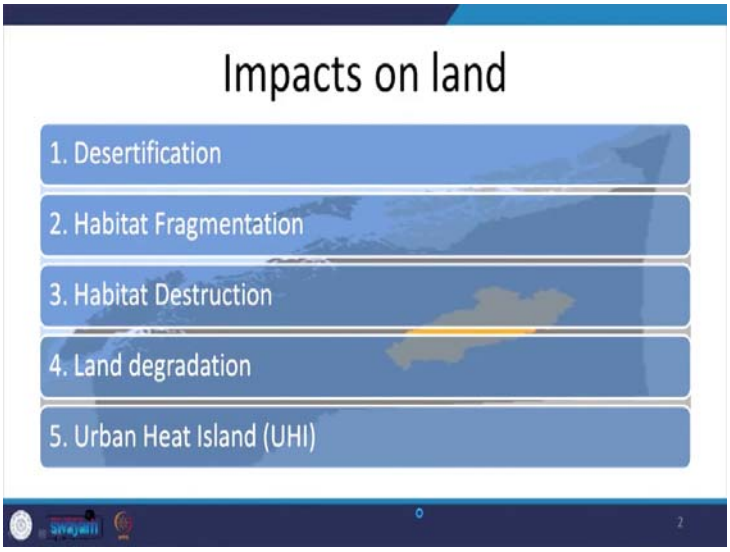
Sustainable Architecture
Prof. Avlokita Agrawal
Department of Architecture and Planning
Indian Institute of Technology, Roorkee

Lecture – 07
Environmental Impacts of Development: Impacts on Land and Air

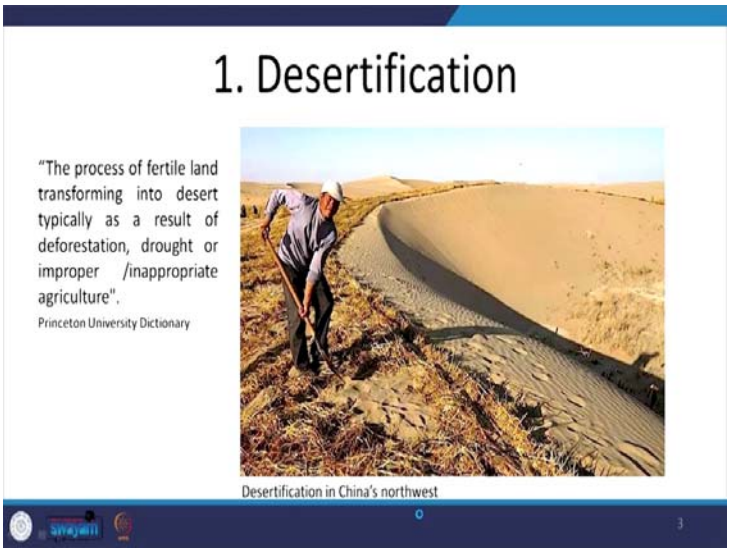
Good morning, welcome to online course on Sustainable Architecture and this is week 2, today we are looking at the lecture 2 of week 2. In the previous lecture we discussed about the impact of development on water, the water element of natural environment. Today we will be discussing about the Impacts of Development or built environment on Land and Air as the allowance of natural environment

(Refer Slide Time: 01:04)



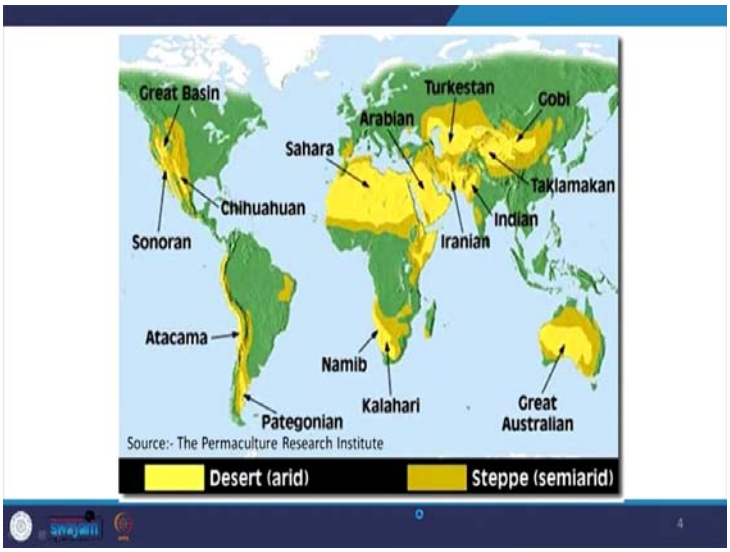
Starting with the impacts on land the 5 major impacts on land of built environment that have been identified are desertification, habitat fragmentation, habitat destruction, land degradation and urban heat island which we commonly know as UHI. Let us go over each one of these. So, the one of the most important and negative impacts of built environment on natural environment is of desertification.

(Refer Slide Time: 01:47)



Desertification is the process of conversion or transformation of fertile land into a desert, which is typically the result of deforestation, drought or inappropriate agriculture.

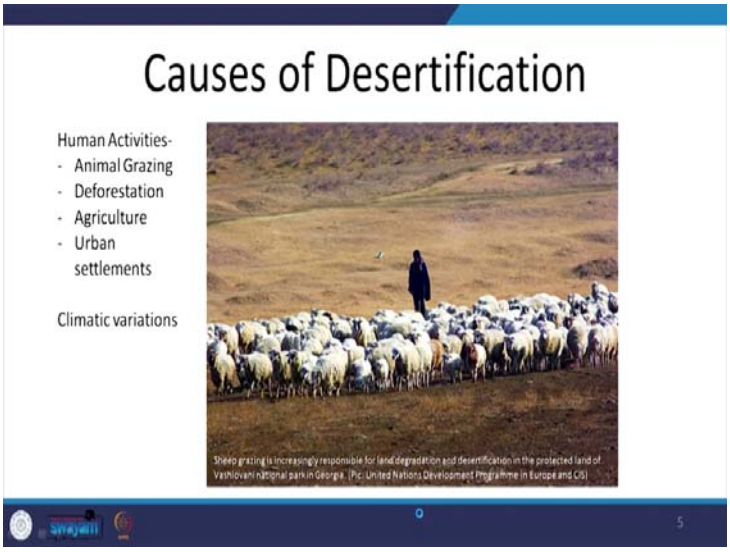
(Refer Slide Time: 02:09)



Every year if we look around the earth besides the existing deserts which are there, which are because of their geographic location and the soil quality and lot of other factors many new deserts are being created where the lands have eventually turned barren and are further turning into desert, which to an extent becomes an irreversible process. So, more and more of the fertile land if it converts into desert there by

hampering the productivity and the possibility of providing food for the entire population. So, we are looking at a very severe impact on land which is desertification.

(Refer Slide Time: 02:57)



Now, how is desertification caused because of the built environment? Now the causes of desertification which are identified have the major cause as human activities, human activities like animal grazing, deforestation, agriculture and urban settlements besides these human activities the climatic variations have also a role to play.

Now, as we have seen yesterday in the previous lecture on impact of built environment on water, we had seeing that even the water cycle is altered due to human intervention. So, to some extent the climatic variations are also impacted by human activities or human interference into the natural system. Here we are looking only for the causes of desertification which are a direct result of human activity.

Let us go over each one of them, first is animal grazing; the increasing use of pastures for grazing animals and inappropriate grazing, irresponsible grazing, is ~~r~~responsible for land degradation, first the land degradation and eventually resulting in desertification. Because, these animals they eat up all the live stock the plant the plantation the greenery of the pastures there by leaving the soil vulnerable to be eroded by wind as well as water and gradually converting ~~this pastures~~these pastures into deserts. Deforestation is another major reason now deforestation is simply because of the expansion of art settlements as cities, towns, villages.

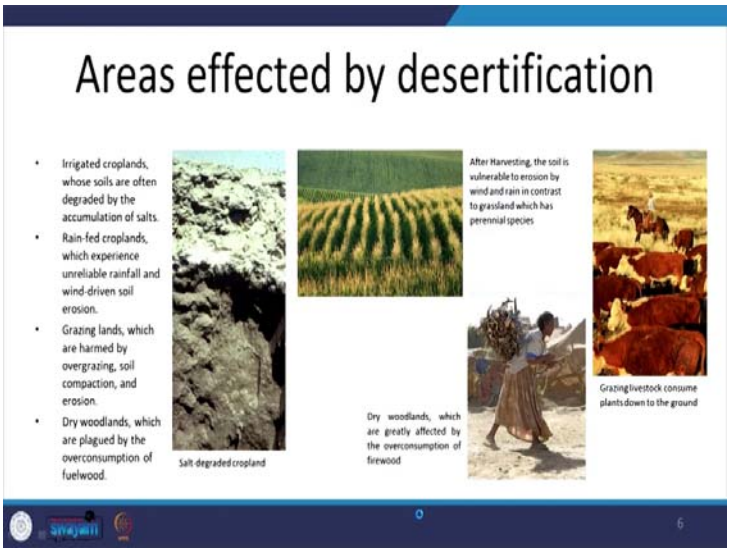
Since population is ~~growing~~growing, we need more and more of the land to make our houses, we need more land to cultivate. Now, these forests are being cut down, deforestation is happening at a very fast pace to pave~~y~~ way for all these all these needs for acres and acres of forests are being burnt or cut down to pave~~y~~ way for manicure plantations which humans are making.

For example, palm oil plantation, now because of all these reasons the forest cover of the entire world has substantially reduced. And, it is reducing every year day by day there by leading more and more land towards desertification. Next is agriculture, an inappropriate or improper agricultural practice often leads towards abandoning or leads to barren lands we will see how agriculture is responsible for desertification. And the last one is urban settlements.

A lot of urban settlements in the previous yesterday's lecture we had seen how an entire sea has dried up ~~Aral sea~~Aral Sea has totally dried up because the urban settlement development came along the streams which were feeding ~~Aral sea~~Aral Sea. Similar thing is happening to other regions as well when the water streams are blocked, when the natural course of water is not available to recharge the ground to support the greenery, the flora and fauna that is how the lands are converted into deserts.

There are some very classic example: if you go to Jaipur one of the dams which use to supply to the entire city of the Jaipur has the reservoir of that dam has stopped receiving water simply because a lot of new settlements were planned in the catchment area of reservoir. Now, because of this the water is blocked from reaching the reservoir and there is no water available downwards the areas which were supplied visual fed by the dams, similar things similar kinds of wrong practices, wrong planning of urban settlements leads towards desertification.

(Refer Slide Time: 07:24)



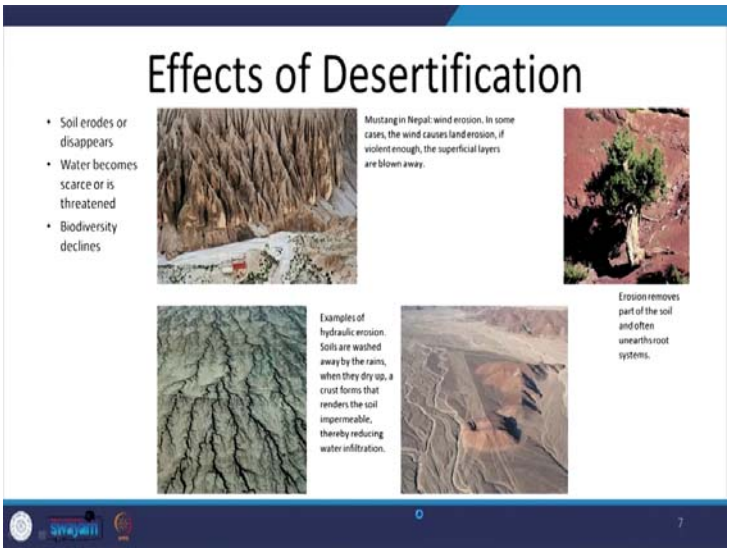
Now what are the areas which are most affected by desertification, as we have already seen the causes for the desertification these areas directly respond to those causes. So, the most affected areas are first the irrigated croplands whose soils are often degraded by the accumulation of salts. Now this accumulation of salts and subsequent desertification will happen because of couple of reasons, one where over cultivation is happening, two were excessive use of pesticides and fertilizers is happening and third were wrong choice of fertilizer is been made where the fertilizer which was not good for the soil is being used which promotes the accumulation of salts in these irrigated croplands.

The second area is the rain fed cropland which experiences unreliable rainfall and wind driven soil erosion, now that is largely because of the climatic variation, here also wrong practices of agriculture are responsible for the desertification. Next is grazing lands which are harmed by overgrazing now these animals who graze on the graze land the pastures they consume plants down to the ground there by totally stopping the growth of the plant the tree and there by gradually year after year reducing the green cover which actually holds the soil and moisture in it and eventually leading it to desertification.

And the last one is dry woodlands which are plagued by the overconsumption of fuel wood. So, areas woodlands which are close to the human habitation specially the underprivileged human population they are at a greater risk of desertification because these woodlands are being consumed as the firewood and since the population is

increasing this over consumption of firewood is leading towards desertification. Now, that we know the causes of desertification and also the areas which are ~~effected~~affected by desertification.

(Refer Slide Time: 09:49)

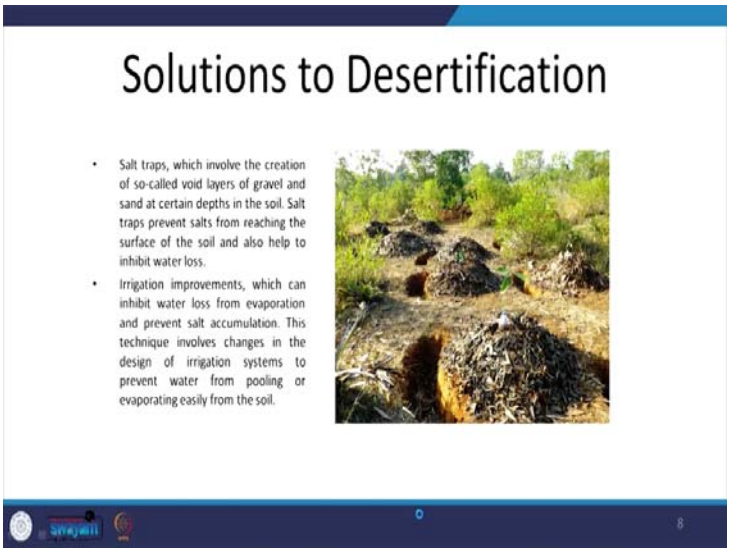


Let us look at what are the effects of the desertification? What desertification does besides converting a fertile land into a barren land, what desertification does? So, the soil erodes or disappears from the place, water becomes scarce or is threatened because the soil loses it is moisture.

So, water table goes further down and since the soil is eroded along with the water there is less of percolation and the water becomes scarced, because of these two reasons since the eroded soil cannot support the plants, vegetation and also water is scarce the biodiversity declines all flora and fauna is reduced in these areas which is an effect of desertification and desertification in itself.

So, what are the solutions? First and ~~foremost~~foremost, solution before I go into these micro solutions first and foremost is to plan our habitat plant our cities settlements in a way that the natural environment is not impacted affected, all the causes that we have seen we take care of those causes through appropriate solutions. Now we saw the cause as improper, inappropriate agriculture, so the solutions.

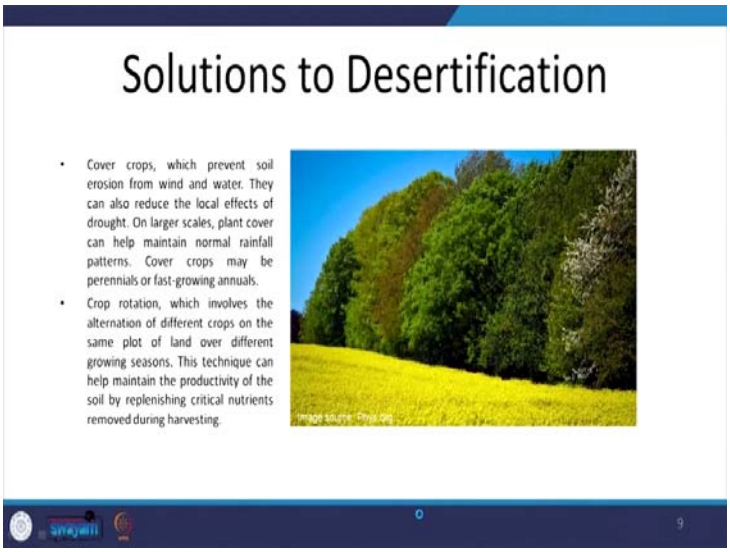
(Refer Slide Time: 11:25)



We can use salt traps where the soils are rich in salts this soil traps actually consist of a wide layer of gravel beneath the soil the top most layer of the soil and that controls salt from coming up to the top and converting the land into a barren land. The second is improvement in irrigation excessive irrigation has often led towards washing away of the top soil. So, improvements in irrigation for example, the one seen on the screen this picture such ~~cost effective~~cost-effective irrigation improvements they help prevent salt accumulation and also reduce the loss of water from the soil loss of moisture from the soil because of evaporation.

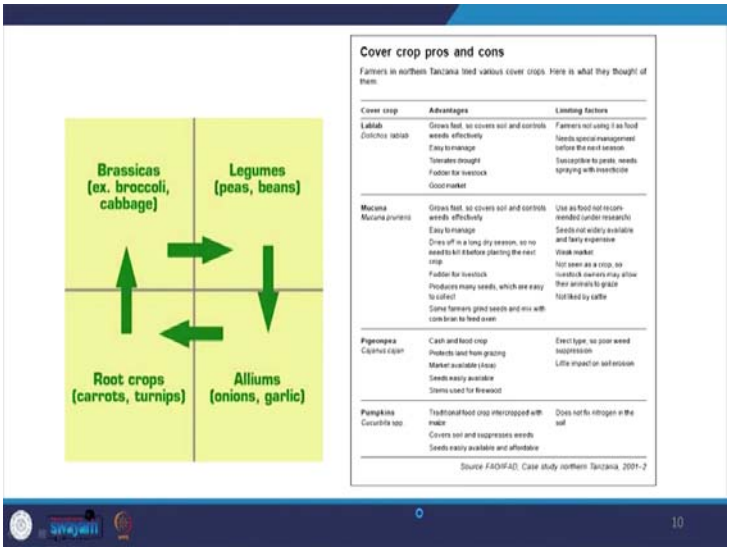
Other solutions to the wrong practices of agriculture are using cover crops to cover the barren land often after the crop has been harvested the main cash crop has been harvested the farm land lies vacant and it is exposed to wind and water, instead of that cover crops can be used which prevent the soil erosion and they provide a cover these crops are such crops which quickly grow and they can be harvested faster.

(Refer Slide Time: 12:57)



Next is crop rotation, if you remember in India we always had the traditional policy the traditional way of farming always had the policy of crop rotation, all of you might have already seen this particular picture.

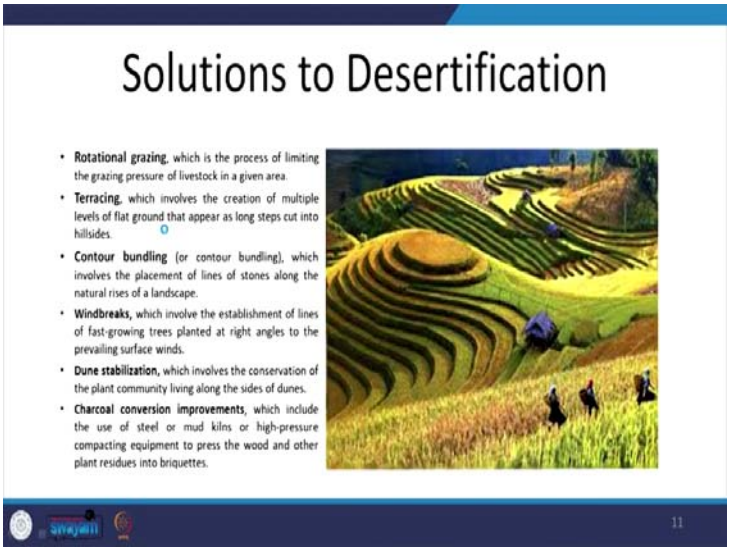
(Refer Slide Time: 13:13)



Where the 4 types of crops the legumes, the alliums, the root crops and brassicas are planted on a field in a rotation manner, this allows the soil to regain it is strength, sometimes nitrogen is replenished, sometimes other minerals are replenished and that is how the soil continues to remain fertile there is no over exploitation of one particular

nutrient and different nutrients replenished and are used by crops in a rotational manner, besides the solutions to agriculture because agriculture is major threat to desertification.

(Refer Slide Time: 14:02)



If you look at other causes for example, grazing so, there is rotational grazing as a solution instead of using the same land for rotation year after year we can change, we can rotate the grazing pastures. India traditional Indian settlements had a very beautiful practice of rotational ~~grazing~~grazing. Our ~~are~~ villages whenever the crops where harvested. So, each piece of land was rotated and animals were left on these pieces of lands for grazing, they would graze they would eat up the ~~left out~~left-out portion of the plant which was left on the land after grazing after harvesting.

Now this ensured that the stock the waste of the agriculture was not used for burning as a fuel it was taken a by animals and when animals stayed~~taid~~ on a particular piece of farm land it also fertilized the land through the defecation through the dung that the animals produced. So, it was a win-win situation and this way the grazing pastures were also rotated within the limits of the settlement within the limits of the village.

Now unfortunately we have stopped that practice all the farmlands cultivated year after year, season after season and there is no place which is left for the ~~cattles~~cattle, the animals to graze or in certain cases specially the crops are grown for the animals to be taken up to be eaten which I say as the cover crops.

The second solution to desertification is terracing, which involves the creation of multiple levels of flat ground like steps. So, we have seen that happening in hills, but even when in plains where there is a very minor slop terracing can be a very good way of preventing soil from getting eroded, because we would this ~~way~~way, we would stop the water from flowing at a greater speed.

The next is contour bundling; now contour bundling involves the placement of lines of stones which act as a barrier to the flowing water of flowing wind and there are wind breaks.

(Refer Slide Time: 16:44)

The wind breaks for example the one which is seen here the trees are planted as wind breaks in between the farmlands, now these wind breaks this trees the break the speed of wind and hence the erosion of soil from the farmland, even when it is not covered by cover crops this one is a contour bundling.

Now, this contour bundling is with the help of rocks, builders, stones, now this stops the water this breaks the speed of water even when ~~there is a~~ there is erosion of soil happening because of flowing water. So, it breaks the soil gets accumulated and only the water flows there by reducing the loss of nutrients from the soil.

(Refer Slide Time: 17:39)

Another solution which is directly related to the human habitation and the settlement is development of appropriate technology for consumption of fuel wood. So, more efficient manners like the creation the formation of briquettes using the agricultural waste which can be use in stoves.

Also the plantation specific plantation which can be grown on the boundaries towards the boundaries of the deserts for example, jojoba plantation this is a hardy tree which grows in arid and semi arid areas and requires very less of moisture to grow and it helps the soil to regain the moisture and it also changes the micro environment micro climate of the place.

So, such similar species have been identified one of which is jojoba and this can help reverse the process of desertification on the adjoining the boundary layer of the deserts which are been created, the second and third impact of built environment on land as a natural element.

(Refer Slide Time: 18:53)

They are habitat fragmentation and habitat destruction, now because of huge infrastructural projects which are being carried out world over, the habitats are being destructed they are being fragmented. This particular image on the screen is of the oil palm estate in Malaysia; here an entire patch of rain forest has been cleared to pay way for oil palm estate and majority of the oil palm plantations in South East Asia they are coming directly at the cost of rain forest clearance.

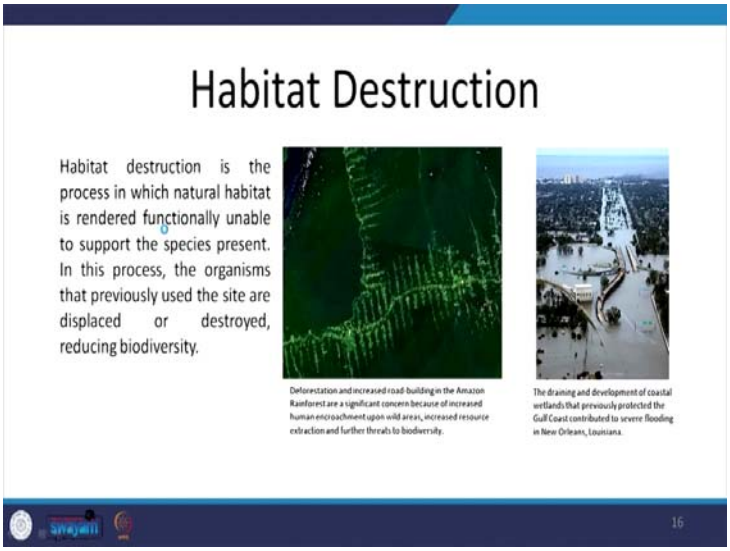
Rain forest clearance implies the destruction of habitat for all the specie we are not just losing out on plant ~~specie~~species, but we are losing out on the habitat of a number of animal animals, insects, birds who were residing thriving in these rain forests there by destructing their habitats.

There is habitat fragmentation the roads are passing through jungles, forests and animals the habitat for animals are fragmented. So, if 100 square kilometer of an area is required for one family of lions to survive and the entire life stock entire stock of animals in that area form an eco system when a road passes to through that forest dividing it into 50 acres of each for one family of lions it is only 50 acre available.

We may not think that way we may still think that it is just road passing by the animals can also cross the roads, but it unfortunately does not happen that way with the animals and that is why their habitats have been fragmented, they come in direct contact with

humans with the transport systems and there by further leading towards extension of these species these animal species.

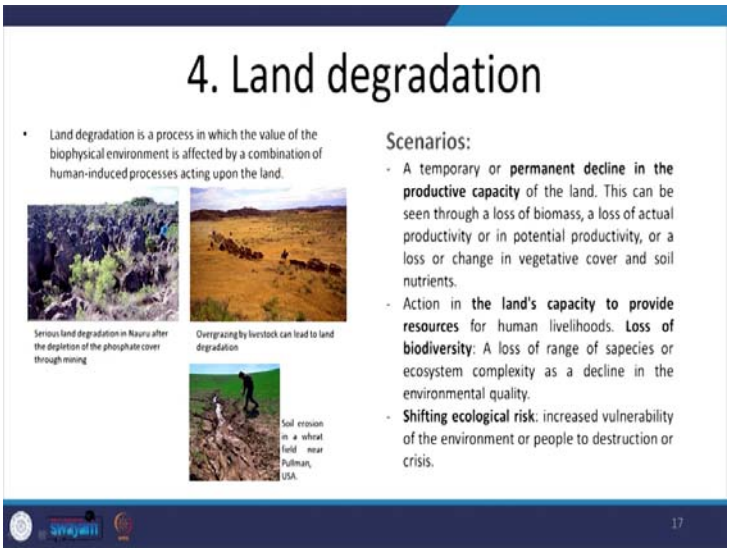
(Refer Slide Time: 21:13)



Entire habitats, forests are in the process of getting destructed simply because of the so, called developmental projects, because we need more land for developing are cities and what happens to the animals to the biodiversity to the organisms living creatures who are residing in ~~these forest~~these forests. They are forced out of their own habitat, they are displaced, they are at times destroyed, they become extinct~~ent~~ and endangered simply because of this habitat destruction.

Across the world efforts are being put in to preserve the habitats from getting destructed if they have been identified as the habitats for certain species mainly the endangered species, but unfortunately the species which was still large in number on earth as on date are not being considered while destructing their habitats the natural habitats.

(Refer Slide Time: 22:31)



Another impact on land is land degradation; land degradation is the first step towards desertification. So, majority of the causes which lead towards desertification are also the reasons which lead towards degradation, which is overgrazing, which is wrong practices of cultivation, faerming, which is wrong use or over use of forest deforestation. So, the same causes also cause land degradation which subsequently result in desertification.

(Refer Slide Time: 23:12)

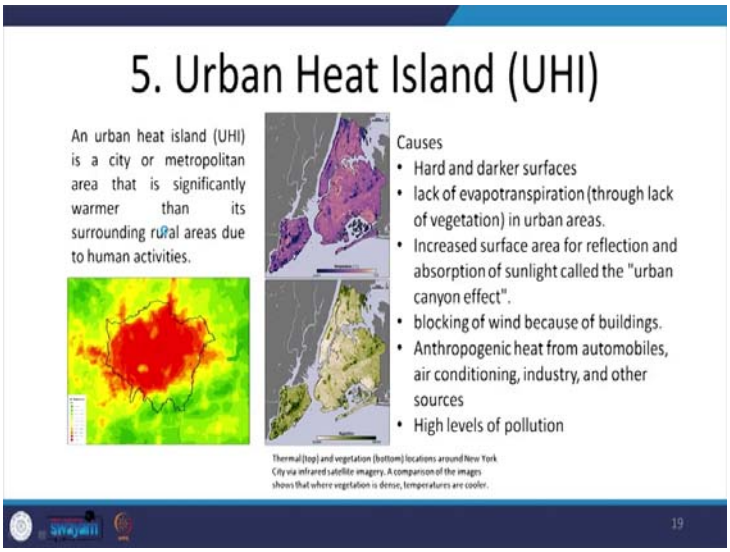
So, the reasons for land degradation and which also further leads to land contamination includes deforestation, a land clearance, agricultural depletion of nutrients from the soil,

overgrazing, inappropriate irrigation, urban sprawl and commercialized development, contamination of soil and acidification of soil because of setting up of industries and dumping of this waste into the soil, soil erosion, loss of carbon from the soil because of erosion, vehicle off roading where the fuel petrol or diesel is getting into the soil because of the vehicles which are off roaded, querying of stone or minerals mining in general is another major reason for land degradation and land contamination.

Increase in the size of field due to economies of scale, reducing shelter for wildlife and as hedgerows and copses they disappear that is another reason now for majority of these problems the reason the bottom line the core reason is that human population has been increasing, we are not controlling are population, we are not limiting it and we are not limiting our needs, we are becoming more and more of a consumer of consumerism society were we need more and more of products produced for fulfilling our needs.

We need more food, we need more industrial products instead of the life style where we required less we now need more and all of it we ~~can not~~cannot consume we waste more and for all of that we again need soil for growing more and for dumping that waste back in to the soil.

(Refer Slide Time: 25:30)



The last one is urban heat island or UHI, urban heat island is a city or metropolitan area that is significantly warmer than it is surrounding rural areas due to human activities. Now what kind of human activities result in urban heat island and how? So, if you look

at the causes hard and darker surfaces lead towards urban heat island, now how is urban heat island caused? During the day when solar radiation receives the surfaces these ~~surfaces~~surfaces, they absorb certain amount of heat some part is reflected back and some part is absorbed depending upon the material property.

Now, this heat which is absorbed since it is constant in the night time when the environmental temperatures outdoor temperatures are low, this body this surface which was at a higher temperature which is at a higher temperature because of higher absorption of all that heat will now reradiate this heat. Now, this reradiated heat is trapped in the atmosphere and that is what causes the atmospheric temperature during the night time to increase this is the phenomena of urban heat island. Now, what kind of surfaces, what kind of materials will store more heat and will reradiate this heat hard surfaces and dark surfaces.

If you look at a grass lawn and if you walk on it during the day or night do you feel the change in the temperature of the surface not really not much. However, if you walk on a paved road during the morning hours and during the evening hours when the sun has already fallen on the ~~surface~~surface, we feel that difference in the surface temperature, that is simply because the surface the material has absorbed lot of heat because it have the capacity.

So, majority of the materials which have been used in a cities are hard materials they absorb a lot of heat unlike our villages in traditional times where the village the homes in the villages the huts were made out of mud, earth and organic materials like weeds and reeds now they did not absorb heat, there capacity to absorb heat is much lower they reflect more and that is why not only the hut would remain cooler, but also the surrounding environment would remain cooler another material for example, is plant itself.

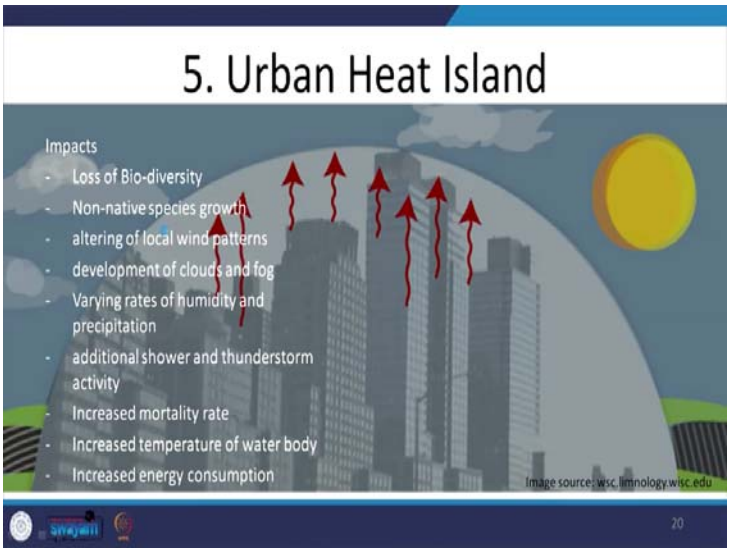
Now, if there is solar radiation which is falling on a plant or a tree it would absorb the radiation and use it for making it is own food instead of absorbing it and reradiating in the night the plants do not do that. ~~Unfortunately~~Unfortunately, in a cities the plants are reducing we hardly have green cover, we only see a lot of hard surfaces the vertical hard surfaces, the horizontal hard surfaces and that is why there is an increase temperature. There is also a lack of moisture there is less of ~~evapotransperation~~evapotranspiration

which is happening because of lesser number of trees which are there the greenery which is their together with increase surface area for reflection and absorption of sun light which is also called the urban canyon effect, blocking of wind because of the urban morphology which is there.

All these 4 reasons lead to an increase in the temperatures of the urban area the urban settlement. Now because the temperature has ~~increase~~increased the energy which is require to create comport inside the buildings through the use of air conditioners and through the use of air conditioned auto mobiles on roads the anthropogenic heat from the human activities that further increases leading to an addition of temperature increase further increase of temperature.

Another reason of urban heat island is high levels of pollution, all these vehicles and industries which emit the ~~green house~~greenhouse ga~~s~~ses they absorb more and more of heat and thereby making our micro environment micro climate hotter warmer.

(Refer Slide Time: 30:23)

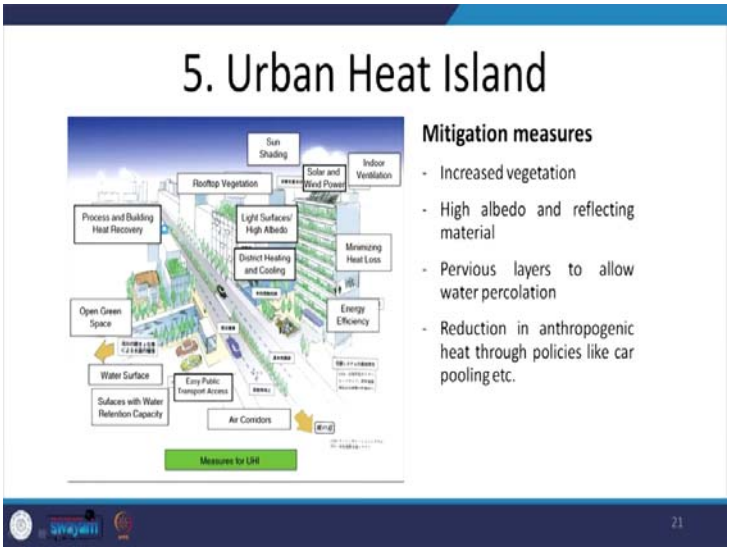


All of this leads to the loss of bio diversity, growth of non native species which we have also seen as alien invaders, altering the local wind patterns, development of clouds and fog which are localized. So, we see smog in daily what we do not see it as we move out of the NCR region when we go towards less urbanized areas. Varying rates of humidity and precipitation, additional shower and thunderstorm activity, because of the negative pressure which is created and there are some socio social impacts like increase mortality

rate in children, increase temperature of water bodies further leading to consumption of energy for creating comfortable environment inside buildings and how can we mitigate?

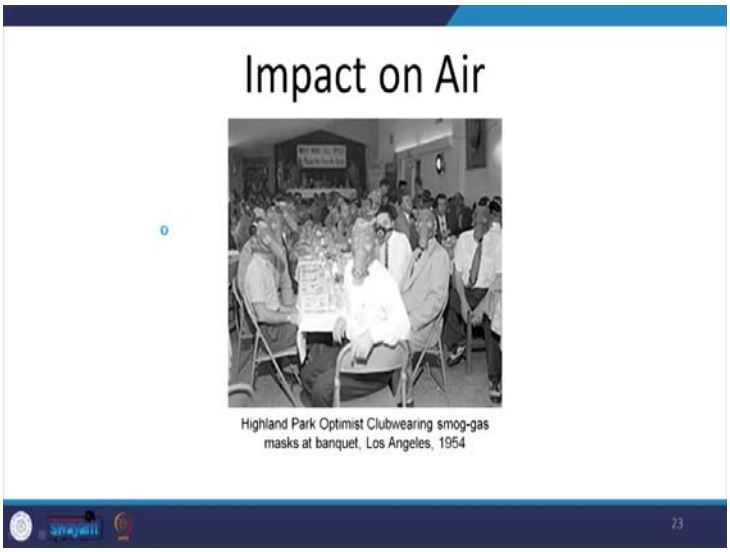
The very simple answer to that is increasing the vegetation more and more trees and green surfaces should be maintained to reduce the urban heat island impact because they will be lesser absorption of radiation. The second important thing is using high albedo and reflecting material, materials which reflect more they directly reflect the radiation instead of absorbing them such materials should be used for example, light coloured surfaces, smooth surfaces on the top of the buildings.

(Refer Slide Time: 32:03)



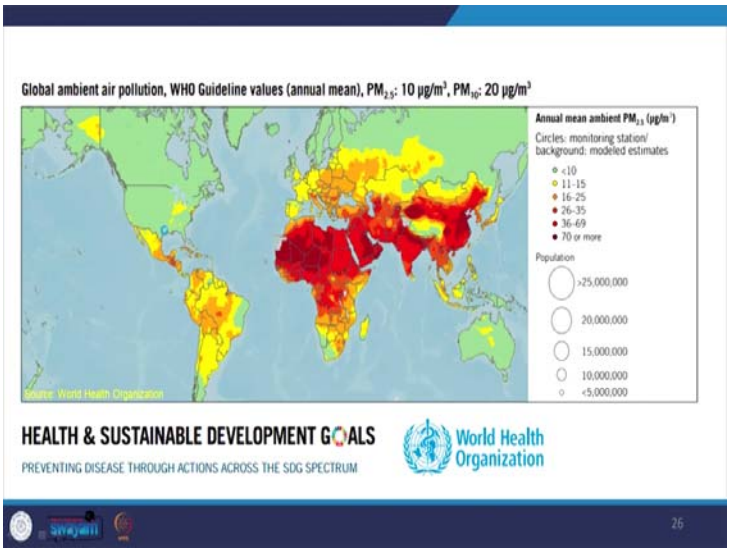
Third mitigation measure is to use pervious layers to allow water peculation if we have very hard paved surfaces roads, they allow for less and less moisture there by reducing the evapotranspiration which further increases the impact of urban heat island. And, reduction in anthropogenic heat through policies like carpooling or improving increasing the efficiency of equipment that is been used in homes through such measures we can reduce the urban heat island in our cities.

(Refer Slide Time: 32:40)



The next we have is impacts on air, this was a protest against the falling quality of air at highland park optimist club wearing smog gas masks at banquet, people started realizing and today we are more aware of how the air quality is changing we know what is the quality of air yet there is not much effort towards improving the quality of air the air is actually becoming poisonous.

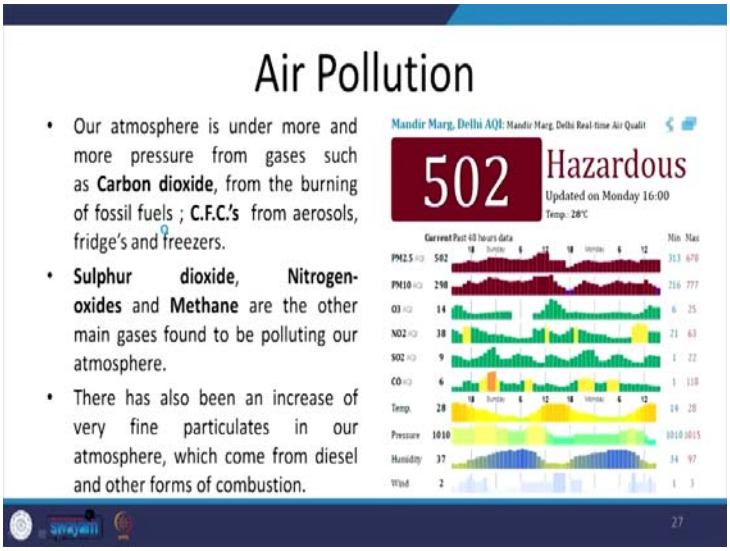
(Refer Slide Time: 33:22)



If you look at this map the world map it clearly shows the quality of air across the world and we see particularly Asia and Africa as the most polluted having the most polluted

air, if you look at the W.H.O. guideline values for the quality of air we realize that large part of the world actually does not have clean air to breath currently. So, what are the further impacts air pollution?

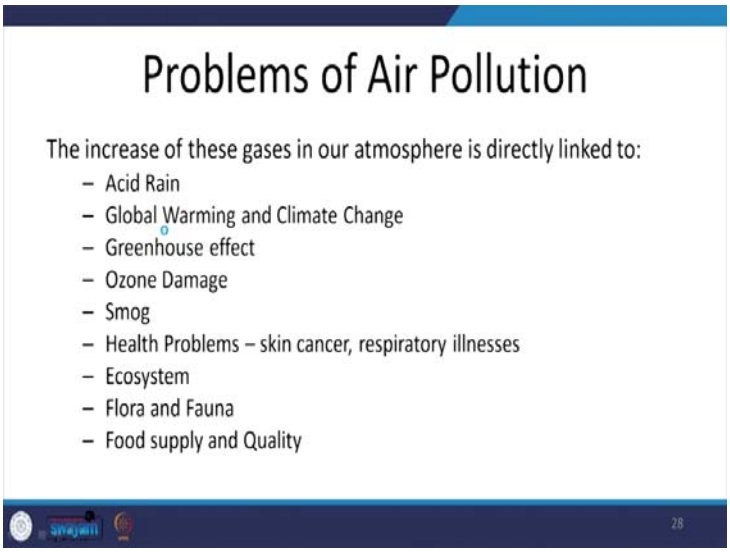
(Refer Slide Time: 34:01)



Now, this is because of human activities only one we are cutting down trees which can reduce the amount of pollution that is present in the air through absorption plants and trees they absorb a lot of different hazards, chemicals which are suspended in the air.

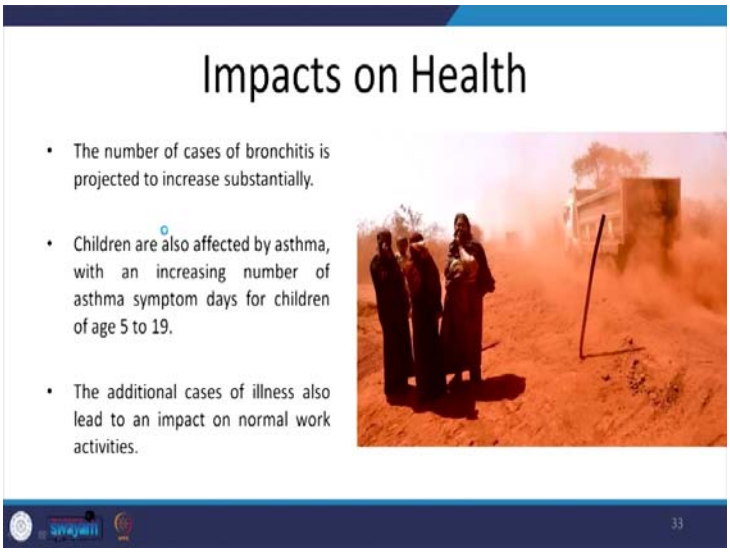
So, the trees, the tree cover is reducing and simultaneously the pollutants are more and more pollutants are be added into the air through our industries, through our transport systems, through the use of equipment for creating comfortable environment inside our buildings, all of them leading to more and more green house gas emissions, more and more ozone deplete things substances, more and more substances which have a higher global warming potential all this together is leading towards air pollution.

(Refer Slide Time: 35:08)



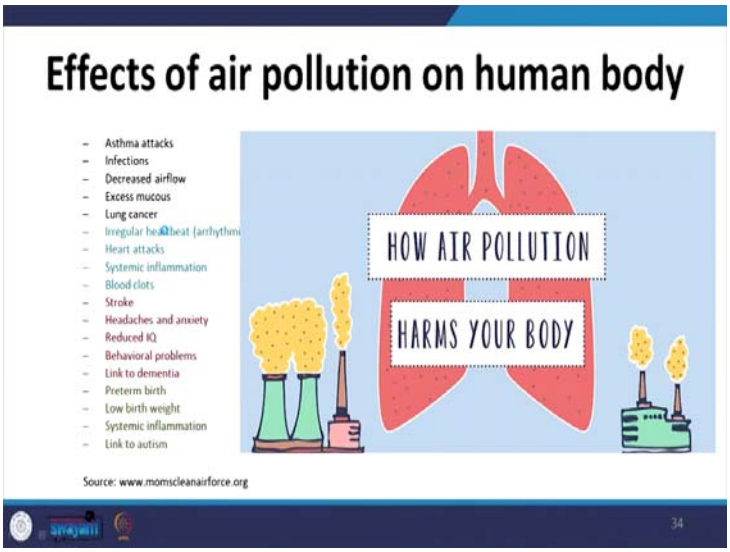
Now, because of air pollution air pollution itself is a huge problem because of air pollution there are further problems which arise for example, acid rain, global warming and climate change these are inter related they are impacting each other, ozone damage, the problem of smog in cities, health problems which are the social problems for example, skin cancer, respiratory diseases, they are increasing because of air pollution. The loss of eco system because of air pollution, loss of flora and fauna and ultimately it is a–effecting these supply of food and the quality of food which is available to the human kind.

(Refer Slide Time: 35:59)

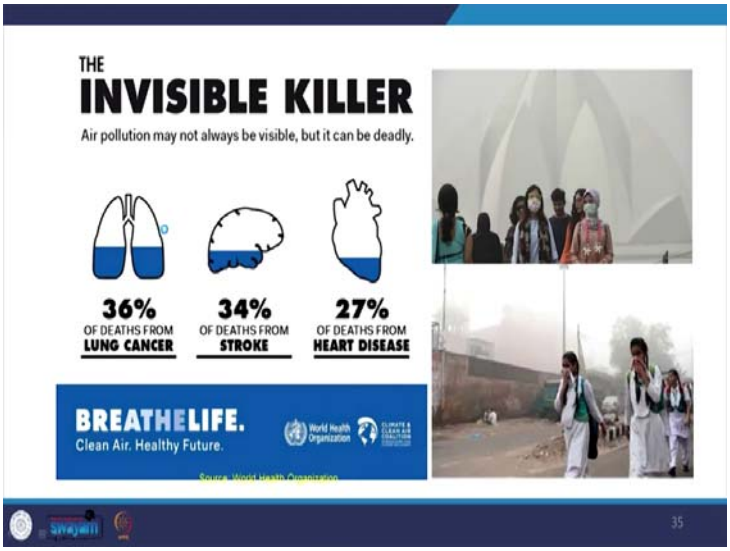


What are the on the health of air pollution, we have more and more specifically in India we are more and more cases of bronchitis, children right from the early ages are ~~effected~~affected by asthma and there is an increasing number asthma symptom days for children in the ages of 5 to 19. There are additional cases of illnesses that lead directly lead to impact the work activities normal work activities there by not just impacting the health, but impacting the economy.

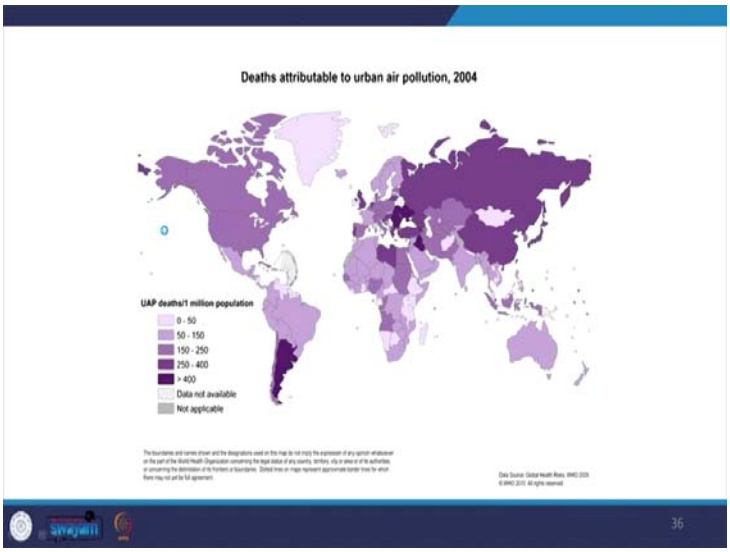
(Refer Slide Time: 36:40)



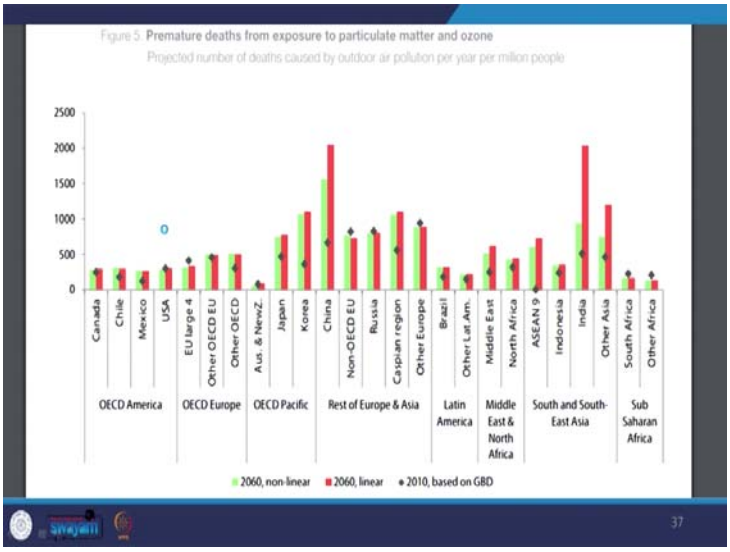
(Refer Slide Time: 36:44)



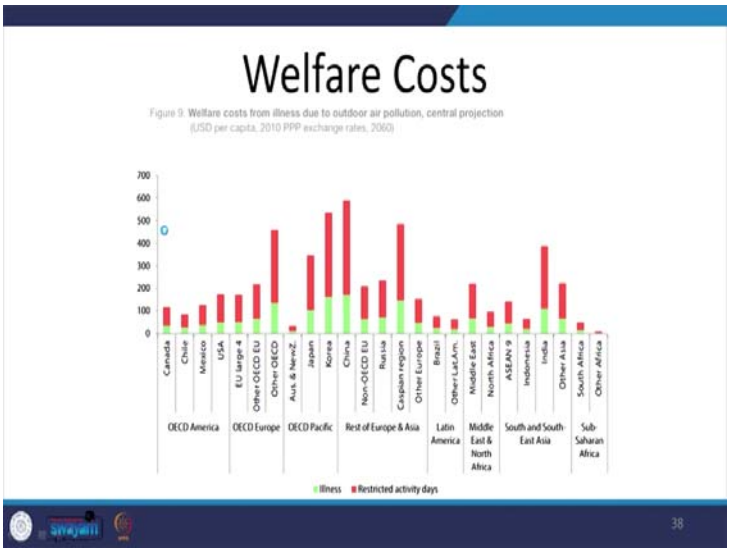
(Refer Slide Time: 36:45)



(Refer Slide Time: 36:48)



(Refer Slide Time: 36:53)



There is a greater impact of air pollution on human body as listed and besides that we have a lot of investment which is going towards the health care which is because of air pollution. So, the welfare costs are increasing if we look at the welfare costs in different ~~countries~~countries, we see that with higher air pollution greater air pollution they spend more towards the welfare costs.

So, such are the impacts of impacts on air because of the built environment. If we look at the impacts of built environment on water, land and air collectively where we realize~~air lies~~ that there is not a single impact which is not there, because of human intervention, everywhere human activity is have led to pollution contamination loss of eco system and in the end all of this is leading to some or the other socio cultural problem.

I will conclude this lecture here and in the next lecture we will look at the ~~socio cultural~~socio-cultural impact of built environment. So, it is not just on natural environment as I said in my introductory lecture I will repeat it again that we are not worried of the impacts are activities have on the natural environment, we have worried of the impacts that this degradation of natural environment has on us as human beings, we are worried of the socio cultural impacts this development and this loss of natural environment has on human kind, see you in the next lecture.

Thank you.