Basic Environmental Engineering and Pollution Abtement
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Lecture 57
Air Pollution Management, Air Quality Survey, NAAQI - 2

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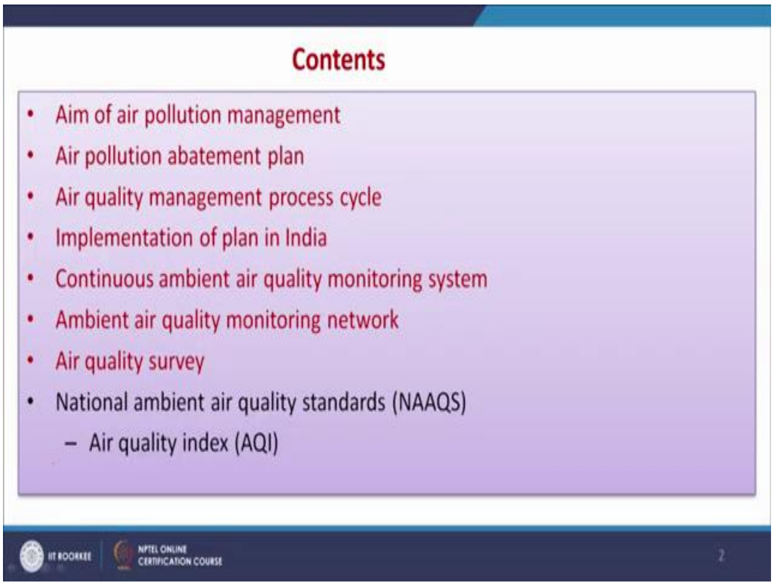

Hello everyone. Now we will discuss on the topic, Air pollution management, air quality survey, National Ambient Air Quality Index part 2. In this class, we will focus on National ambient air quality standard and Air quality index.

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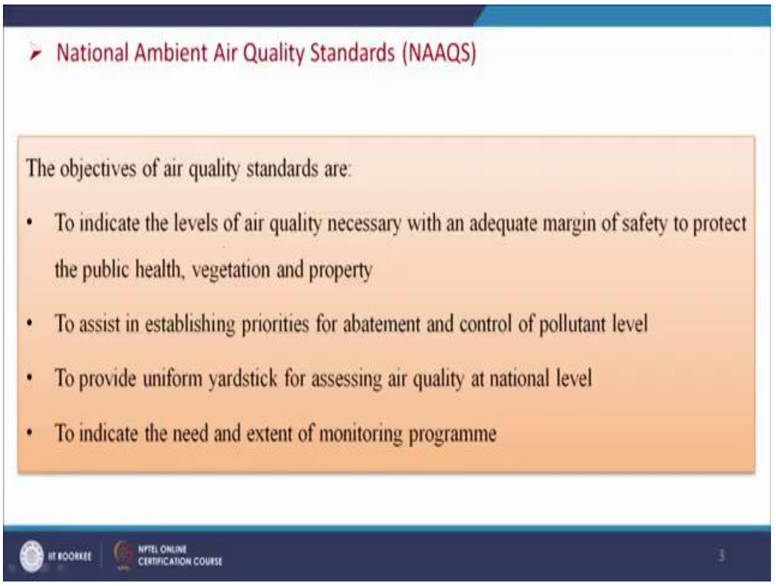

In your previous classes, we discussed on the ambient air quality standard and we have seen for different pollutants, different permissible limits are provided in the standards. So, the main objective of air quality standards are to indicate the levels of air quality necessary with an adequate margin of safety to protect the public health, vegetation and property. To assist in establishing priorities for abatement and control of pollutant level. To provide uniform yardstick for assessing air quality at national level and to indicate the need and extent of monitoring program.

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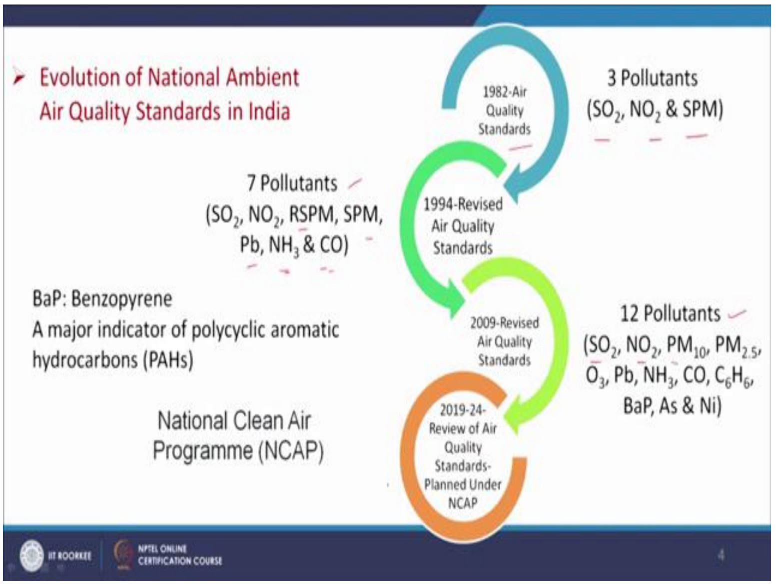

Now, we will see the evolution of National Ambient Air Quality Standard in India. So, in 1982 air quality standards was first introduced, and at that time, 3 pollutants SO_2, NO_2 and suspended particulate matter were considered.

In 1994, the standard was revised and 7 pollutants were included in the standard that is SO_2, NO_2, RSPM, respiratory suspended particulate matter, SPM, suspended particulate matter, lead, ammonia and CO. So, these 4 pollutants are added in 1994. And the concentration of these pollutants are also defined what should be the permissible limit.

In 2009, again it was revised and the air quality standard in 2009 contains 12 pollutants like say SO_2, NO_2, PM_{10}, $PM_{2.5}$, Ozone, lead, ammonia, carbon monoxide, C_6H_6, BaP, Arsenic and Nickel. So these are the different 12 pollutants from 7 to 12, it is increased in 2009. The BaP is Benzopyrene, a major indicator of polycyclic aromatic hydrocarbons or PAHs. And during 2019 to 24 review of air quality standards is proposed for 2009 to 2014. And this is planned under NCAP that is National Clean Air program.

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National Ambient Air Quality Standards (NAAQS)

S. No.	Pollutants	Time Weighted Average	Concentration in Ambient Air: Industrial, Residential, Rural and other Areas	Concentration in Ambient Air: Ecologically Sensitive Area (notified by Central Government)	Methods of Measurement
1	Sulphur Dioxide (SO_2), $\mu g/m^3$	Annual*	50	20	1. Improved West and Gaeke 2. Ultraviolet Fluorescence
		24 Hours**	80	80	
2	Nitrogen Dioxide (NO_2), $\mu g/m^3$	Annual*	40	30	1. Modified Jacob &Hochheiser 2. Chemiluminescence
		24 Hours**	80	80	
3	Particulate Matter (Size < 10μm) or PM_{10} $\mu g/m^3$	Annual*	60	60	1. Gravimetric 2. TEOM 3. Beta attenuation
		24 Hours**	100	100	
4	Particulate Matter (Size < 2.5μm) or $PM_{2.5}$ $\mu g/m^3$	Annual*	40	40	1. Gravimetric 2. TEOM 3. Beta attenuation
		24 Hours**	60	60	
5	Ozone (O_3), $\mu g/m^3$	8 Hours**	100	100	1. UV Photometric 2. Chemiluminescence 3. Chemical Method
		1 Hours**	180	180	

National Ambient Air Quality Standards (NAAQS) Contd.

S. No.	Pollutants	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
			Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (notified by Central Government)	
6	Lead (Pb), $\mu g/m^3$	Annual*	0.50	0.50	1. AAS/ICP Method after sampling using EPM 2000 or equivalent filter paper 2. ED-XRF using Teflon filter
		24 Hours**	1.0	1.0	
7	Carbon Monoxide (CO), mg/m^3	8 Hours**	02	02	Nondispersive Infra Red (NDIR) Spectroscopy
		1 Hours**	04	04	
8	Ammonia (NH_3), $\mu g/m^3$	Annual*	100	100	1. Chemiluminescence 2. Indophenol blue method
		24 Hours**	400	400	
9	Benzene (C_6H_6), $\mu g/m^3$	Annual*	05	05	1. Gas chromatography based continuous analyzer 2. Adsorption and Desorption followed by GC analysis

National Ambient Air Quality Standards (NAAQS) Contd.

S. No.	Pollutants	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
			Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (notified by Central Government)	
10	Benzo(a)Pyrene (BaP)-particulate phase only, ng/m^3	Annual*	01	01	Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As), ng/m^3	Annual*	06	06	AAS/ICP Method after sampling using EPM 2000 or equivalent filter paper
12	Nickel (Ni), ng/m^3	Annual*	20	20	AAS/ICP Method after sampling using EPM 2000 or equivalent filter paper

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time, 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

*Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

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And National Ambient Air Quality Standard here we see as per 2009, when 12 parameters were included, let us say, as given here, SO_2, NO_2, particulate matter PM_{10} and $PM_{2.5}$. $PM_{2.5}$ means as already we have discussed that is size, less than or equal to 2.5 micrometer and Ozone then lead Carbon monoxide, Ammonia, Benzene and BaP, Arsenic and Nickel.

So, these 12 parameters are included. And we see here, time weighted average so different pollutants have different impact on human health. So, the concentration is taken different weighted average, time weighted somewhere it is Annual and we see 24 hours some 8 hours like this we have already discussed on this.

And as per the National Quality Standards, the industrial residential, rural and other areas as per 2009, Air quality standard industrial residential, rural and other areas have been made into the same one category and ecologically sensitive area notified by central government is going into the other category.

So, these are the salient feature of this and in this case we see that 24 hourly or 8 hourly or 1 hourly monitored values as applicable shall be complied with 98 % of the time, 2 % of the time they may exceed the limits, but not on 2 consecutive days of monitoring and annual arithmetic mean of minimum 104 measurements in air at a particular site taken twice a week, 24 hourly at uniform intervals. So, these are the process of collection of data on air quality.

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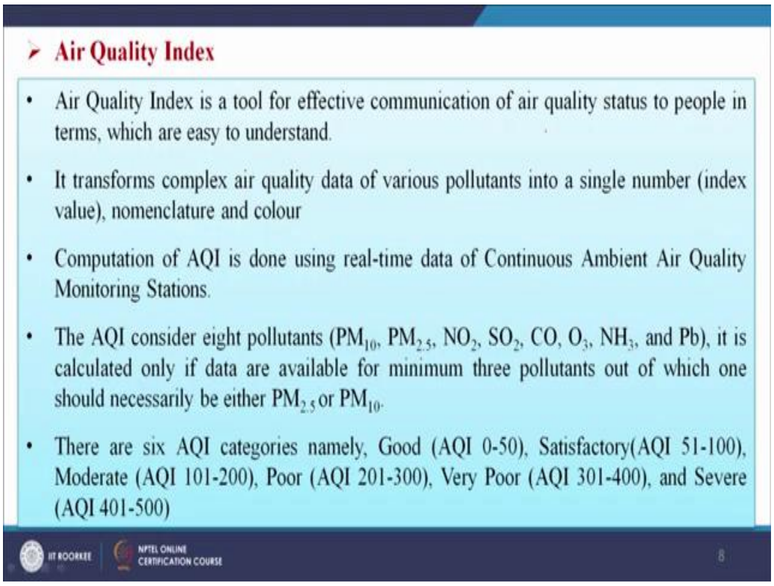

Now, we will discuss on air quality index. So, we have come to know that there are 12 air quality parameters and it is measured across the air following certain methods or procedure. So, for 12 parameters we will be getting large number of data and their impacts will be different and all are present in air. So, what will be the cumulative impact that is the most important point for assessing the quality of the air.

So, that is why new approach has come, that one index will be given that will give some indication about the potential of the air to make harm on human health or animal and plants or on the environment or in the society.

So, that way air quality index is introduced just like say CGPA the performance of any students. So, different subjects have different scores, but CGPA is calculated on the basis of some formula and then one number is assigned. So, it indicates that what performance the candidate is having. So, similar way, air quality index is given to identify the quality of the air.

So, Air Quality Index is a tool for effective communication of Air quality status to people in terms which are easy to understand, it transforms complex air quality data various pollutants into single number that index value nomenclature and color.

Computation of AQI, Air Quality Index, is done using real time data of continuous ambient air quality monitoring stations. So, in the previous class we have discussed that, continuous standard air quality monitoring stations are there where continuously data are being collected and recorded. So, those data are used for the production of this air quality index.

And the air quality index, consider 8 pollutants. So, far although the standards contains 12 pollutants, these here it contains 8 pollutants PM_{10}, $PM_{2.5}$, NO_2, SO_2, CO, O_3, NH_3 and Pb, this is basically for Indian scenario. And it is calculated only if data are available for minimum 3 pollutants including either PM_{10} and $PM_{2.5}$. Any of these 2 must be included in the air quality index.

And the index values have been given in such a way that quality can be defined into different category. So, there are 6 AQI categories namely, Good AQI 0 to 50, satisfactory AQI, 51 to 100, Moderate AQI 101 to 200, Poor AQI 201 to 300, Very poor AQI 301 to 400 and Severe that is AQI 401 to 500. So, this is the different AQI categories and the quality of the air, this is with respect to Indian context.

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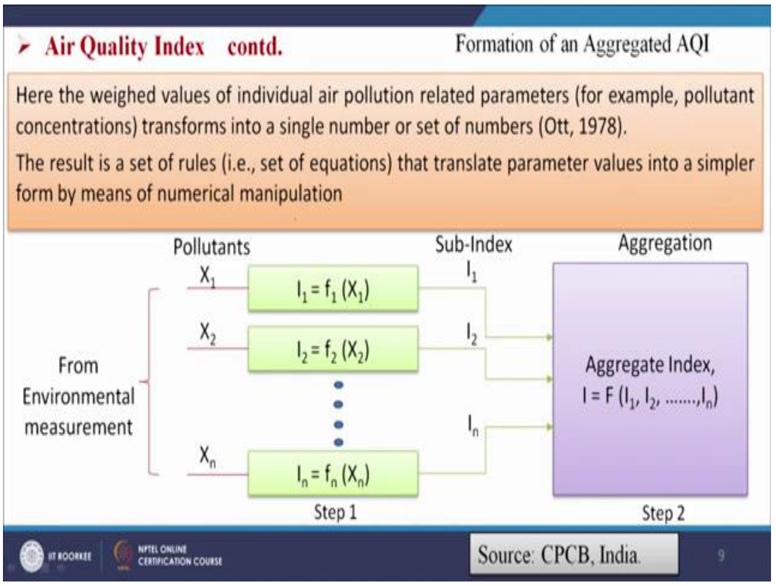

Now, we will discuss how can we develop the AQI or aggregated AQI, that is, collectively what is the impact. So, for that, we need to develop sub-indices, that is for individual pollutants, and then we will get the aggregate of those.

So, these are the sub-index of any pollutant that will be related to the concentration of the pollutant, so, there will be some mathematical relationship and here you see from environmental measurement, we get the concentration of different pollutants, so, those pollutant in concentration will be transformed into some sub-indices corresponding to each pollutants.

So, say I_1 that is index 1 for pollutant 1, so, I_2 for pollutant 2, so, I_n for pollutant n. So, that is I_1 is a function of X_1, that is I_2 is a function of X_2, I_n is a function of X_n, so, that we are getting I_1, I_2, I_n so, these are sub indices and aggregating this, we can get, these are total index or aggregate index that is functional I, that is a function of I_1, I_2, I_3, I_n.

So, there are 2 steps basically, for the determination of air equality next step 1 and step 2. In step 1, we determine the sub-indices, and in step 2, we get the aggregate index. Here the weighed values of individual air pollutant related parameters, for example, pollutant concentration transform into a single number, or set of numbers, the result is a set of rules, set of equations that translate parameter values into a simple form by means of numerical manipulation.

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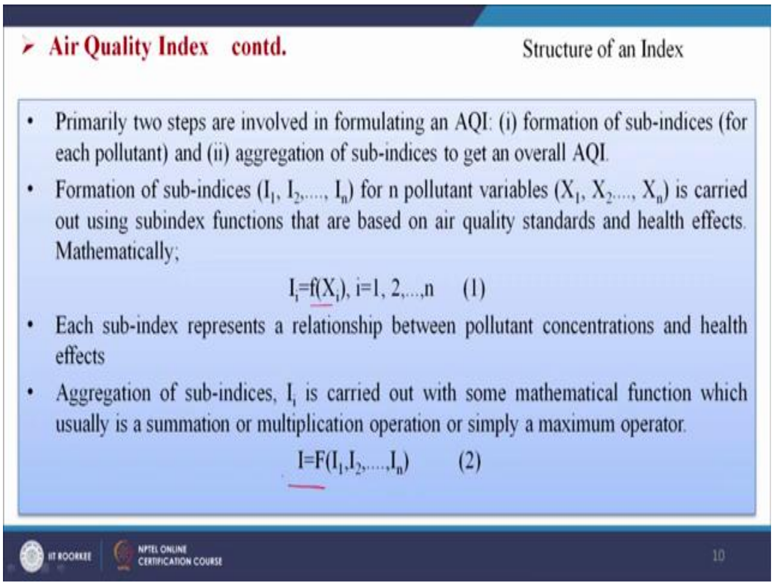

Now, we will say the structure of an index. So, the sub-index is first developed, and you know that this is a function of the pollutant, and this function may be linear, or maybe of other types. And then, once we will be getting the different sub-indices, we will be getting the aggregate of it that is function of I_1, I_2, I_n, etc. So, that will give us the aggregation of sub-indices.

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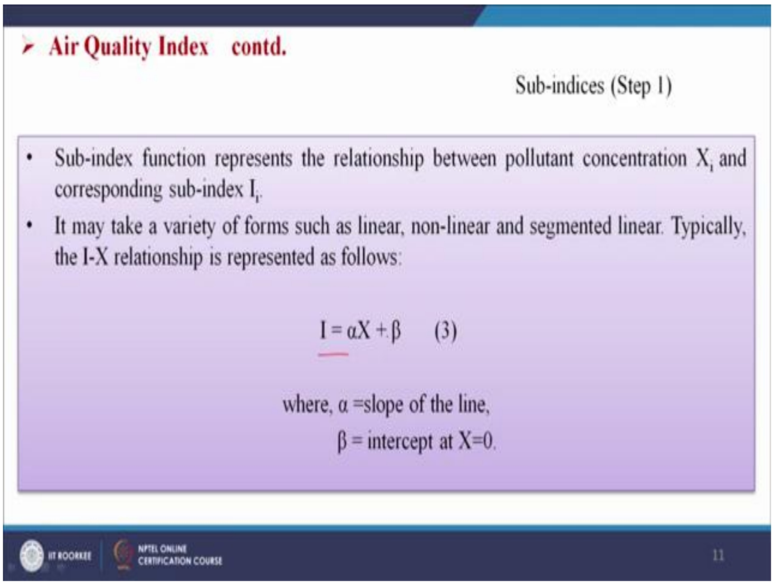

Now, as I mentioned that sub-indices or sub-index maybe of linear or nonlinear type. So, very common, and very simple is a linear one, I-X relationship, concentration of pollutants and impact relationship.

$$I = \alpha X + \beta$$

Where α is slope of the line and β is equal to intercept at X equal to 0, because $I = \alpha X + \beta$ is a linear expression. So, this is one typical relationship, which can be used for the calculation of the sub-index or sub-indices.

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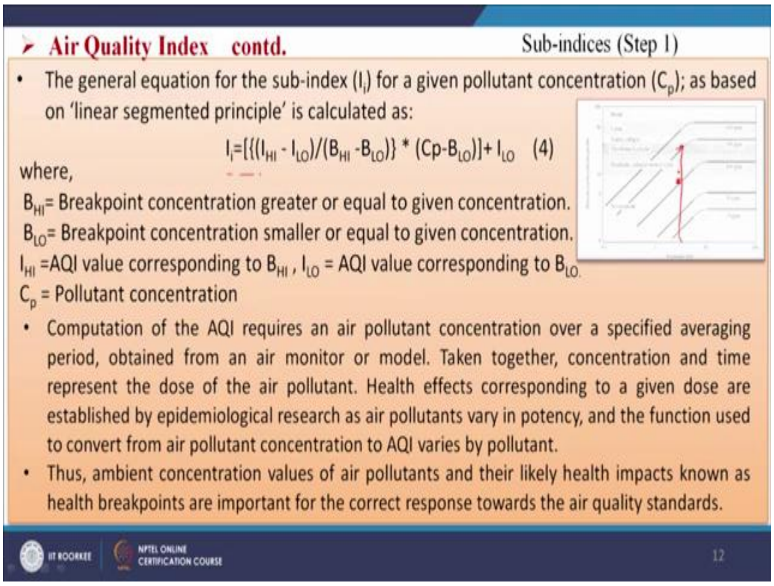

Another method for the determination of sub-indices is mentioned here. The general equation for the sub-index I_i for a given pollutant concentration C_p as based on a linear segmented principle, it is calculated as this,

$$I_i = [\{(I_{HI} - I_{LO})/ (B_{HI} - B_{LO})\} * (Cp-B_{LO})] + I_{LO}$$

Where B_{HI} is the breakpoint concentration greater or equal to given concentration, B_{LO} breakpoint concentration smaller or equal to given concentration, I_{HI} equal to AQI value corresponding to B_{HI} and I_{LO} equal to AQI value corresponding to B_{LO} and C_v is the pollutant concentration.

Now, we will see how we can identify the B_{HI}, B_{LO} etc. So, one typical example, already we have discussed in our previous classes on the impact of CO on human health. So this B_{LO} and I_{HI} is basically determined on the basis of some relationship and some study.

So, to study that competition of competition of the AQI requires an air pollutant concentration over a specified averaging period obtained from an air monitor or model taken together concentration and time represent the dose of the air pollutant, health effects corresponding to a given dose are established by epidemiological research as air pollutants vary in potency and the function used to convert from air pollutant concentration to AQI varies by pollutant. Thus ambient concentration values of air pollutants and they are likely health impacts known as health breakpoints are important for the correct response towards the air quality standards.

So, here we have got one point that is breakpoint concentration. So, from this figure, it will be very clear what the breakpoint concentration means, with respect to carbon monoxide as you already have discussed earlier, that exposure time and this is the concentration of carbon monoxide in the blood or in the hemoglobin.

So, if we see and these are the effects, you see, this is time, this is our concentration. So, if we can take a fixed time, and if we go up here, so, this point and this point we are getting. So, this you see here, headache is starting from this point, and it is above this, there will be some collapse.

So, this impact on the health is taking place within this limit this point to this point. So, this is that will be the B_{LO} and this will be the $B_{HI,}$ and this B_{HI} this how much 160 ppm and this equal to 300 ppm. So, these are saying this point 160 ppm for this same time of exposure, the minimum concentration that is 100 ppm will be giving us some impact that is represented by this band that is headache etc. And when the concentration is more 300 ppm for the same exposure time we are seeing another symptom that is your vomit or collapse.

So, now, the impact is changing. So, for this particular impact, this is our lower dose or B_{LO} value that is breakpoint concentration. And this is our higher breakpoint concentration for the same symptom on the human health.

So, that we are getting B_{HI} and B_{LO} and for this we will be having one impact here that is I_{LO} for B_{LO} and I_{HI} will be getting at this point. So, these two different impacts we are getting in this graph.

So, that way, the impact which we are getting those are different and B_{HI} and B_{LO}, we are getting from this type of relationship and C_p - B_{LO}. Say one example, this is 100, this is 300 any points say 200 in between. So, in between means this one. So, that is our base point that impact of I_{LO} plus some increment on the impact because of the increment in the B values that is C_p.

So, this is our C_P, 200-100. So, due to this increment, we will be getting some increment in this impact also. So, that increment that is equal to I_{HI}-I_{LO} total because of this, changes in the B value from B_{HI} to B_{LO}. So, (I_{HI} - I_{LO})/ (B_{HI} -B_{LO})*(C_p - B_{LO}), so, this is our increment and I_{LO} was the impact related to the lower value of the B or the concentration that is your B_{LO} value. So, that way this impact is calculated.

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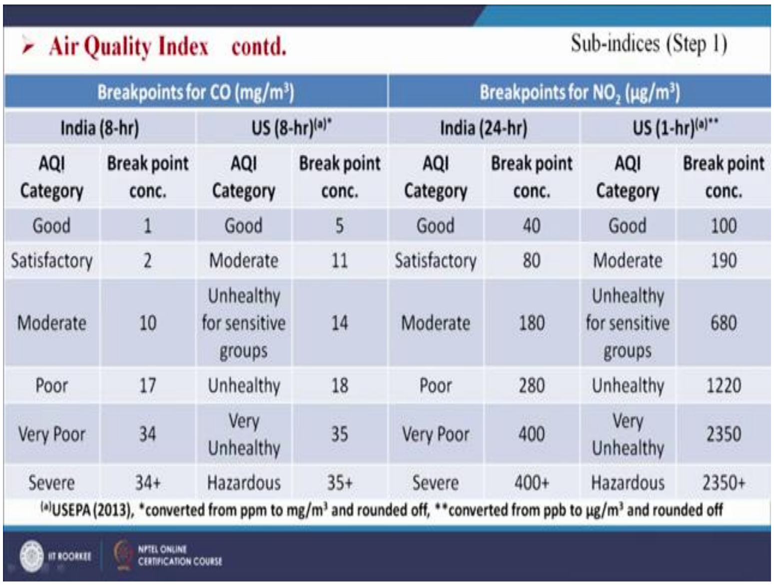

Breakpoints for CO (mg/m³)				Breakpoints for NO_2 (µg/m³)			
India (8-hr)		US (8-hr)[(a)*]		India (24-hr)		US (1-hr)[(a)**]	
AQI Category	Break point conc.	AQI Category	Break point conc.	AQI Category	Break point conc.	AQI Category	Break point conc.
Good	1	Good	5	Good	40	Good	100
Satisfactory	2	Moderate	11	Satisfactory	80	Moderate	190
Moderate	10	Unhealthy for sensitive groups	14	Moderate	180	Unhealthy for sensitive groups	680
Poor	17	Unhealthy	18	Poor	280	Unhealthy	1220
Very Poor	34	Very Unhealthy	35	Very Poor	400	Very Unhealthy	2350
Severe	34+	Hazardous	35+	Severe	400+	Hazardous	2350+

(a)USEPA (2013), *converted from ppm to mg/m³ and rounded off, **converted from ppb to µg/m³ and rounded off

And now, we will see that breakpoints for CO for different country, varies because this AQI ultimately is developed on the basis of some relationship as you have mentioned, and then individual indices are determined and then aggregative indices is determined and these values are different AQI values are different for different quality of the air, like for good quality for Indian context for CO, that is concentration is 1 mg/m^3, but for US, that is 8 hourly basis, that is 5 mg/m^3.

So, similarly it is satisfactory here 2, here 11 similarly, for NO_2, for two different countries India and US you see here 24 hour basis our data collection here 1 hour basis US data collection, and they are good, satisfactory moderate, poor, very poor, severe we India we have this type of classification of the air quality, but US has another type of classifications of the air quality and their values are also different.

So, that way the air quality index are not similar for each country. Individual or sub indices, we can determine and then we will be doing the aggregation of the sub indices and this can be done by different ways.

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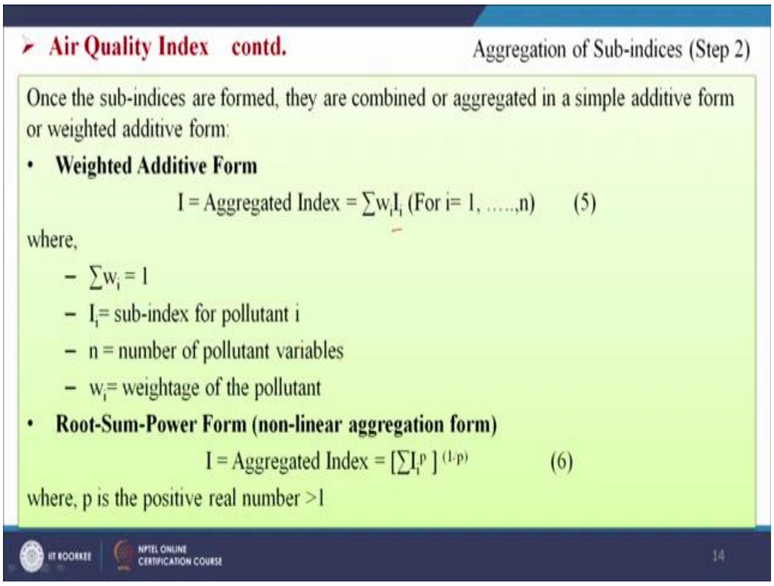

Once the sub-indices are formed, they are combined or aggregated in a simple additive form or weighted additive form, like say

I = Aggregated index = $\sum w_I I_i$, (for I = 1,…….,n)

where $\sum w_i = 1$ and I_i = sub-index for pollutant i and w_i is the weightage of the pollutant and n = numbers of pollutant variables.

So, this weightage can be given by brainstorming involving experts on this area. And since then Roots-Sum-Power from that is nonlinear regression from that is

I = Aggregated index = $\sum[I_I\, p]^{(1/2)}$,

where p is the positive real number. So, these type of expressions can also be used.

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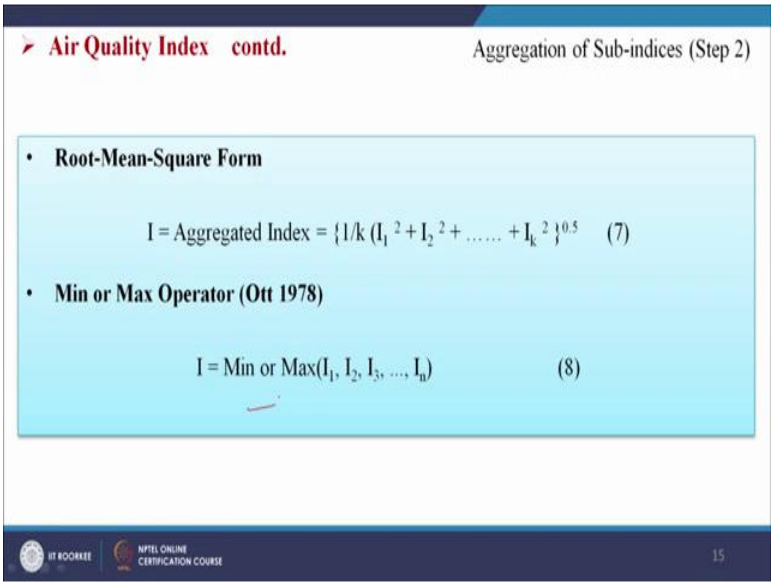

Root-mean-square form has also been proposed, that is,

$$I = \text{Aggregated index} = \{ 1/k (I_1^2 + I_2^2 + \ldots\ldots\ldots\ldots\ldots\ldots\ I_k^2\}^{0.5}$$

And minimum or maximum operator that is another approach, that is when we are calculating the individual indices. So, we can consider the maximum value of individual indices as the aggregative index. So, in Indian context this process is implemented.

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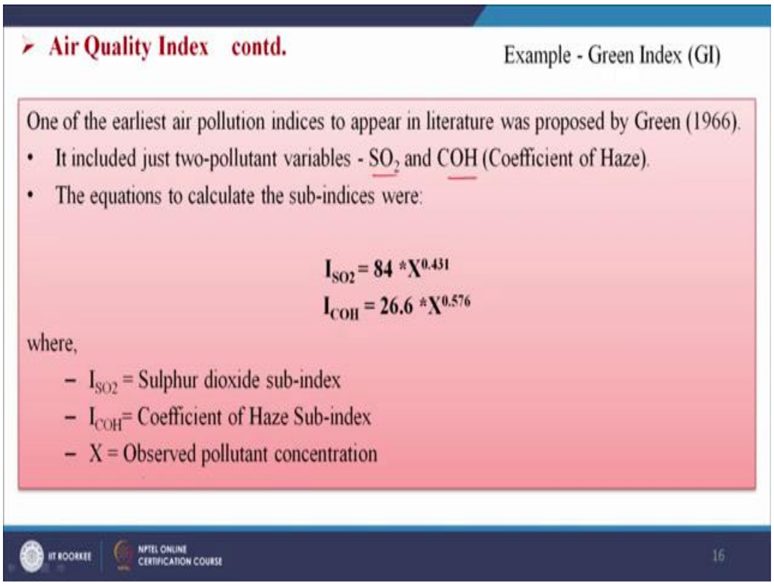

Now, we will see some example of air quality index that is green index, GI. So, green index, this is one of the earliest air pollution indices to appear in literature and it was proposed by Green 1966, and it included just 2 pollutants that it does SO_2, and COH coefficient of H.

So, the I_{SO2}, the impact of SO_2 that is individual impact is a function of X and linear function, $I_{SO2} = 84*X^{0.431}$

$I_{COH} = 26.6 * X^{0.576}$.

So, that is our per green index and then these are the individual indices and I_{SO2} sulfur dioxide sub-index, I_{COH} coefficient of H sub-index, and X observed pollutant concentration.

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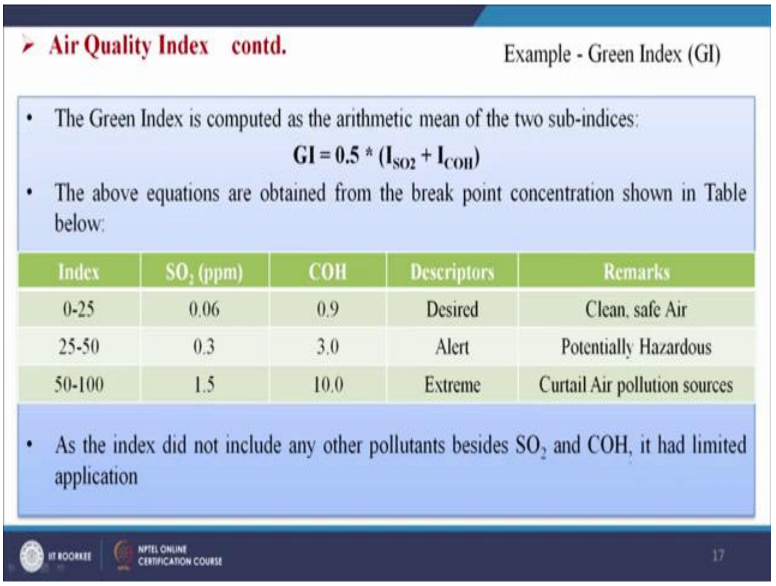

Then green index aggregative is determined like this formula

G.I. = 0.5 * (I_{SO2} + I_{COH})

And here are some examples by using this, the GI for SO_2 and COH index 0 to 25 SO_2, this concentration and COH is 0.9, so, 25 to 50, so, 0.3 to 3 and then 50 to 100, 1.5 to 10, so these 1.5 and 10 for these 2 different pollutants, and they have given different descriptions of these air quality.

So, this is 0 to 25 desired and then 25 to 50 alert and 50 to 100 extreme. So, these remarks that desires been clean safe air, if it is alert been potentially hazardous and extreme means curtail air pollution sources, that is needed for the preventive measures. As the index did not include any other pollutants besides SO_2, and besides COH, it had limited application.

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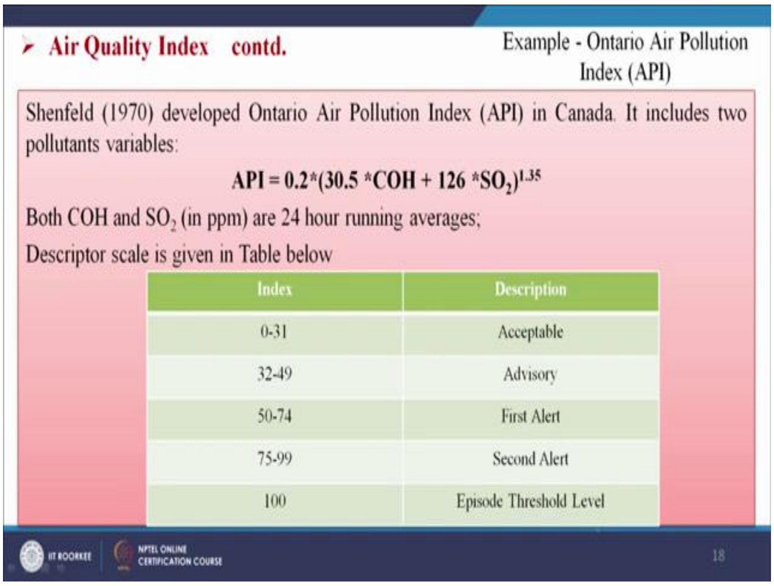

Now, another example is Ontario air pollution index.

$API = 0.2 *(30.5 * COH + 126 * SO_2)^{1.35}$.

So, aggregative API is presented here, they are also same way you see this is a sum, that is a arithmetic mean of these two individual indices and individual indices are defined by this.

So, here, we can see API is equal to this one. So, this 30.5*COH can be the first indices and $126*SO_2$ can be the second indices for a SO_2. So, this the API can be calculated by using this formula, again, it is a function of I_1 and I_2.

So, that way API was proposed and both COH and SO_2 are 24 hour running average, and the values of index was determined at 0 to 31, that is acceptable, 32 to 49 advisory, 50 to 74 First Alert, 75 to 99 second alert, and 100 Episode threshold level, so that way, one method was implemented.

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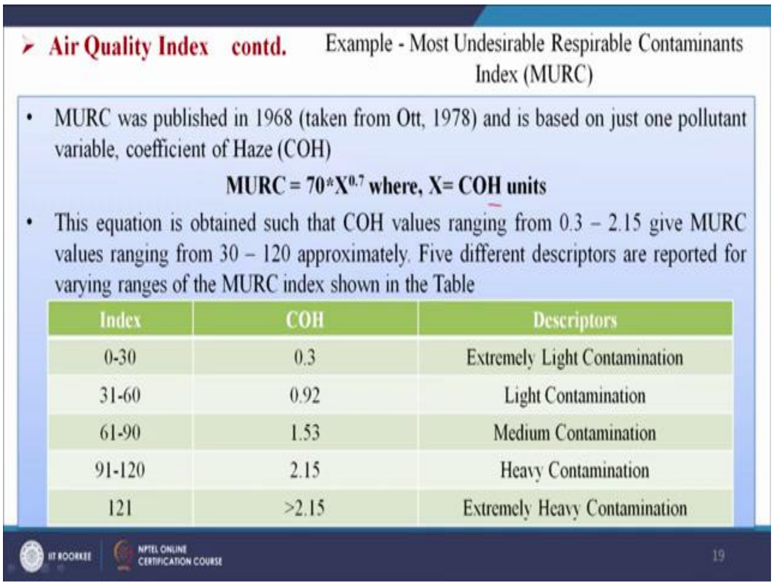

Another example is most undesirable respirable contaminants index MURC. So, MURC was published in 1968 taken from Ott, 1978 MURC is based on the expression that is

MURC = 70 * X $^{0.7}$, where, X = COH units.

So, this is based only one parameter that is COH units. And this equation is obtained such that COH values ranging from 0.3 to 2.15. Give MURC values ranging from 30 to 120 approximately. 5 different descriptions are reported for varying ranges of the MURC index shown in table that is 0 to 30, 31 to 60, 61 to 90, 91 to 120 and 121.

So, COH values are given for different indexes and the descriptions is also given that is extremely light contamination and it is 0 to 30, 31 to 60, light contamination 61 to 90 medium contamination. So, 91 to 120 heavy contamination, 121 means extremely heavy contamination. So, these are the classification of it.

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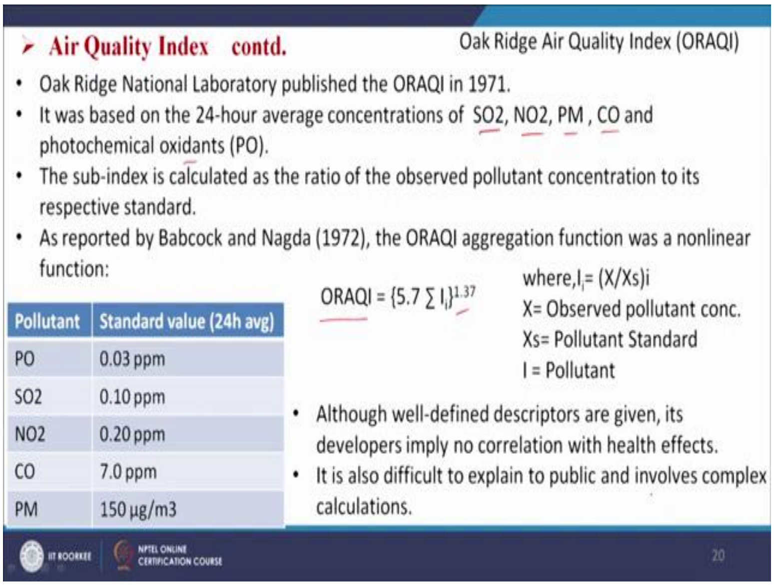

Another is Oak Ridge air quality index. So, Oak Ridge National Laboratory published the Oak Ridge Air Quality Index in 1971 and it was based on the 24 hour average concentration of SO_2, NO_2, PM, CO and photo chemical oxidants.

The sub index is calculated as the ratio of the observed pollutant concentration to its respective standard ratio. As reported by the Babcock and Nagda the ORAQI, aggregation function was a nonlinear function. So, ORAQI = $(5.7*\sum Ii)^{1.37}$, where Ii is the individual indices that is (X/Xs)i. where X is the observed pollutant concentration. Xs is the pollutant standard and I is the pollutant.

So, that way it is, as given here. So, PO, SO_2, NO_2, CO, PM, these are the standard values and that were used in this expression. And all the well defined descriptions are given its developers imply no correlations with health effects. It is also difficult to explain to public and involves complex calculations.

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Air Quality Index contd.

Indian Air quality (IND-AQI)

- The sub-index (Ip) for a given pollutant concentration (Cp), as based on 'linear segmented principle' and is calculated as:

$$I_p = [\{(I_{HI} - I_{LO}) / (B_{HI} - B_{LO})\} * (C_p - B_{LO})] + I_{LO}$$

where,

- B_{HI} = Breakpoint concentration greater or equal to given concentration
- B_{LO} = Breakpoint concentration smaller or equal to given concentration
- I_{HI} = AQI value corresponding to B_{HI}
- I_{LO} = AQI value corresponding to B_{LO}; subtract one from I_{LO}, if I_{LO} is greater than 50

- Finally;

$$AQI = Max\ (I_p)$$

(where; p= 1,2,...,n; denotes n pollutants)

Air Quality Index contd.

Indian Air quality (IND-AQI)

The AQI values and corresponding ambient concentrations (health breakpoints)

AQI Category, Pollutants and Health Breakpoints

AQI Category (Range)	PM_{10} 24-hr	$PM_{2.5}$ 24-hr	NO_2 24-hr	O_3 8-hr	CO 8-hr (mg/m^3)	SO_2 24-hr	NH_3 24-hr	Pb 24-hr
Good (0-50)	0-50	0-30	0-40	0-50	0-1.0	0-40	0-200	0-0.5
Satisfactory (51-100)	51-100	31-60	41-80	51-100	1.1-2.0	41-80	201-400	0.5-1.0
Moderately polluted (101-200)	101-250	61-90	81-180	101-168	2.1-10	81-380	401-800	1.1-2.0
Poor (201-300)	251-350	91-120	181-280	169-208	10-17	381-800	801-1200	2.1-3.0
Very poor (301-400)	351-430	121-250	281-400	209-748*	17-34	801-1600	1200-1800	3.1-3.5
Severe (401-500)	430+	250+	400+	748+*	34+	1600+	1800+	3.5+

*One hourly monitoring (for mathematical calculations only)

Air Quality Index contd.

Indian Air quality (IND-AQI)

The AQI values associated likely health impacts

AQI	Associated Health Impacts
Good (0-50)	Minimal Impact
Satisfactory (51-100)	May cause minor breathing discomfort to sensitive people.
Moderately polluted (101-200)	May cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults.
Poor (201-300)	May cause breathing discomfort to people on prolonged exposure, and discomfort to people with heart disease.
Very poor (301-400)	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with ling and heart diseases.
Severe (401-500)	May cause respiratory effects even on healthy people and serious health impacts on people with lung/heart diseases. The health impacts may be experienced even during light physical activity.

Source: CPCB, NAAQS-2019, India.

Now, we will see the Indian Air Quality Index. So, for the development of Indian Air Quality Index, the first step is to calculate the sub indices or the index for individual pollutant that is based on this linear segmented principle just as we have discussed

$Ip = (I_{HI} - I_{LO})/(B_{HI} - B_{LO})*(C_p - B_{LO}) + I_{LO}$,

But here one thing had I_{LO}, AQI value corresponding to B_{LO}. We need to subtract 1 from I_{LO} if LO is greater than 50, then finally, AQI will be the maximum of I_p. So, this is the methods for the calculation of Indian AQI

And here we see the break point concentration for different 8 pollutants, as mentioned here and then AQI category that is good satisfactory, moderately polluted, poor very poor and severe.

So, this is for the concentration of different pollutants. So, we have to get the index and then sub index and then what will be the maximum value of that sub indices that will be the AQI for Indian context. So, here some values are given that is for breakpoint values.

So, for the say for example, so, B_{LO} for PM_{10} is 0 and 50 and the AQI range will be 0 to 50. Similarly, say for 51 to 100 if it is then this is the satisfactory I_{HI} on this one. So, this I_{HI} will be 51 minus 1 that will be 50 because that we can calculate.

And the different quality of air that is good, satisfactory, moderately polluted poor, very poor and severe. That is different health impacts which are associated with these a minimal impact that is good, satisfactory may cause minor breathing discomfort to sensitive people, and moderately polluted means may cause breathing discomfort to people with lung disease such as asthama, and discomfort people with heart disease children and older adults. And then poor may cause breathing discomfort to people on prolonged exposure, and discomfort to people with heart disease.

And very poor may cause respiratory illness to the people on prolonged exposure effect may be more pronounced in people with lung and heart disease. Severe may cause respiratory effects even on Healthy People and serious health impact on people with lung, heart diseases. The health impacts may be experienced, even during light physical activities. So, these are the severe condition.

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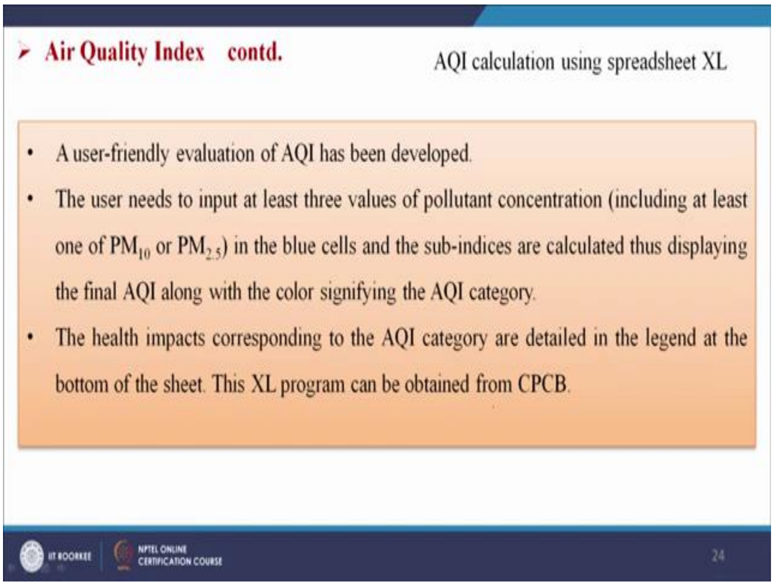

So we will be discussing in tutorial how to calculate the AQI with some example. Now we will see that quick determination of AQI, already some Excel sheets are developed and available in the CPCB website.

So, it user friendly evolution of AQI has been developed, the user needs to input at least 3 values of pollutant concentrations, including at least one of the PM_{10} or $PM_{2.5}$ in the blue cells and the sub indices are calculated thus displaying the final AQI along with the color signifying the AQI category. The health impacts corresponding to the AQI category are detailed in the legend at the bottom of the seat. So, this Excel program can be obtained from the CPCB.

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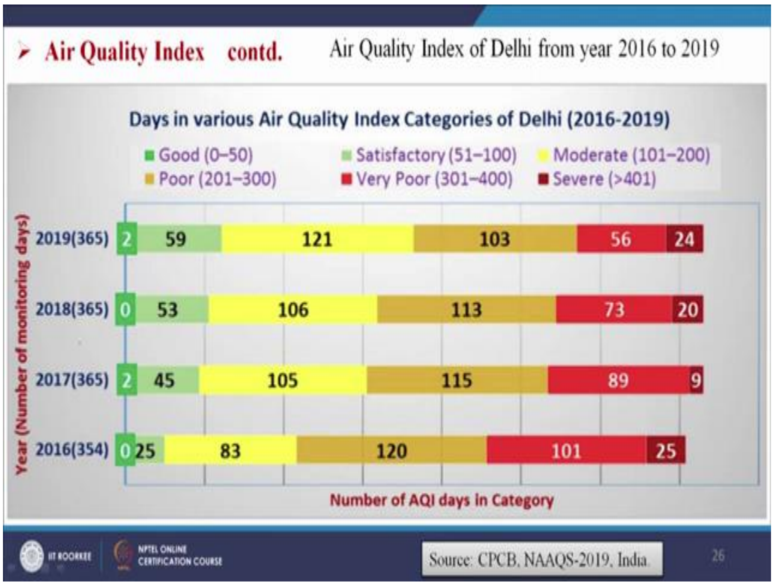

So, you can see this is an example of it. If we have, when we are the concentration values here. So, sub-indices will be generated and ultimately AQI will also be given here. So, here 97 means it is less than 100 so satisfactory. So, this color is also saying satisfactory. So, this is developed by IIT Kanpur and this can be used for the calculation of air quality index, but we need at least 3 air quality parameters out of which one must be either PM_{10} or $PM_{2.5}$.

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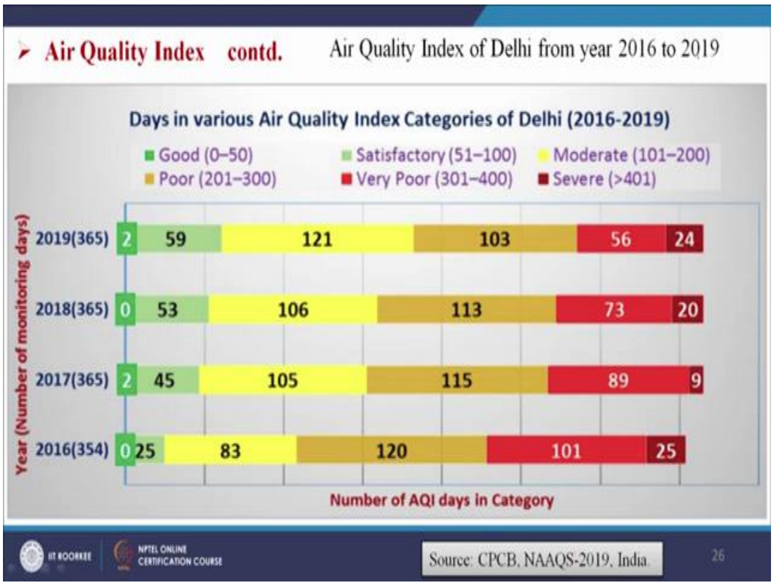

And now, we will see the air quality index of Delhi from year 2016 to 2009. So, you see here 2019, 18, 17, 16. So, we have 0 in 2016 and 2018, that is good quality index with 0 and here in 2019, 2 and 2017, 2 and then days in various Air Quality Index, these are days out of 365 days, 2 days were good in 2019, and 2017, 2 days were good, but 18 and 19, not a single day was good and then satisfactory, that is 59 days, 53 days, 45 days, 25 days, and moderate that is a 121 and 106, 125, 105 and 83 and here poor, 103 113, 115, 120.

So, that way and very poor you see 56, 73, 89, 101, and then severe 24, 20, 9, 25. So, what we can see here since 2016, at least 50 % of the air, the air quality is not good and it is poor and very poor category.

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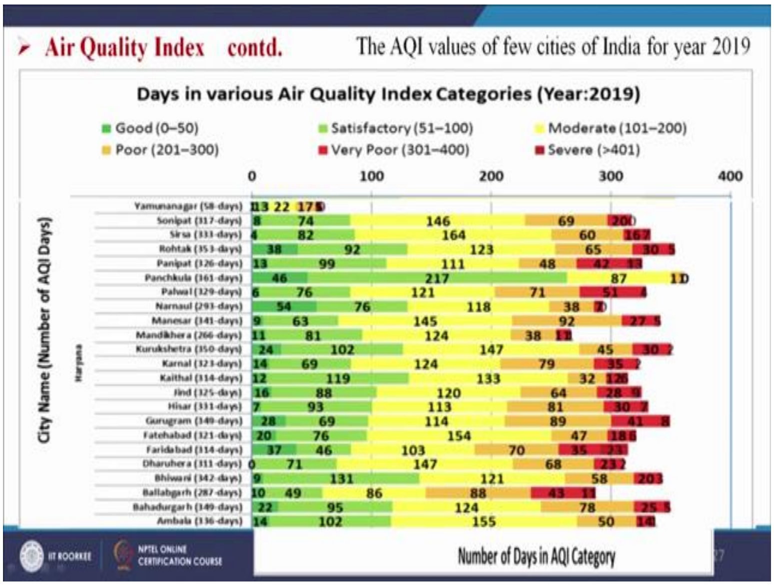

This slide shows us the air qualities index values of few cities of India, for the year 2019. So, here different cities are given. So, out of 365 days, how many days different air quality has shown.

So, it is very clear that with respect to Delhi, more number of days in these places, the air quality index is good. So, air quality is better. So, that air quality index help us to get some idea about the quality of the air by a single number and it is very important for assessing the quality of the air. So, up to this in this class, thank you very much for your patience.