Lecture - 31
Air Quality: Pollutants and Standards

So, it is important for us to read that article land set article in a little more in detail, to understand what are the sources of pollution in the air ok? So, you have to get that big picture first, and then look at you know the fact that what is it you want to go after so, that you will reap rich benefits if you control one of those variables right. So, you must read that article very carefully, we cannot cover the full article, but I will give you an overview of this article which I already started.

So, let me point out to this article again.

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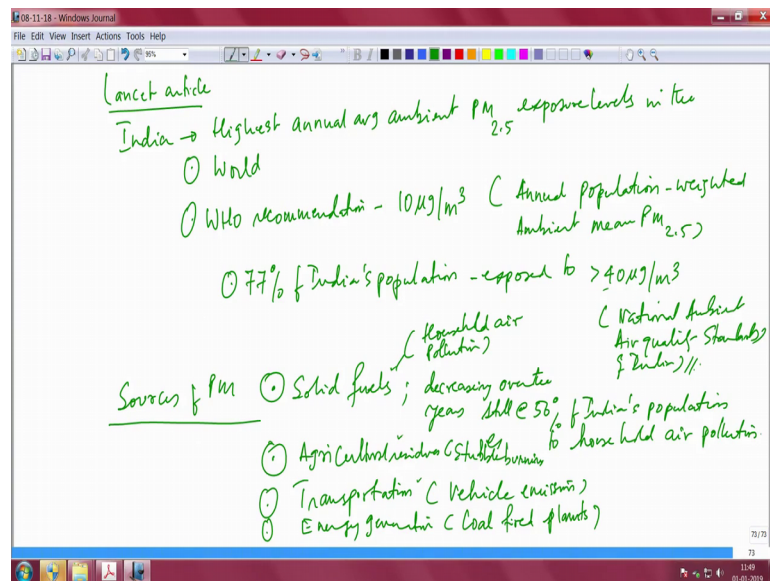
Which essentially says India in as for as India is concerned highest annual average ambient pa particulate matter 2.5 exposure levels is the highest this is the highest; we are the highest in the world this is a big highlight. We the highest annual average ambient 2.5 exposure levels; that means, each humans are basically based on the annual population weighted ambient mean for P M 2.5 this if you take this way of calculation, you understand that we are the ones who are exposed to the maximum levels of P M 2.5 WHO recommendations World Health Organisation recommendation is just 10

microgram per metre cube, based on the same matric annual population waited ambient mean particulate matter 2.5.

But Indian standard is not saying that; Indian standard comes from national ambient air quality standards of India I have written it here and this essentially is the one that is laying standard and 77 percent of India's population is exposed to even the national ambient air quality standards of India which fixes at 40 micrograms per metre cube. So, 77 percent of India is even greater than the value that is fixed by the even by Indian standards, the value is very very high ok.

So, 77 percent of India's population is exposed to greater than the national ambient air quality standards; which is really an issue in such a serious issue that you have to somehow see how can IOT solve; that is all I would say it is as a first step to monitor the air quality standards in this country a large scale monetary large large scale monitoring cheap sensor ok.

Cheap sensors any RND lab which is which you know sort of puts maximum effort in trying to design develop and make you know air quality sensors, I think will do a great service to this country by reducing cutting down by making things very cheap for sensing and monitoring of air quality. Once you know that there is an impending danger some where, you can do hundred different things, but first step is to actually start monitor and give you a real feel for the spatial distribution of the air quality in a city, in a village, in any urban setting, rural setting industrial setting and all that. So, this is important.

So, you must look at sources of particulate matter. So, this article while its talking about particulate matter in a what shall I say in a way that it seems to make noise just about particulate matter this is really not truth, there are other elements also which are essentially causes for you know human suffering from air quality deaths. However, particulate matter indeed is a big contributor, percentage of people dying due to particulate matter is a particulate 2.5 is indeed a large number.

So,., it is not that it is a bias opinion about just particulate matter and what happens to other air pollutants, this paper is sort of focusing more on the P M because that appears to be the one that seems to have a maximum impact. For example, it encompasses several areas from which you can look at air quality. I will come to that because this

article itself is talking about that it is a several areas in which P M actually gets generated.

First thing is solid fuels is a important thing; why is this critical? Because you look at you know different type of efforts by several national labs and I know institutions RND labs and all that, they come out with the; what is the good stove for the village population. How to ensure that you know they do not absorb too much of smoke and which is encompass with so, much of particulate matter because you need to cook right and there is no fuel this is a fuel essentially. Solid fuels are essentially fuels for cooking and this is a source huge source of air pollution in households see.

If you are problems starts right inside your home even for a country like India it is going to be very hard to cut down, because you cannot monitor at the household level what you can do. Therefore, major initiatives have to be taken to as dispel this problem of air pollution in the country itself and therefore, lot of effort has gone in trying to make you know fuel efficient and clean a energy based stoves for cooking stoves for village for towns for cities and so, on so, therefore, it has been there.

So, you make it cheap make it affordable let people buy that, and make the necessary fuel available and make create an ecosystem around the availability of fuel a clean fuel at then people will start using it and cut down on usage of all the solid fuels which essentially can be a the major. So, it is decreasing there is no doubt about it in this country the usage of solid fuels is coming down, but we need to do a lot more that is the point really.
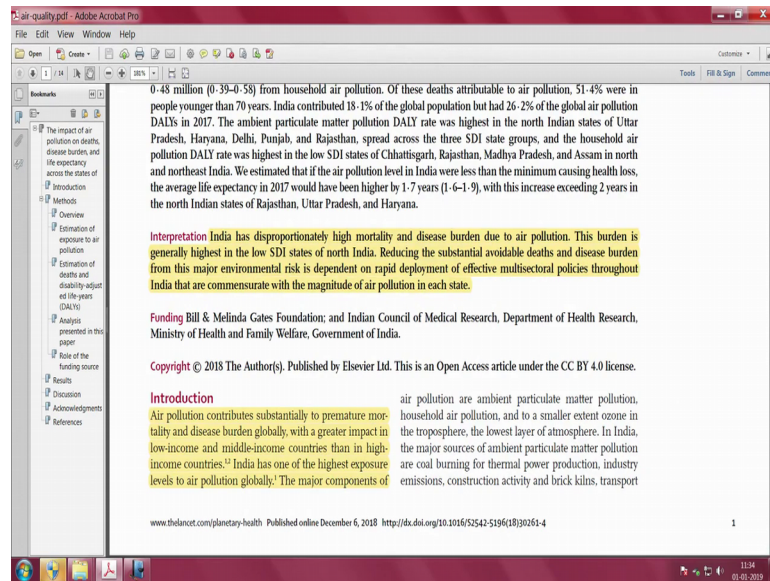
So, still 56 percent of India's population is exposed to household air pollution. This is indeed the major problem I often go back in many years in time to let us say a 40 years back right. So, it to own a wrist watch for every individual in the house was not going to was not really a reality, and there use to be one wrist watch and one clock in the house and that clock in the house was a big luxury right which means wrist watches are very expensive you cannot afford it. But today everyone has maybe I do not know tens and fifteens of watches each time you go you buy a new model you want to hold.

It become cheap affordable. So, if you can you know get air pollution measurement to a simple devices like this and you say that wherever you go, you get a beep or a buzzer says that this is a polluted air and its just 10 rupees I can pay 15 rupees I can buy a watch

of that nature, all though it has just a lifetime of about a month or two I will all use it I will ensure it is biodegradable, I will throw it I will buy a new one and then I will be done fantastic right.

So, you are really revolutionizing the way you are doing air quality measurement every individual around wherever he or she is making a measurement and sort of you know getting some update on what is good what is bad and so, on. But that is a really a dream its not going to happen just like that, at least at the household level if you have a piece of equipment which a sort of monitors everything it is like the wall clock ok. If you have one wall clock equivalent thing for the home and it becomes affordable to buy that device fantastic you have done really wonder.

So, let us see how to build these systems and what kind of a problems technologies have in trying to instrument and be make these systems cheap affordable as well as system design such products; so, this is one thing.

So, summery is you must go back and read this article. So, I will open this article for you and this is the article of interest.

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Reading this article and let me ensure that we go through this article in a little bit more detail, I have marked some parts of it I am sure you be able to .
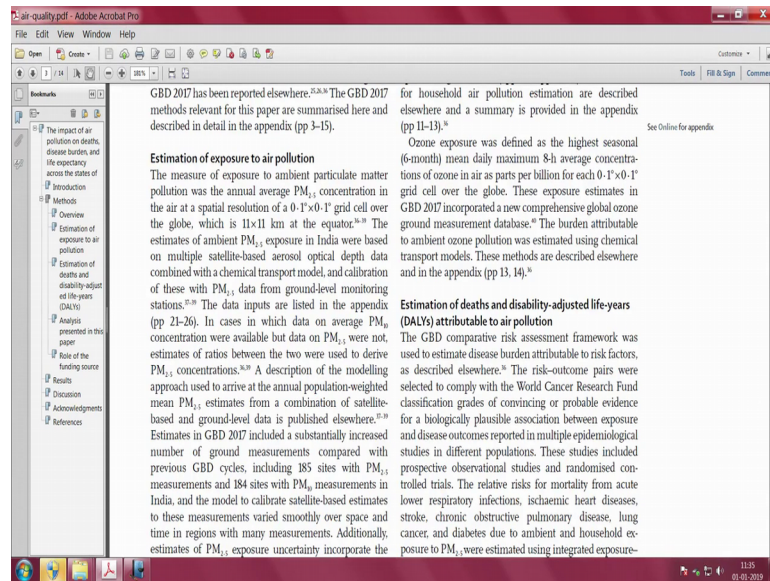
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Download this article and read it and you know look at how grim the situation is.
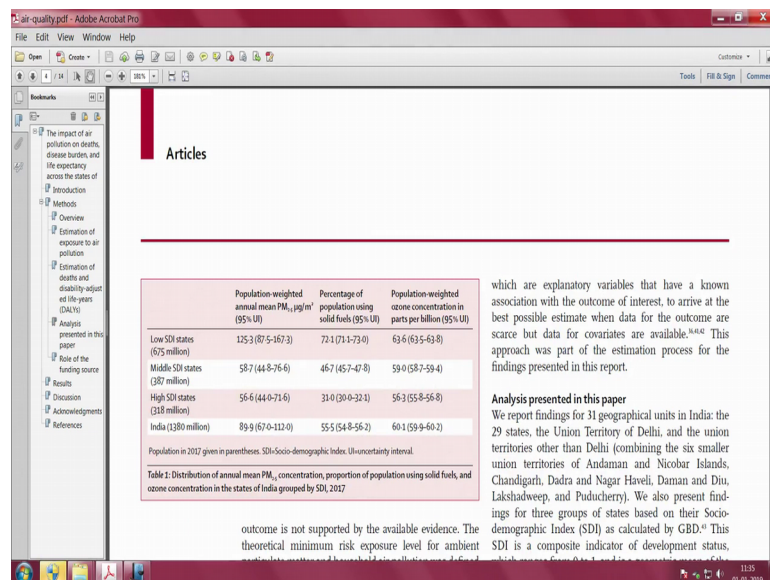
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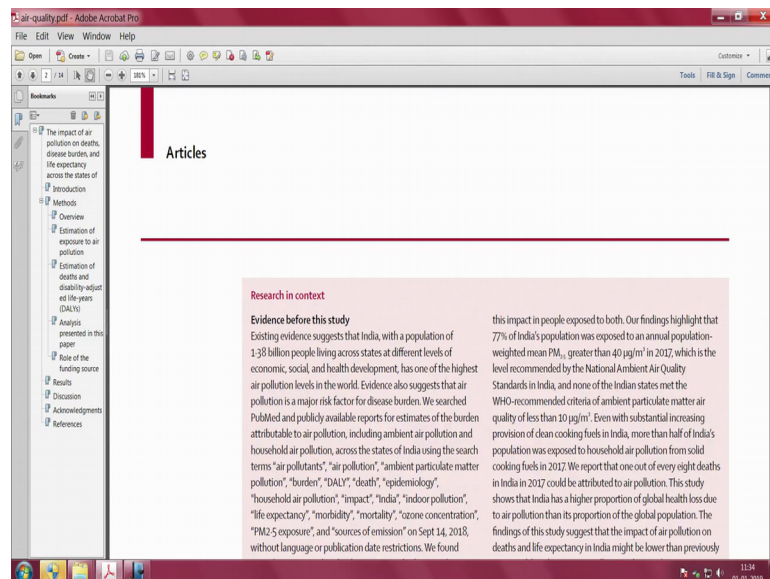
So, this paper is also talked about how does one arrive at some super conclusions like the ones that we have; this paper is talking about the methodology as well. So, it will give you some idea on how they went about making that research and how they actually concluded.
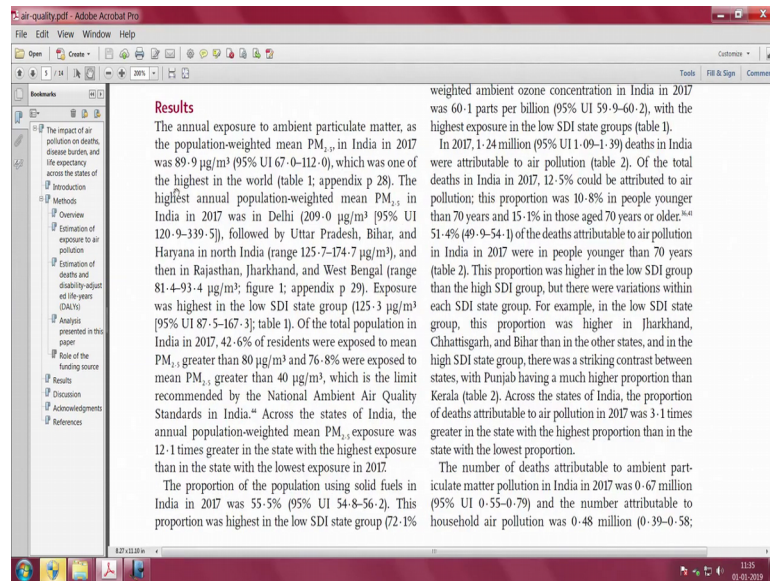
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So, the methods in which they have used to estimate air exposure of air pollution, what is area, what is grid size and what kind of a methodology they adapted all of that is out there in this paper.

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So, we will skip all that, but will come to the most important part which is sources right.

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Can see here, this particular part it says, of the total population in India in 2017, 42.6 percent of residents were exposed to mean particulate matter 2.5, greater than 80 microgram per metre cube and 76.8 percent where exposed to mean particulate matter greater than 40 microgram per metre cube, which is the limit recommended by National Ambient Air Quality Standards in India.

This is indeed the Indian standard, then it says across states what is exposure and so on and so forth. And the number of deaths that are attributable to pa ambient PM pollution in India is 2017 was some number 0.67 million, and the number attributable to household air pollution is 0.48 million. So, these numbers will keep coming and you have to read it carefully to understand what exactly is the real issue behind this air quality.
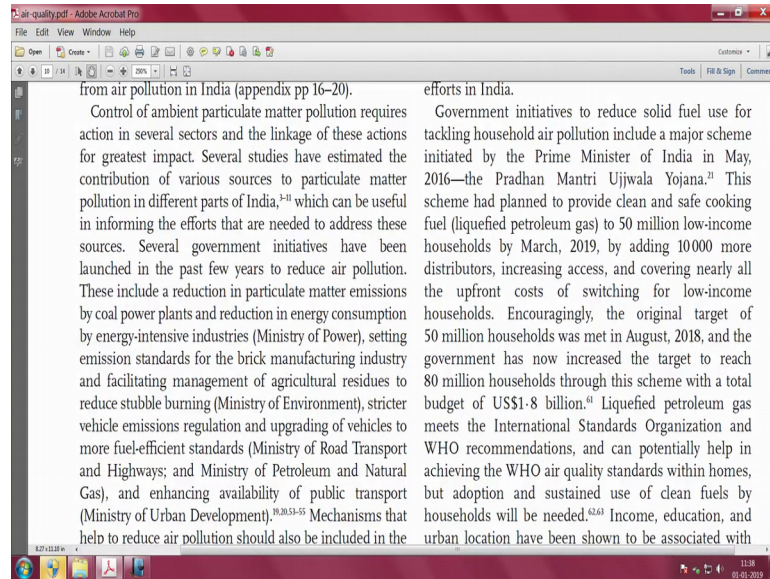
So just to fly through this article; so let us do this reading together and get a grip of the subject. Control of ambient particulate matter, pollution required several action in several sectors and linkage of these actions for greatest impact exactly what we discussed. Several studies have estimated the contribution of various sources of particulate matter pollution in different parts of India, which can be useful in informing efforts that are needed to address these sources. Several government initiatives have been launched in the past few years to reduce air pollution ok.

They have several efforts have been there, and this include reduction in P M emissions by coal power plants and deduction in energy consumption by energy intensive industry. So, first thing; reduction in P M means, you should do reduction in particulate matter missions by coal power plants; our power coal power plants power plant should be much more efficient in its generation and also it should have efficiency in reduction in P M emissions.

This is what Ministry of Power is pushing. Setting emission standards for the brick manufacturing industry and facilitating management of agricultural residues to reduce stubble burning This is a become a major issue in fact, the problem of Delhi pollution air quality mark pollution indeed is something happening from neighbouring states at least this is what the claim of the Delhi government.

So, this is a second thing, facilitating management of agricultural reds residues to reduce stubble burning. So, one is coal power plants, second is stubble burning Ministry of Environment, stricter vehicle emission regulation and upgrading of vehicles two more fuel efficient standards, third is vehicular pollution right and that is from Ministry of Road Transport and Highways and Ministry of Petroleum and Natural Gas. And the other one is an enhancing availability of public transport; when you do mass transport of people, you are bound to reduce the number of fossil fuel driven vehicles and therefore, public transport Ministry of Urban Development and so, on.

Mechanism that help reduce air pollution should be included in the Smart Cities Mission launched by Government of India, about two-thirds of electricity in India is produced from fossil fuels, mainly coal see its again back to coal. But India has pledged in the Paris Climate Agreement, to generate 40 percent of its electricity from renewable sources by some year 2030.

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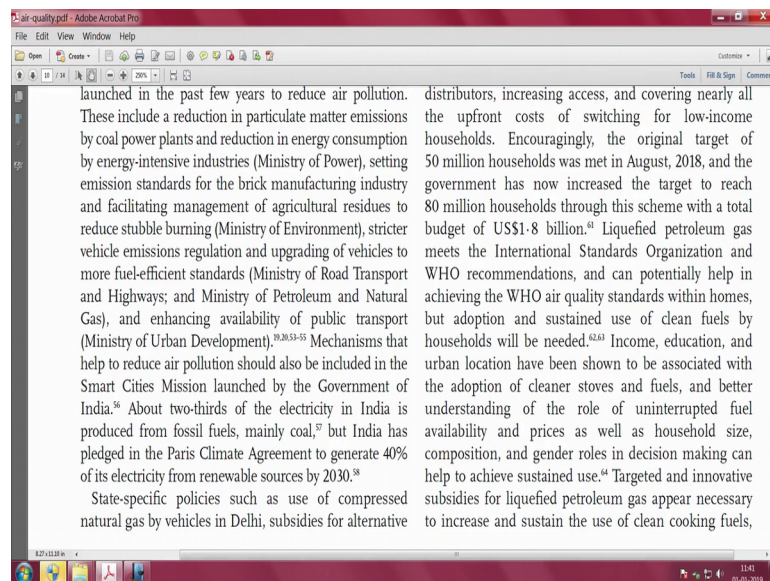
State-specific policy such as compressed natural gas by vehicles in Delhi, subsidies for alternative technologies to composed agricultural waste instead of burning it in Punjab.

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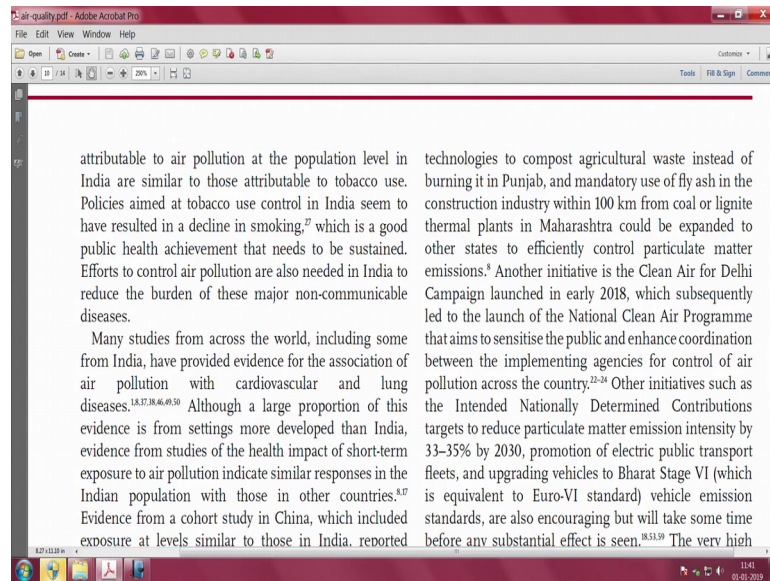
And mandatory use of fly ash in the construction industry, within in 100 km from coal or lignite thermal plants in Maharashtra could be expanded to other states to efficiently control particulate matter emission. So, there are mitigation mechanism switch are looking at how to manage particulate matter generation itself so, that you have clean air. Another initiative is it Clean Air for Delhi campaign launched in early 2018, which subsequently to launch National Clean Air Programme that aims to sensitize public and enhance coordination between implementing agencies for control of air pollution and so on right.

So, then there is other initiative such as intended Nationally Determined Contributions targets to reduce P M emissions by 33 to 35 percent by 2030. Promotion of electric public transport fleets upgrading vehicles to Bharat Stage VI which is equivalent to Euro-VI standard vehicle emission standards, are also encouraging, but will take some time before any substantial effect is seen.

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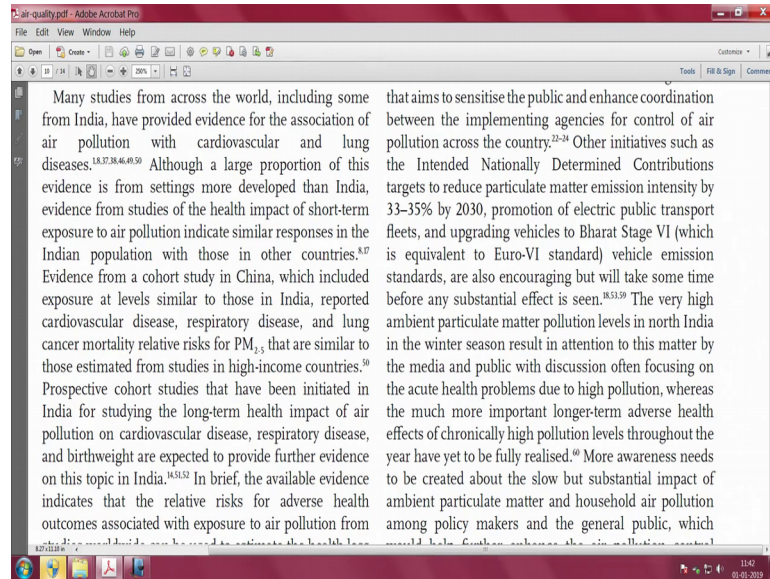
So, you can see so, many reasons why particulate matter is an issue coal fired write coal is an issue, then stubble burning is another issue, then vehicular emissions is an issue for generation of particulate matter and all that. So, the fourth one indeed also will come to.

So, we have already identified three right. The very high ambient particulate matter pollution levels in north India in the winter season, result in attention to this matter by the media and public with discussion on focusing on the acute health problems due to high pollution whereas, the much more important longer-term adverse health effects of chronically high pollution levels throughout the year have yet to be fully realised. More awareness needs to be created about the slow, but substantial impact of ambient particulate matter and household air pollution among policy makers and the general public which would help further enhance the air pollution control efforts in India.

So, you can see household air pollution is another major problem um. So, how many way have we identified already? Coal fired power plants stubble burning third one is vehicular emissions, fourth one is household air pollution four major four major bullets if you have to say, who generates what generates particulate matter you can think of these four as a major problem and you have control each one of them as much as possible, and you have to monitor first if you are to control you have to monitor right. So, you have to do sensing. So, the large scale sensing then followed by some actuation some control.

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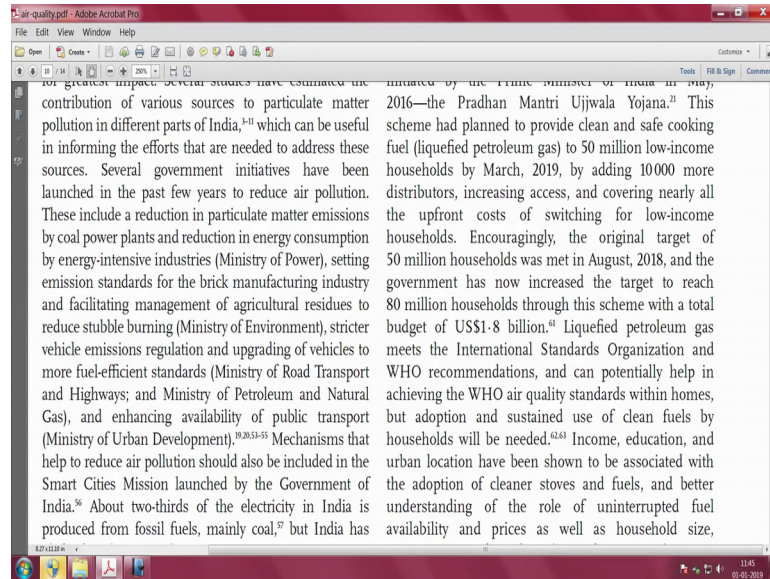
Come to household air pollution. Government initiatives to reduce solid fuel use tackling household air pollution include a major scheme you know about the Pradhan Mantri Ujjwala Yojana which was started in 2016. It is trying to provide clean and safe cooking fuel liquefied petroleum gas to 50 million low income households by some year.

By adding 10000 more distributors and trying to giving access clean fuel and although essentially all of this means that you know you have to move in the direction of sense and mitigate reduce particulate matter right. The WHO higher quality standard with in homes is there and you have to adhere to those WHO recommendation so, that you essentially keep the pollution levels at the manageable levels.

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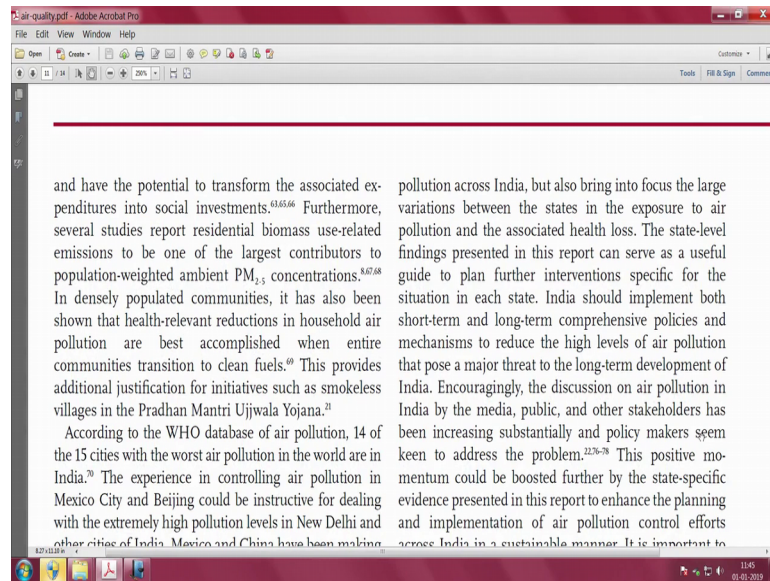
There are several studies that reports such residential biomass use related emissions to be one of the largest contributors of population weighted ambient P M 2.5 concentrations. So, in densely populated communities it has also been shown that health relevant reductions in household air pollution are best accomplished when entire communities transition to clean fuel it is not enough if you do in one. So, you have to do it in a major way, smokeless villages in all that you have to worry about.

So, essentially I want you to read this paper in great detail and arrive at you know your own conclusion on why this is a huge problem and what we can do to reduce to monitor using IOT sensors and ensure that you move towards a positive momentum which could be boosted further.
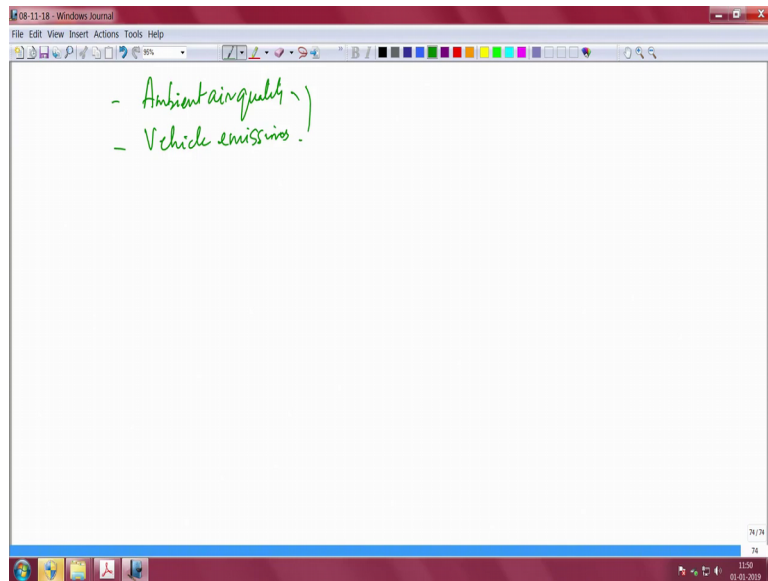
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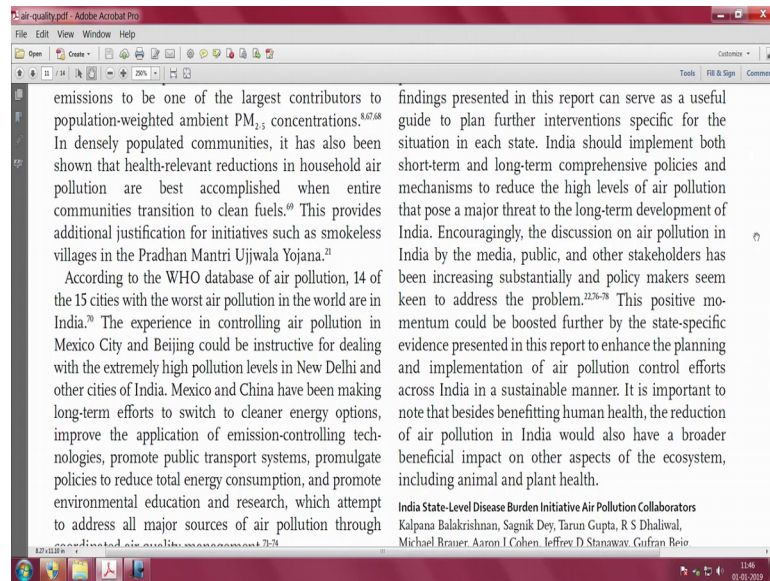
By state specific evidence presented in this report to enhance the planning and implementation of air pollution control efforts across India in a sustainable manner this is important. It is important to note that besides benefiting human health, the reduction of air pollution in India would also have a broader beneficial impact on other aspects of ecosystem including animal and plant health.

So, you can see that this is a major problem and so, later summarise the whole areas under which we could put sources of P M. Solid fuels Pradhan Mantri Yojana is there all that you have you seen in those articles. Second one stubble burning right this is agricultural residue. Third transportation right this is all about vehicle emissions ok. So, solid fuels stubble burning transportation and energy sector energy generation sector generation coal fired plants, for the purpose of energy I would say that you should replace and then you say solid fuels.
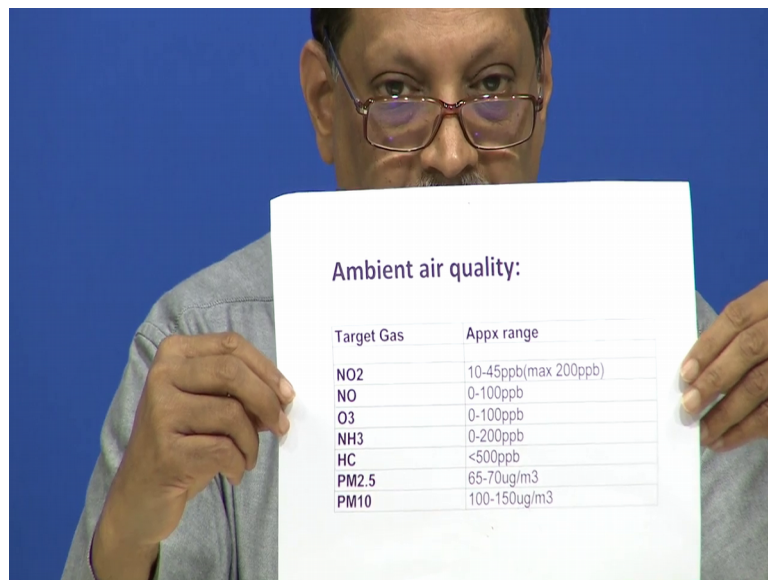
How can IOT solve this problem this is the issue. What I suggest for the remaining part in this course another in this module, ultimately we have to build systems right.

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Let us look at ambient air quality and also let us look at vehicle emissions. So, I mention to you about ambient air quality I will put back this chart for you.

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You can read some numbers you can see ambient air quality these are important, there are others there is sulphur dioxide for instant which is missing in this um.

But never the less nitrogen dioxide is the range here, is a number here you can see nitric oxide is mentioned, ozone is mentioned, NH 3 ammonia is mentioned, then hydrocarbon is mentioned, particulate matter 2.5 is concerned and particulate matter 10 is mentioned.

You can see that 40 microgram per metre cube is what a the you know the safe value which is proposed by Indian standard, but I have put here 65 to 70 which is already extremely bad ok.
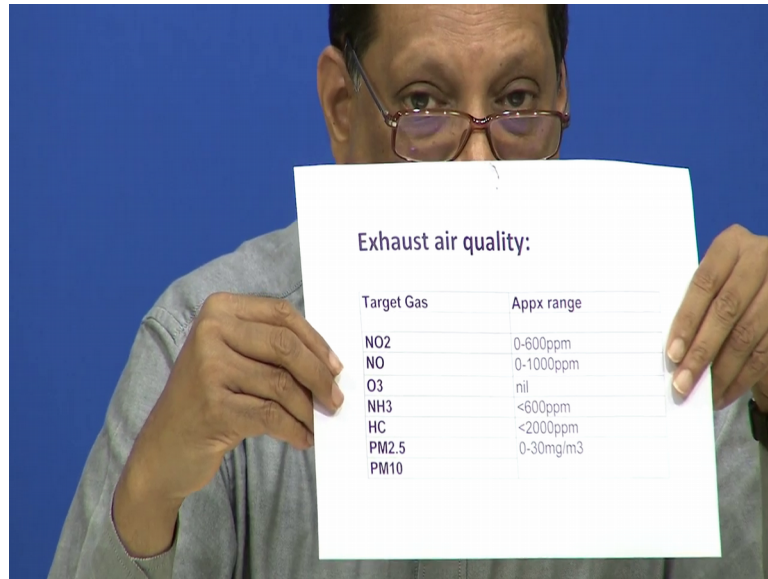
No choice at the moment if you are able to measure 65 70 microgram per metre cube you are already, but if this number goes some four times higher you can think that most dangerous pollution level. So, where is 10 where is 40 and what is the number I have put here? It sounds pretty ridiculous, but I would say that if you are able to at least monitor this value 65 70 microgram per metre cube up to this value accurately, then you are very good.

So, this is not really you do not you do not have to regard this as the number that is very good for humans it is not a good number for humans, what we are saying is this is the approximate range you want to measure very accurately. Up to this value you want to measure very accurately. For instance NO 2 10 to 45 p p b is what it should be one less than that it should be around 10 20 p p b or so, but if you are able to approve ma maximum able to measure up to 20 p 200 p p b accurately whichever sensor you choose if it is doing that its a good job.

So, kindly interpret this chart more from the sensor the sensitivity the range over which a sensor should be able to measure these values accurately not so, much from the fact that these are safe values for humans to live in. These are not really safe values for humans to live in and as you can see it is a clear indicator is particulate matter 2.5, Indian standards says 40 microgram per metre cube, WHO standard says 10 microgram per metre cube, this is already the difference.

So, I hope you are clear with the interpretation of this. For a similar chart can also be done for exhaust air quality.

So, this is another problem that we have, and you are looking at sensors which can measure accurately yeah NO 2 nitric nitrogen dioxide up to 600 p pm, nitric oxide up to about 1000 ppm, ozone should not be there at all ammonia should be less than 600 parts per million and you can see that particulate matter 2.5, you can you should be able to measure accurately up to about 30 milligram per meter cube.

All this happening because of fuel burning inside the vehicle, it is all about fossil fuels it is about petrol petroleum products like petrol diesel and so, on which essentially are contributing to these gases which are coming from the tail pipe ok. Again absolutely unsafe for human breathing, but sensors you choose should essentially be able to cater to this you know range and you should measure quite accurately up to these ranges; that is the real focus of these two charts.