>> All right everyone. We are going to switch topics here and begin talking about deforestation. We're going to talk about deforestation in two parts. We're going to start with where deforestation is currently taking place in the largest amount and that is tropical deforestation. And then our next lecture we will talk about the United States and deforestation that took place previously in our recent history. And kind of tie together some ideas about what's happening in the topical rain forest with what happened historically with forest in the United States. What I would also say and I'll point it out as we get to some of the information here, is that what I hope you'll start to notice is kind of a crossover amongst our topics where we'll, we'll have mentioned information previously, briefly. And we'll pick up and expand upon it a bit more. And the idea that as we look at all of these problems that we're encountering on earth's surface that they aren't happening by themselves or in a vacuum. But that the problems that we talk about with overpopulation add onto the problems. We'll talk about the deforestation add on to the problems. We'll talk about the species depletions et cetera, et cetera, et cetera. And we'll start to see this crossover. The other thing I would mention is that the information for the most part that we talked about with population numbers came from the United Nations and the World Bank. And something that I wanted to mention. If you were wanting to look up some information on population that is where most of the statistics came from that we're talking about with population numbers. A lot of the information we'll talk about today with, with tropical deforestation is coming from the World Wildlife Fund. And so, keep that in mind as well as we read through our slides. So as we talk about tropical rain forest we can just say that all forests, not just tropical rain forest, but all forest since that – there is again the agricultural revolution when people stopped hunting and gathering and moving and laying down roots and pulling up roots from plants to do crops and raise livestock. Ever since agricultural revolution forests have been cleared. And you have to clear the forest before you can plant crops, to have pastureland, raise livestock on a pasture. And so, this is certainly not new this idea of deforestation. But it's the most recent type of forests that we're seeing being deforested in great amounts. So, with that in mind where are the tropical rain forests? They're found between the Tropics of Cancer and Capricorn which are at latitudes 23 1/2 degrees north and south of the equator. So, this is a pretty narrow band of the earth's surface that doesn't have a lot of land primarily at latitudes 23 1/2 degrees north and south of the equator. You're going to find ocean. So, all of the tropical rain forest are in this very narrow band where there isn't a lot of solid earth. The major regions of rain forested land are in Latin America, Africa and Southeast Asia. And once again, we had pointed out with population numbers that 85% of the world's human population within these three regions. And we said we're going to come back to these three regions quite often as we discuss things that we're encountering around the world. And so here they are. Those three regions, the most major regions of the tropical rain forest are in that band that includes Latin America, Africa, and Southeast Asian islands. So, a map showing the distribution of the tropical rain forest. And that same grouping where we saw high population numbers. Where we saw higher rates of hunger.

Higher rates of poverty. And now we're seeing also deforestation in these same regions. So, originally - the original acreage has been estimated about four, with a B, billion acres. And has now been reduced to approximately two billion. So, about in half. It's actually a little over half of the rain forested original rain forested area has been diminished. And certainly, two with a B billion acres sounds like a lot and it is. But losing half is problematic for reasons that we will discuss as we move through. And what happens is this, what we're seeing here in the dark green area here. This is solid forest. This was once solid forest that has now been deforested. And so, we're seeing these areas of deforestation. What usually happens is - what we're seeing here are roads. So, in order to get into the forest, which is quite dense, the first thing that has to happen is that you have road building. And as you have road building, more roads are built on top of roads that are already there. The forest is taken down in small bits that eventually become for the most part deforested. So, this is how the entrance into the forest is by building roads in great quantities. So, with that in mind, we've lost about half of the rain forest. What is the rain forest being used for? Why is it being cut down? How is it being converted or changed is what that means. And so we're going to look at several categories. And the first reason that tropical forest is being cut down is that the wood and other plants are being used for fuel wood and fodder. And so, what that means is in less developed countries, those developing countries they're probably in any of these rain forested countries, is not a lot of fossil fuel in these regions. And so, in order to become right these are areas that are in transition, trying to become fully developed. And in order to develop you need energy and so you're going to use whatever energy you have since there's already competition for the fossil fuels that are available in the world. And so, you use what you have. And wood can be used as a fuel source. As you know we can burn wood for energy. And so, in some less developed countries the wood is being used in a large-scale industrial setting. This is not very efficient. Before you can use wood in an industrial setting that is in a factory, you burn the wood at a low temperature to turn it into charcoal. And then you burn the charcoal in industrial setting. But it takes about five tons of wood to make one ton of charcoal. And that then is not a very efficient use of that particular source. Fodder means dried food. And so, some of the forest is being cut down for cattle, sheep, goats, horses, organisms that are not naturally occurring in the rain forest. And are being raised by large agribusiness corporations to sell meat to other countries. And we'll talk about that in a bit. And so, with that happening the wood that is used and needed by single family groups that, that is their only energy source is becoming scarce. And families have to travel long distances, further distances to gather wood to use at their dwellings to cook food, heat their dwelling, boil water, to have light. Traveling to get that wood is becoming further and further. And as we talked about last time that is mostly done by women and sometimes children. Second reason topical forest is being cut down is to get the logs from the wood. And that's because in the tropical rain forest there are beautiful, beautiful, beautiful hardwoods in the forms of mahogany, and teak and cherry woods. And tropical hardwoods are quite beautiful. They're

used to manufacture things like furniture and flooring. And not only are they beautiful but they're naturally resistant to decay and to termites. And so, used in for those types of manufacturing processes, they last a long, long time. They are also an export income. So, they're saying that this - these regions that are developing are trying to become fully industrialized, and these beautiful tropical hardwoods are going to bring money into the economies in these regions where the, the , the country is trying to become fully industrialized. So, it's a money-making venture as well. When those trees are cut though however for the wood, the beautiful hardwoods only about 10% to 20% of the trees in the rain forest are these beautiful tropical hardwoods that are cut and used as an export income. Then in order to get to those beautiful tropical trees 30% to 50% of the rest of the trees are destroyed. They're not considered hardwoods. They're not used in any kind of manufacturing process. But the hardwoods grow few and far between, so you have to take out the plants that are found in between the hardwoods to get to them. And then those trees are just destroyed, burned. So, the reason that these are cut down is because there are countries and regions that import these hardwoods. And the two main regions in the world right now that are importing tropical hardwoods are China and India. Now this is different. This used to be when I started this discussion oh way back when. In the 1990s the primary importers of tropical hardwoods were the United States, Japan, and Europe. However, because of the worries about deforestation in these particular regions, these obviously, for the most part, more earlier developed countries than China and India, there is now what's called sustainable forest certification. And so now wood that is sold – materials that are sold by - from wood; furniture, wood planks et cetera do have to meet requirements of a certification standard for this sustainable forest certification. And so, we can we still purchase hardwoods in the United States? Of course, we can. But they do have to have certification standards that they are being sourced sustainably. And so, not all tropical hardwoods are sourced sustainably. And only those that are, are going to be sold in Europe, the United States and Japan. So, this is what it looks like. This is what we mean by these tropical hardwoods are quite distant from each other. And in between the tropical hardwoods are trees that would not be considered good for logging. And they have to be cut down in order to get from one tropical hardwood tree to the next. And that's why those are destroyed. Then next thing, number three that tropical forest being converted because of is small scale agriculture. Small scale agriculture happening for colonizing where this particular type of agriculture is called slash and burn. Slash and burn agriculture has traditionally been used in the rain forest for thousands of years. And when done traditionally the land, a small plot of land is cleared. And the vegetations burned to release the nutrients in the vegetation. So, like a natural fertilizer. The land is planted then. Once that crop has come in on that year the plant, the plants that are left behind are reburned. And then that little area of land is left so that it can regrow into forest. So, this burning, clearing, burning, releasing nutrients and leaving a small plot of land has been happening for centuries and is quite environmentally sound. It's a very small area that can-the forest can regrow

very readily. And it looks something like this. So, we have the forest here. A new plot of land cleared. This is an area that was cleared but is now re-growing. And the area right next to that was cleared previously and is a further stage of growth. An area right next to it that's in a further stage of growth. And the surrounding forest because there is a small area that has been cleared the forest can actually regrow, replenish into its original state. But currently poor families are becoming homesteaders. Families that are not indigenous. Families that do not know the correct way to slash and burn the rainforest. And so instead of letting the plots replenish after one planting. That's hard work. That's hard work. Cut down all those trees and get [inaudible] that vegetation. So, then you replant the same plot again a second year you don't get quite as good a crop. [inaudible] in a third year. Maybe now you have to add some fertilizer because it's really not re-growing very well. And so, if you stay on the same plot beyond the time which it - the forest around it can actually replenish the plot and the ground becomes infertile. The plot declines in productivity. And the forest around it is not able to regenerate the forest - the plot back into original forest. So, you look at this idea of slash and burn right, an area that's burned to release the nutrients. If that plot of land is regrown, regrown, regrown multiple seasons then it's no longer viable. It's not growing enough food for the family. They cut down an area of the forest immediately adjacent. Stay there. Burn, burn, burn. Don't move on. You're getting larger and larger pieces of land that are now becoming infertile because too much time is spent growing crops that are not native to the rain forest. That's small-scale agriculture. But there's also large-scale agriculture taking place in the rain forest. And much of the land that's on any productive soil in the rain forest is held in large farms with one or two commercial crops. It's called agribusiness. It's called agribusiness anywhere. What we're seeing in different, the different regions of rain forested land are different types of crops. Some in southeast Asia. We're seeing rubber and palm oil, cocoa, and rice being grown for agribusiness. In Central America and Africa; bananas, coffee and sugar cane are grown in one or two commercial crops. In South America we're primarily seeing cattle ranching and soybeans being produced in commercial sized crops. And so, we talk about palm oil. We're looking at - these are the regions across that tropical belt that would be a suitable climate for palm tree growth. Currently most of the palm plantations are in Southeast Asia. Some amount of palm oil is starting to be produced in the, in South America. But in that Southeast Asian area right, we're talking about this area of - right through here. Malesia, Borneo Southeast Asia island Sumatra. I just wanted to show you this map to give you an idea of where that's located to comparatively to Vietnam, Cambodia and Thailand and Australia. So, this area of the Southeast Asian islands Indonesia and the - in between the Indian and Pacific oceans. And so, we're looking at is this area of deforestation. Primarily for palm plants. And so, the - you can see in the background the tropical forest. This area that has been cut down, getting ready to plant palm. And this was once complete tropical rain forest that is now palm plantation. So, palm oil is found in about 50% of the products on our supermarket shelves contain palm oil. So, this is my first - the first time [inaudible] to you we should

be checking food labels for all reasons. You know I have some nutrition agers out there and you all already aware of that. But we should all be checking labels all types including food labels to see what is in the foods we eat. So, foods and snack items. But also, things like personal hygiene items; lotions, cosmetics, animal feed, drugs, other medications and biofuel. About – a biofuel called BEE20 where - that is 80% diesel and 20% palm oil. And so, it's being grown as an alternative energy source. The idea there being that the you're probably going to find palm oil in almost everything. And that's why it is so sought after. And so, this -these areas where forest is coming down to be replaced with palm oil plantations. The - in terms of large-scale agriculture then of course, that is going to concentrated in hands of very small minority of people. The large-scale agriculture is designed to maximize profits of the landowners. Those that own the land, that are growing the crops, raising the livestock. And from companies that also make money from things like shipping the materials from the rain forest. The manufacturers of the coffee and the palm oil and the soybeans that are being used, the cattle that are being used. The restaurants that use the beef that is being raised in the rain forest. Those are foreign companies. Those are not companies in the regions of rain forest. So, there's a combination of actors that keep this large-scale agriculture going because it's not just the rain forested countries where money is being made. So, things like cattle ranching, soybean and palm plantations don't really have any sort of local food or job production. These large-scale agricultural agribusinesses are mechanized. They're not employing a lot of local people. And certainly, people that live in the rain forest are not eating anything like beef. So, that is not making - doing anything for the local peoples in terms of jobs or food. Right. So, there again we're seeing some deforestation in the Amazon. Starting to clear plots of land so that we can maybe start to raise cattle on the land. This is in the Amazon Rain Forest rowed soybeans. So, a soybean plantation in Amazon. About 80% of the soybeans from the Amazon are used as animal feed. And so, the animal feed that's being exported or for animal feed within the rain forest. Behind beef, soybeans are the second largest agricultural driver of deforestation worldwide. And the region again that imports the most soybeans from all around the world is China. So, we're looking at the soybean production, soybean plantations taking the place of the natural rain forested area. What else is happening? Hydroelectric dams are being built. When you build a dam the - across a river, behind the dam the region is flooded. So, areas of rain forest are becoming flooded to provide electricity. Again, this is an energy source to try and get full industrialization into these developing countries. So, hydroelectric dams are being built and flooding rain forest. Mining and oil explorations is taking place in the rain forest. So, things like gold and diamonds and uranium are found in rain forested areas. And there is mining taking place taking out the rain forest. And so, all of those things together are - so it's not just one, but multiple reasons that the rain forest is being converted. And the problem then is that tropical forest of which we've lost a little over half can't easily regenerate. And the reasons that a tropical forest can't easily regenerate is because the soil in a tropical forest is infertile and easily degraded and eroded. Which kind of

doesn't make sense because you have so many plants, so many animals that are living there. How can the soil itself be infertile? Well, we'll discuss that in a moment. We said that that the soil that is fertile is already held in the hands of large agribusiness, commercial business owners. So, that 95% of the remaining soil is actually this infertile and easily degraded type. So how can there be so many plants in an area with infertile soil? Well those ecosystems survive on the poor soil by quickly very quickly recycling the nutrients from the leaf litter that is as leaves fall to the ground, as plants die, as animals die, as fungi, bacteria die in the rain forest, the nutrient value of the - those materials gets recycled very quickly into the living plants. In most soils what happens is as plants die, animals die those other organisms dies, they slowly get biodegraded. They slowly mix into the soil. The soil becomes fertile because of this mixing of the nutrients from the dead matter. But in the rain forest the - there are fungi. There they are again. So important. Fungi which are the main decomposers on earth. Very, very, very quickly break down the materials that have fallen. The leaf litter that's fallen. The organisms that have died. Very quickly break it down are directly connected to the roots of the living plants. And directly move the nutrients into the living organisms. And so, the soil itself is not fertile. The fungi are breaking down the materials and directly supplying the plants with the nutrients. Now this is not something that can be duplicated with agricultural plants. This is an adaptation that tropical fungi have a mutualistic relationship between plants in the rain forest and fungi in the rain forest that has evolved over time. And agricultural plants do not have this mutualistic relationship with the fungi in the rain forest. So, the - when we bring un-native plants, they do - cannot quickly recycle the nutrients that are being dropped to the ground from dead organisms. And once the plants are gone the soil erodes. Because what holds the soil down? The plants and the roots of the plants hold down the soil. So, once all that very dense cover of plants is gone, the soil is very easily eroded. The tropical rain forest doesn't regenerate then. The forest is gone. If the forest is gone, the fungi area gone. The area is eroding. And now it's very difficult for the forest to regenerate. And that's because the native organisms have a very narrow, here's our term, range of tolerance. So, the range of tolerance things like too much sun. the rain forest is very, very dense and dark. The plants that are at the bottom of the canopy have adapted to very little sunlight. Now when the canopy is gone the tall trees area gone, the region has been cut away. Seedlings are not going to do well with too much sun. the opposite of what we would think for most plants. But in the rain forest the plants have adapted to very little light. So, this is now too much light in that idea of narrow range of tolerance. Most rain forest plants cannot tolerate too much light. And are not going to grow well in open areas. A lot of the seeds of the plants in all ecosystems are spread by animals. Animals eat the seed or eat a fruit that has a seed. They move. They release the seed when the defecate. And the seed has been moved to another place to grow. Well, if the animals are no longer there because the forest is no longer there, the animals can no longer move the seeds. And spread the seeds so that the forest can regenerate. Many plants require cross pollination. So, whereas some plants can self-pollinate many plants have

to have another plant that produces pollen and eggs to cross pollinate to mate. And the cross pollination again, cannot take place if there are large open areas where two plants of opposite type, male and female get the sperm that is the pollen, can not reach the eggs in the flower. That also happens by way of insects. And again, animals and birds. And if those organisms are not there, the cross pollination is not going to take place. This happens in every ecosystem. Once an area is burned, once an area is flooded, then the first thing that takes over in that area tough fire-resistant grasses and shrubs. And tough fire-resistant grasses and shrubs in particular in the rain forest will then take over the areas as opposed to the tall tree canopies and the other smaller trees in the area. So, they will actually crowd out the ability of some of the hardwoods and other plants to take root and grow. So, this is what the rain forest is supposed to look like. This is the Amazon River through the Amazon Rain Forest. Right. Very dense, very dark, very wet. The low-lying plants not getting a lot of sunlight, that have adapted to that. And this is what it looks like when you start building roads in an area into the forest. Dark green, still pretty dense forest. But over time in the same area as more and more roads get built, the elimination of any of the forested area. Very difficult then for all the reasons we just talked about, for the forest even if everyone left, for the forest to regenerate. Other problems, right. Loss of people and cultures. Thousands of year-old cultures. People that are being displaced. Not even just displaced, but murdered, hunted down. Removed form their lands. I'm going to post along with our podcast, I'm going to post a couple of videos to watch that [inaudible] very, very good information about indigenous peoples in the Amazon Rain Forest. And more wildfires. So, one of the videos will be about the raging wildfires that have - that took place - are still taking place since last summer in the Amazon Rain Forest. So just some really good visuals and explanations about what's happening with people in the rain forest, cultures being lost and the devastating wildfires that have been taking place. The other problem in terms of the rain forest is that because the rain forests are in these areas of the developing countries, many of these countries have been in a debt crisis since the 1970s. You weren't even a twinkle in anyone's eye most of you. And in the 1970s, we'll talk about this in a few lectures away, when we talk about energy sources. But just to mention it now, just a cliff hanger. In the 1970s we had a first oil crisis. And in that oil crisis there was an embargo, a cutting off of oil supply from oil distributing countries in OPEC nations. And less developed countries developing countries, were right trying to become industrialized and so they borrowed very heavily during this time from industrialized countries so that they could continue to try to become industrialized even during this embargo of oil. And so, with this heavy borrowing in response of the rising price of oil was in many times in the form of a loan for development project. Because what are the - what were these countries trying to do? Trying to become industrialized. So, they were borrowing money to build hydroelectric dams so that they could produce electricity. So, that they borrowed money so they could do mining. So, that they could mine for precious metals and gems and - if the area, some areas of south America certainly are oil rich. So, development projects. So, the loans

were for development projects. And what does development mean? Cut down the rain forest. And the reason that, that was - that, that is now continuing to be a problem is because the earnings that these countries make by exporting all of the things they're exporting out of the rain forest in cutting it down, are needed to make the payments to pay back on these loans made from the 1970s. So, the export earnings - the countries that loaned the money want to be paid back. And so, this is how a lot of that money's being paid back by the export earnings from all of the types of business that we mentioned previously. Well because of that, because of this idea of oh my gosh we have to make export, exports to make money. We owe money. What might some solutions be in some of these regions? And one of the solutions that actually have worked are called debt for nature swaps. And this was a program introduced in 1984 by a biologist by the name to Thomas Lovejoy who suggested that those nations that owe a debt, if they were willing to protect some of those natural resources. Instead of just cutting it down and exporting, that they might be eligible for discounts or credits against some of their debts. And in order for that to work the conservation group can buy part of the debt from the bank. So, instead of the country paying back all of the money that's owed, a conservation group pays part of the debt and in exchange the debtor nation agrees not to cut down, not to destroy the forest and lands. Debt for nature swap. So, some of the conservation groups that buy up debt from a bank out of debtor nations so that nature can be set side are the World Wildlife Fund. And the Nature Conservancy. And the Rian Forest Alliance. So, these are groups that - how do they get their money? From donations. So, as people and corporations and groups donate money amongst many other things that they do for ecosystems, they will buy tracks of land. Not just in the rain forest. All around the world including areas in the United States by the way. We will discuss when we talk about species depletions. And pay off some debt and in return the debtor nation agrees to protect some of its natural resources. And of course, that's important because these natural resources aren't just natural resources important for the nation, but as we'll discuss later, the rain forest is important for all kinds of ecological reasons. Production of oxygen and clean water and maintaining the water cycle and certainly preserving all the organisms that are found there. So, debt for nature swaps is a - one solution to debtor nations that are trying to make money within the rain forest to prevent them from cutting all of the rain forest and saving some and protecting some of that for nature and ecological reasons. Right. So, what's going to happen if as the forest continues to be deforested? Regional decrease in rainfall. This is supposed to be a rain forest. This is a very particular climate. Without all of the plants the rainfall decreases. And that's because part of the reason there's so much rain is that as the many, many, many, many plants draw water up through their root system and it travels up their bodies and out through the leaves, water then leaves the leaves through a process called transpiration. And transpiration is part of the water cycle. That's part of how water gets back into the atmosphere. Without that transpiration, without leaves losing water with less plants to undergo transpiration, the area becomes more like a desert. And that is a process called desertification. Where

an area that is wet a lot of rainfall has less rainfall is less wet becomes more like a dessert, right. We have less rainfall. We're seeing a global increase in temperature. Temperature is raising for many, many reasons. And one of the reasons is deforestation. Plants pull carbon dioxide out of the atmosphere for photosynthesis. When we cut trees down, we get a double whammy for increase temperatures. Because now we need our not pulling as much carbon dioxide out of the atmosphere. Less plants in the rain forest doing that. But then on top of it we burn the plants and release more carbon dioxide. So, we're not only not pulling that carbon dioxide out of the atmosphere for photosynthesis, but we now release carbon dioxide when we burn the plant. Double whammy in terms of excess of carbon dioxide when deforest and then burn. Right. What are we going to get then? The carbon increases as does nitrogen. Nitrogen oxides are also a - are also greenhouse gasses, gasses that hold heat up against the earths surface. What we already say that all living things in terms of their organic molecules that make up all the main organism. When we talk about proteins in particular. Proteins are made of chains or rings of carbon and nitrogen. So, the nitrogen is released. But what else is happening? As nitrogen - as things are burned, they require air to burn. The nitrogen in the atmosphere is also heated up and burned. And then becomes instead of atmospheric nitrogen into it becomes again, nitrogen oxides that are toxic in creating more of an increase of heat in our atmosphere. Extinctions of large numbers of plant and animal species. Currently one in ten known species on earth, one in ten known species on earth reside in the rain forest. And those are known species. We don't even know what all the species are because all of the rain forest has not been, has not been researched in terms of cataloging all of the species. So, one in ten known species. There're estimates as high as 50% of all species on earth reside in the rain forest. So, large numbers of plant and animal species are – may be being led to extinction. A devastating consequence in deforestation all around the world. We already talked exposure and erosion of the soil in the rain forest. When the forest is gone, increased poverty of the people that are homesteading in the rain forest. This is what desertification looks like. This Sahel region of Africa is a band between the Sahara, the desert north and the rain forest below. And it was a buffer zone with vegetation that was, that was a transition between dessert and rain forest. And it looks more, and more like desert then like forest as the deforestation continues. Organisms, organisms, organisms that are currently threatened because of deforestation. These are just a few. But Leopards and birds of all types. And amphibians of all types. And plants, other than trees of all types. Asian elephants, African elephants. The orangutan and the gorilla. One of ten species on earth, known species reside in the rain forest. And when the rain forest is gone the other organisms that live their animal organisms, plant organisms, fungi, bacterial organisms are also depleting in numbers. So, to finish up here's the problem that we face with a lot of our environmental discussion this semester. And that's that if we're really looking at consequences and effects that might happen; continuing decreasing rainfall and increased carbon and nitrogen in the atmosphere and decreased numbers of other species, problems for indigenous tribes. A lot of the

effects in their worst case scenario are not going to be felt until the problems are irreversible. And so, it's important to people where now of what is happening in all ecosystems including tropical rain forest. The problems with determining any consequences taking place in the rain forest currently is that there are very few long-term studies except in those areas where debt for nature swaps have been occurring. And those agencies from outside of the country are monitoring and studying and doing scientific research. And right that in some regions the only money coming in is from foreign conservation groups. There is not a lot of money to be had for studying what will happen if all of the rain forest is depleted. The monies, these are developing countries. And so, the funding is not going to scientific research, but it is going to development. So, with that in mind tropical deforestation. I'm going to post a couple of videos that I hope that you will take a look at, that will encourage you to look further and look at some other videos that you might find on your own. Our next discussion with be American temperate deforestation. Talk to you then.