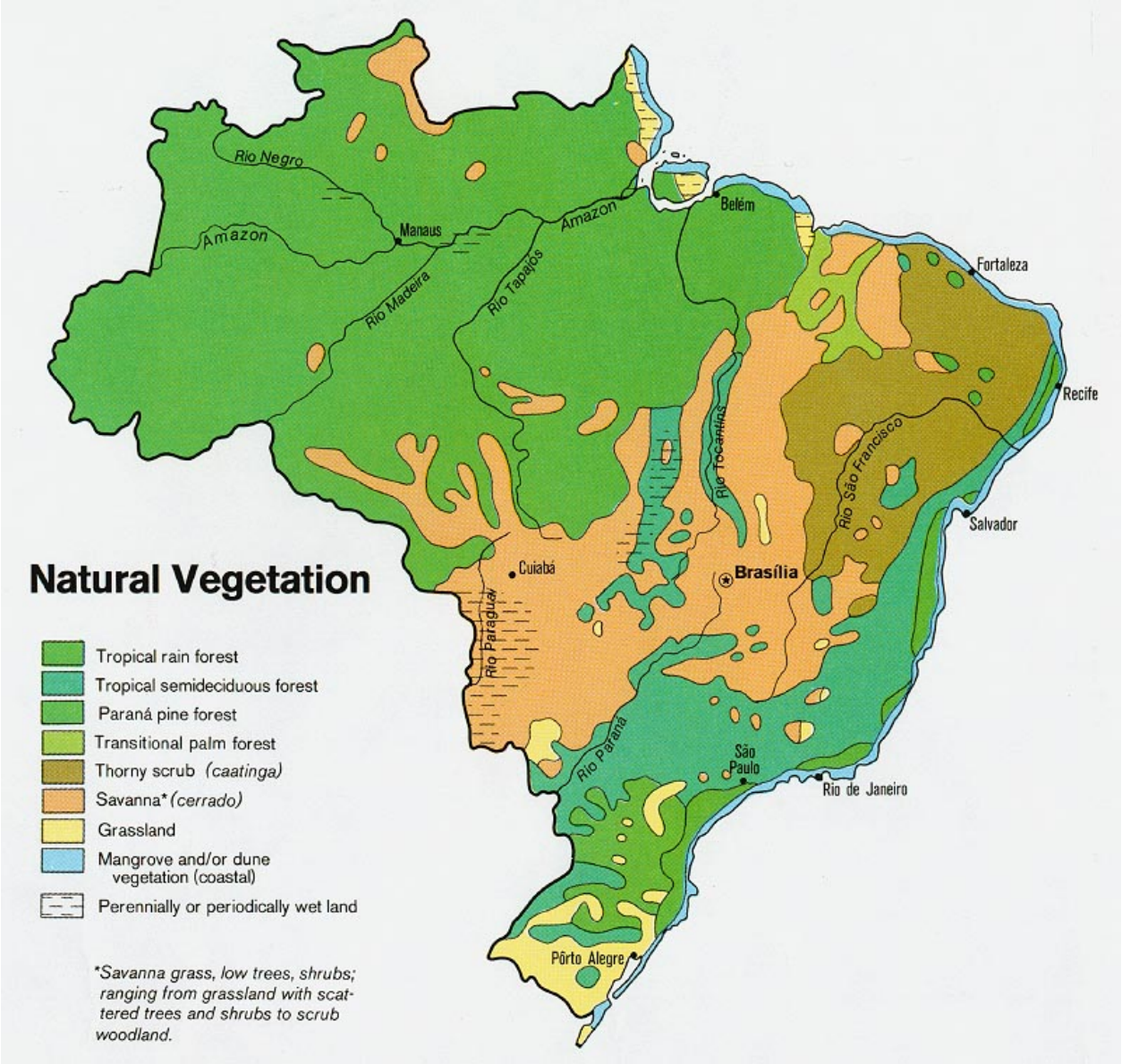

Figure 4: Ecological Regions.

Figure 5: Deforested Land.