**Air Pollution and Control**
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**Lecture - 14**
**Air Quality Index (AQI)**

Hello friends. Today we will discuss about Air Quality Index. Before that we have gone through about air quality monitoring status across India and what is the significance of air quality monitoring. So, there are various uses of air quality data which we collect through air quality monitoring and one of them is generating Air Quality Index. So, from the name itself it is revealed, index it is some figure or some values. So, these are the values which are used for various purposes for air quality management.

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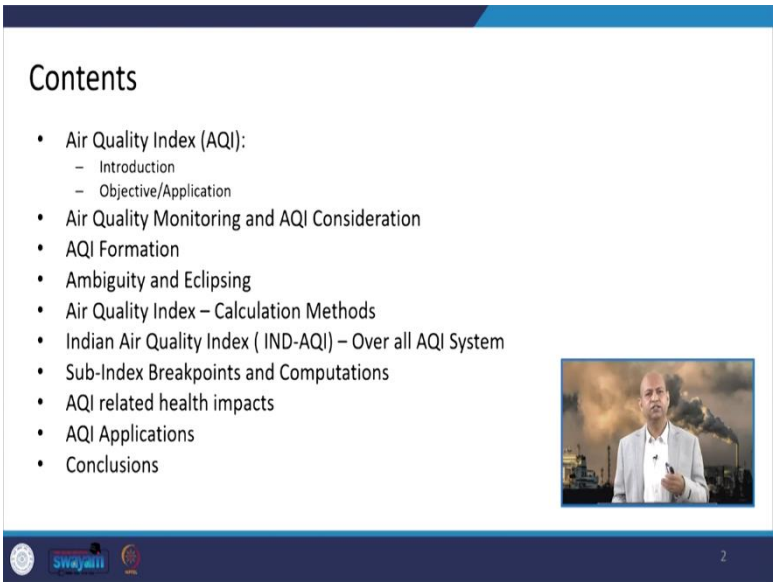


So, today we will discuss about this Air Quality Index and its objectives, its applications, how air quality monitoring and AQI are related to each other? What are the mathematical relationships or formulations of Air Quality Index and then there are certain ambiguity or eclipsing, those kinds of issues are there, how to deal with that related to the data? Then, the methods or various methods are available for calculating Air Quality Indices. So, which is more important and in Indian context which kind of Air Quality Index is more popular or we use.

Then there are issues when we calculate the Air Quality Index then before that we also calculate some sub-index values because after combining all sub-indices, then we calculate the Air Quality Index. So, before that what is the calculation purpose of sub-indices and on what breakpoints they are based upon.

So, what are the computations methods of those? Then we will see health impacts related to different ranges of Air Quality Index, Then applications means, how do we apply those Air Quality Indices for air quality management in different cities or countries and after that we will conclude.

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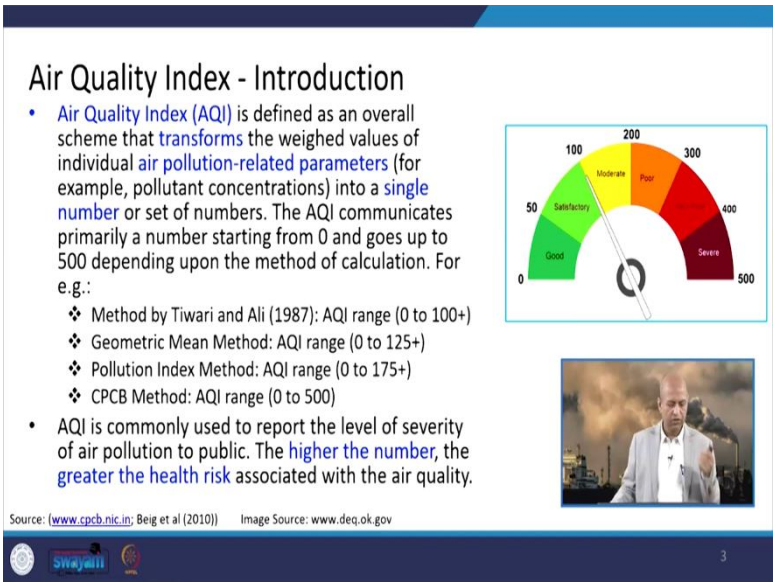


So, when we go about Air Quality Index. So, basically this is nothing but the kind of thing which define a relationship, a figure, a value which defines an overall scheme that transformed the weighted values of individual air pollution concentrations, different air pollutants like $SO_2$, $PM_{10}$, $PM_{2.5}$ all those into a single number. So, we first calculate the different pollutants concentrations and their weighted average or weighted value depending upon their health impacts, and then we combine them.

So, then Air Quality Index is basically kind of the communication purpose primarily a number which starts from 0 to certain high level, like in India we go from 0 to 500. In other cases, it could be like one method is there from Tiwari and Ali that gives AQI range 0 to 100 plus. Then other method is there, which gives 0 to 125 plus. Another one is 175 plus and the CPCB Central Pollution Control Method which we extensively use in India that is 0 to 500 and methodology is similar to USEPA methodology basically.

So, we can say that this Air Quality Index is commonly used to report the level of severity of air pollution to the public, means at any location, at any place, how much intensity or severity or loading of the pollution is there. So, that is reflected by Air Quality Index. Low value means cleaner, very high value means polluted region. Higher number the greater the health risk associated with the air quality.

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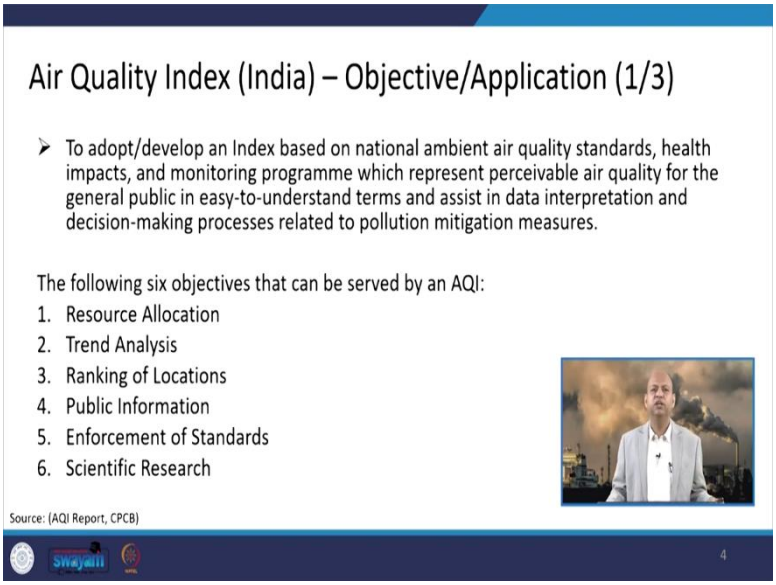


So, how to go for this? What are different objectives? What are different applications? So, basically to adopt or develop this one Index, which is AQI, it is based on national ambient air quality standards and health risk assessments. Monitoring program which are representative for different kind of pollutants in and around a location.

So, those data interpretation is there and this particular range can be coded into different colour schemes which is easily to understood by the public, general public because scientific and engineering approach may be quite complex in terms of values, equations, etc. But general public wants to know whether it is good or bad, moderate, severe, risky all those, dangerous, hazardous, those kinds of things.

So, to go for those kinds of qualitative interpretation, we should have certain quantitative approach also. So, this quantitative approach is basically Air Quality Index related values which gives certain range, according to the range we can announce that this is good or bad or poor or moderate, satisfactory something like that. Then in overall sense, we can say that there are broadly 6 objectives which are served by the AQI, like it is used for resource allocation, it can be used for trend analysis or ranking of locations in terms of polluted or cleaner one.

Then informing the public about the air quality, then enforcement of certain standards whether they are being exceeded or they are being honoured or met, then scientific research because whenever you are coming up with certain new research, new methodology, then also Air Quality Index can give you new approaches to look into that.

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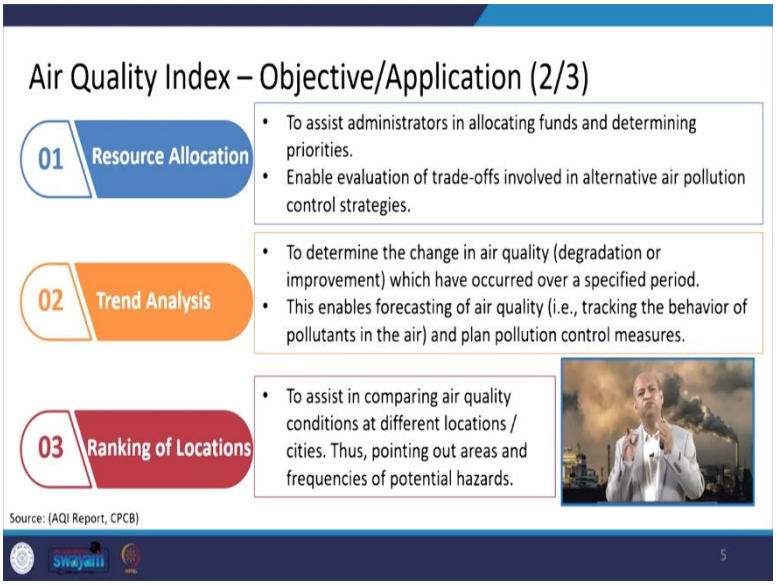


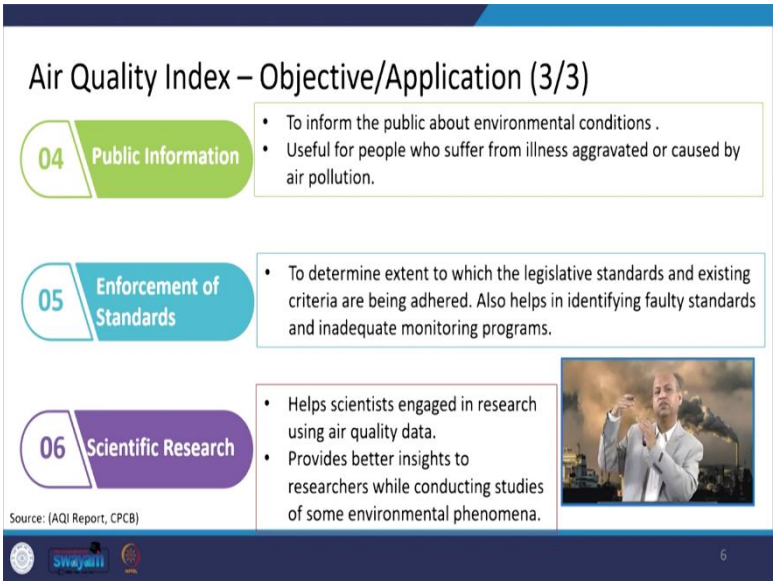


So, when we go about these six objectives basically like resource allocation as you know, because we have, that is limited resources whether it is funding etc, we want to solve certain problem. So, Air Quality Index can give you priority list. Some location is highly polluted then better we invest some resources there to clean it first. Then we can go less polluted areas something like that. So, evaluation of trade-offs, it helps in.

Then trend analysis because, over the years or over the months, we can have different values of the Air Quality Index. So, that also gives certain trends whether it is increasing or decreasing. So, those kinds of trends can give us some information whether, whatever some majors we are taking to clean the air to improve their quality, whether it is working or not, those kinds of things. So, trend analysis can give that kind of information.

Then ranking of locations as I said, you can easily rank with the, this is highly polluted, this is less polluted. So, ranking of different cities with the Air Quality Index you can go for or ranking of different locations you can go for. Then public information, it is very easy because easily understand that range, whether it is high value, then it is highly polluted, less value less polluted, and you can also link it with some colour schemes which can be through website or through boards etc, digital boards, you can give that kind of information which is visible to public and they can understand it easily.

Enforcement of standards because there are certain standards and if they are exceeded by high concentration, ambient air concentration, then this Air Quality Index will be higher. So, we can easily link means if some standards are being met or being exceeded Air Quality Index can give us information. So, we can think in a very easy and very fast way to see whether standards are being met or not.

Then scientific research like it can give new information for research purposes related to air quality data, it can give new insights for conducting studies on some environmental phenomena which could be responsible for poor AQI or something like that. Suddenly, suppose, you get AQI at a particular location very severe.

So, then you want to study what is the region? Whether some local sources is responsible or some transportation of from a wind direction some pollution has come, so, that you can do research and you can link the regions of that poor air quality.

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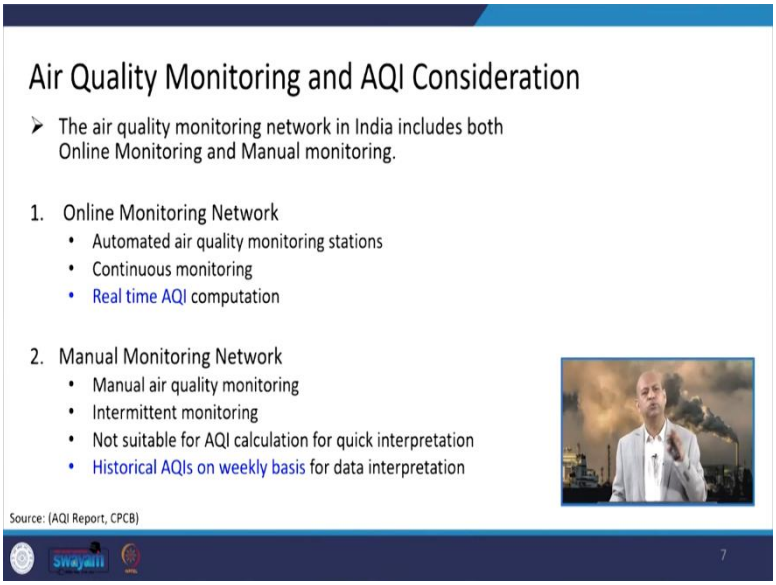


Then we can address those regions. Well, when we go for, what is the role of air quality monitoring in generating AQI or Air Quality Index. So, basically, online monitoring and more manual monitoring goes on in entire country and the online monitoring network, which is automated way of air quality monitoring, this gives continuous monitoring of different pollutants.

So, this is the real time AQI computation is possible with those data. But in case of manual monitoring there is a data gap. Because intermittent monitoring is there, you have to change, you have to analyse in the lab, so real time concentration values are not available for those purpose. So, this is not suitable for AQI calculation for quick interpretation.

But historical AQI is on weekly basis for data interpretation is possible, means just to see some kind of relationship but if you want to go real time AQI to public that every day or some forecasting something then only this online monitoring network is really helpful.

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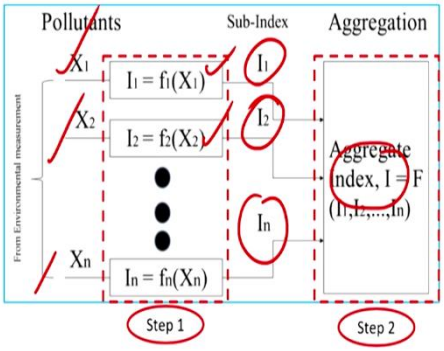
## Air Quality Index – Formation (1/7)




- Primarily two steps are involved in formulating an AQI:
1. Formation of sub-indices (for each pollutant)
2. Aggregation of sub-indices to get an overall AQI

Source: (AQI Report, CPCB)



## Air Quality Index – Formation (2/7)

1. Formation of Sub-indices

- Formation of sub-indices ($I_1, I_2, \ldots, I_n$) for n pollutant variables ($X_1, X_2 \ldots, X_n$) is carried out using sub-index functions that are based on air quality standards and health effects.
- $I_i = f(X_i)$ , $i = 1,2,3, \ldots n$
- Each sub-index represents a relationship between pollutant concentrations and health effects.

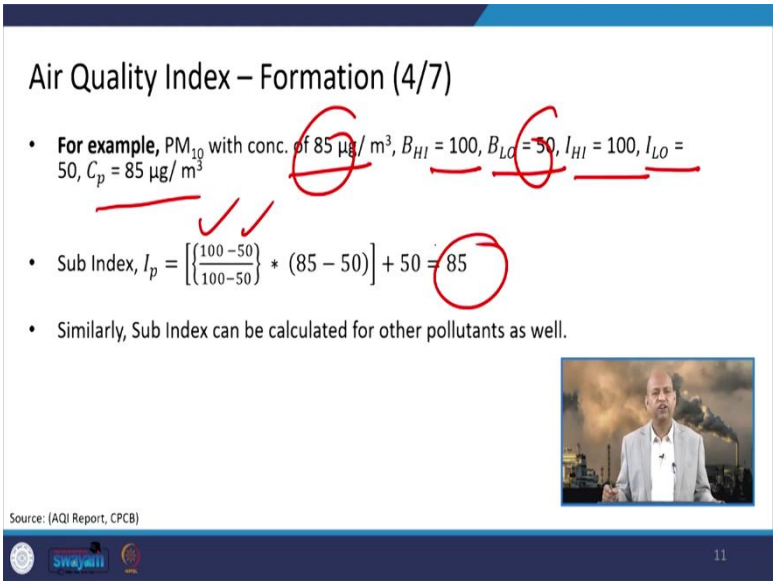
Source: (AQI Report, CPCB)



## Air Quality Index – Formation (3/7)

- The general equation for the sub-index ($I_i$) for a given pollutant concentration ($C_p$); as based on 'linear segmented principle' is calculated as:
- $I_i = \left[\left\{\frac{I_{HI}-I_{LO}}{B_{HI}-B_{LO}}\right\} * \left(C_p - B_{LO}\right)\right] + I_{LO}$ , where
- $B_{HI}$ = Breakpoint conc. higher or equal to given conc.
- $B_{LO}$ = Breakpoint conc. lower or equal to given conc.
- $I_{HI}$ = AQI value corresponding to $B_{HI}$
- $I_{LO}$ = AQI value corresponding to $B_{LO}$
- $C_p$ = Pollutant Concentration

Source: (AQI Report, CPCB)




Well, then how to calculate this Air Quality Index? So, these are two calculation steps like first of all we go for each pollutant like $X_1$, $X_2$, $X_3$, $X_4$, $X_n$. So, we know that for each pollutant we can calculate one index, like $I_1$, $I_2$ something like that, this is the function of the concentration of that pollutant $X_1$, $X_2$ something like that.

Then we develop these indices sub-indices $I_1$, $I_2$, $I_n$ for each pollutant. That will give us whether this pollutant is highly like polluting that particular place or it is okay, it is satisfactory within the range of acceptable limits. Then we combine all these sub-indices, we aggregate, we aggregate, so the combination of all these indices when we integrate or aggregate then we come up with a single index value, I, that is the summation or multiplication or integration you can call of those individual indices depending upon different pollutants.

So, that is the basically aggregation single value of the Air Quality Index, which incorporates or which take into account all sub-indices related to different pollutants. So, this is the way like sub-indices we form $I_1$, $I_2$, $I_3$ for different variables, these are nothing but concentration of pollutants. Then, this is the function, so we get values and then we go for this kind of summation like this equation is there.

So, for each kind of pollutant you can calculate I and then you have single value of summation or integration of aggregation of all those values and here this particular formula which is used in India also basically, so, you can see this $I_{LO}$, this is AQI value corresponding to $B_{LO}$ and $B_{LO}$ is nothing but Breakpoint Concentration lower or equal to the given concentration, which is available concentration, monitored concentration.

$B_{HI}$ breakpoint concentration higher or equal to given concentration and these are related to like $I_{HI}$, AQI value corresponding to $B_{HI}$, $I_{LO}$, AQI that is Air Quality Index value corresponding to $B_{LO}$ and $C_P$ is the pollutant concentration basically. So, you put those values and you get this index I. Then you go for different pollutants and then you summation occurs then you can get the single value.

So, there is one example like for $PM_{10}$, let us assume that concentration is 85 micrograms per cubic meter and $B_{HI}$ is 100 and this $B_{LO}$ is 50 and $I_{HI}$ is 100, $I_{LO}$ is 50. So, the calculation becomes very easy and you get this value you put those values 150, 85, this is 85 and 50, this is 50. So, you get the 85, this sub-index of this pollutant P is 85. Similarly, you can calculate for different pollutants and then you can aggregate them.

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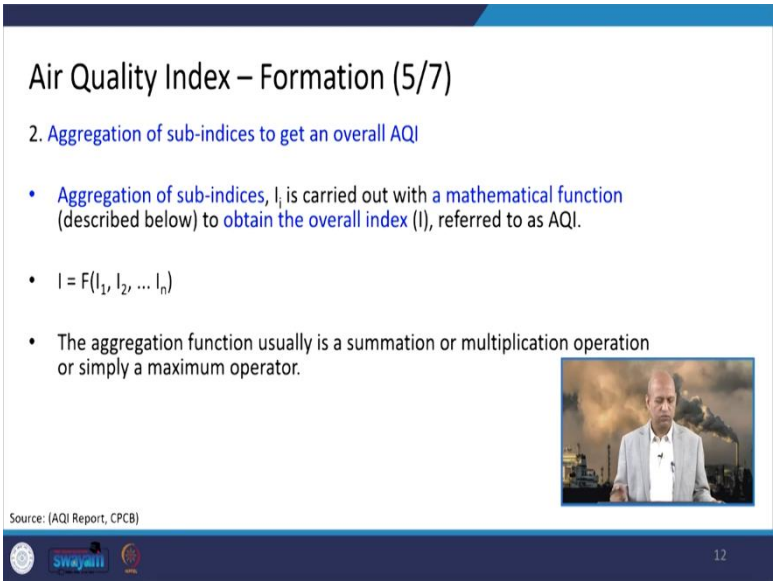


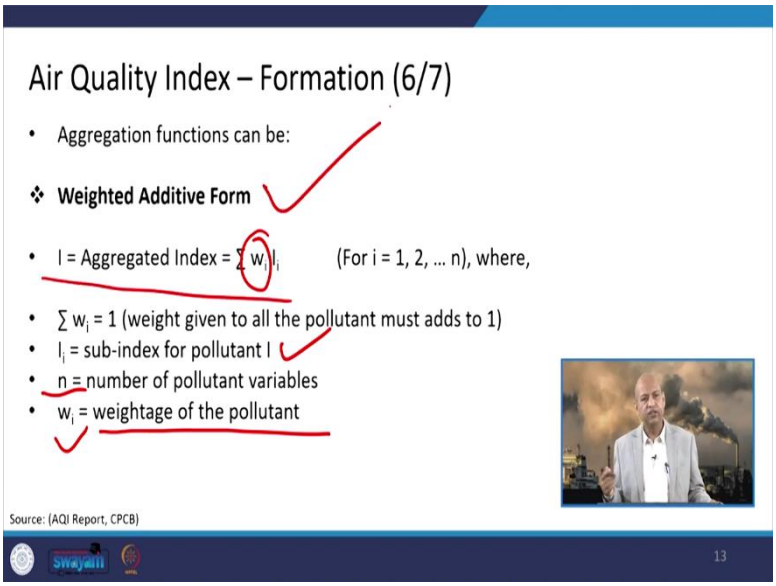

So, this Air Quality Index aggregation is there for all $I_1$, $I_2$, all $I_n$. So, aggregation is possible and you can get the single value like summation may be there, but there are other ways like weighted additive form can be there. So, this is like for each pollutant waiting is there. Weight means for depending upon their intensity, depending upon their health impacts etc.

So, you can go for that number of pollutants is N, $W_i$ weightage for the pollutant I. And $I_i$ is sub-index for the pollutant I, that kind of thing is there. So, you can go for aggregation in the fashion have weighted additive form.

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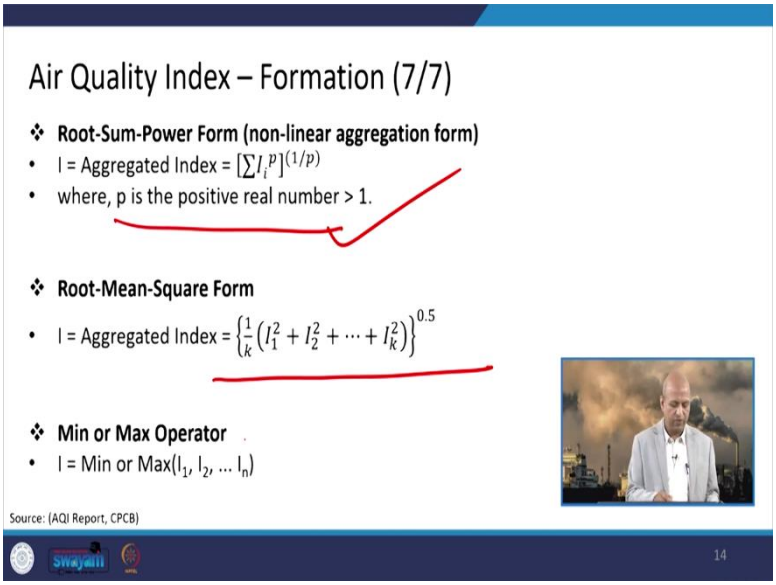


Other ways are there like for example, root sum power non-linear aggregation form. So, this is submission $I_{IP}$ so, integration is there and 1 by p. So, this kind of you know p is no positive real number greater than one, so that you can have from other sources.

Similarly, root mean square form is also there for aggregation. So, this is the way for root mean square, you get square root of this. All the I values square of submission and then a square root. Minimum or maximum operator will be there $I_1$, $I_2$ so, you can get minimum and maximum values.

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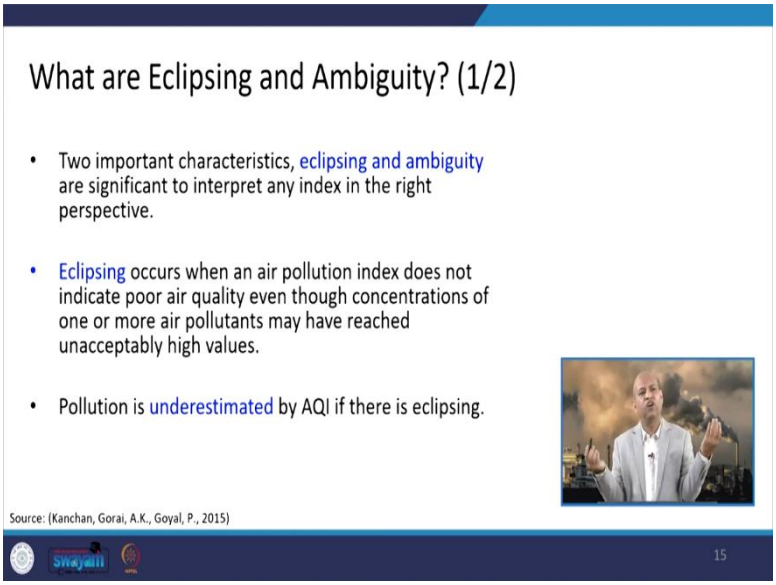


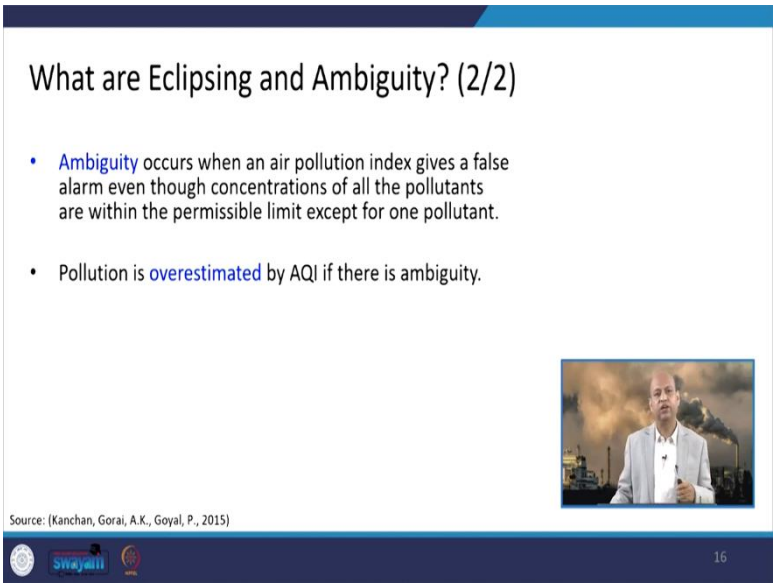


So, different ways are there for aggregation purpose. Then when we go for these kinds of numbers or indices, there are issues like eclipsing or ambiguity like this eclipsing is something when an air pollution index does not indicate poor air quality even though concentration of one or more polluted may be reaching unacceptable high levels, high values. So, that is the eclipsing, means polluted environment is there, but index is saying that it is fine, no problem. So, that kind of error may be there.

So, that is kind of underestimation means single value AQI is coming underestimated although the parts of it, certain pollutants are having poor air quality range but when we are going kind of aggregation then it erroneously comes out that it is fine. That means, underestimation is there so, that is eclipsing.

Ambiguity is there when air pollution index gives you a false alarm means, there is no individual pollutants are within the range. They are not exceeding those standards, but when we are summing up we are aggregating, then the value is higher that means it is overestimating. So, this gives the false alarm, so, that is ambiguity. So, we have to deal with that kind of statistical thing.

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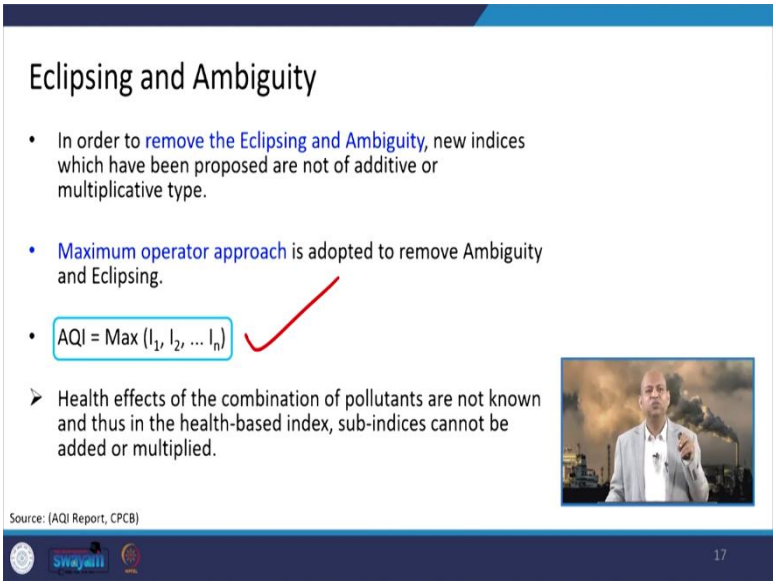


We should be careful otherwise, even if air is clean, we are giving false alarm to the public and public is confused, they say that we have been alarmed that we should not go, we should not go to that particular place where air quality index is poor, but in real sense it is not there. So, those issues we have to deal with.

So, in order to remove these kind of error eclipsing and ambiguity related problems, new indices have been developed. So, like maximum operator approach is adopted to remove these kinds of errors. So, AQI maximum, $I_1$, $I_2$, $I_n$, those kinds of values are computed. And the health impacts of the combination of pollutants are not known, because synergy is not known and thus in the health-based index sub-indices cannot be added or multiplied. So, that is another issue basically.

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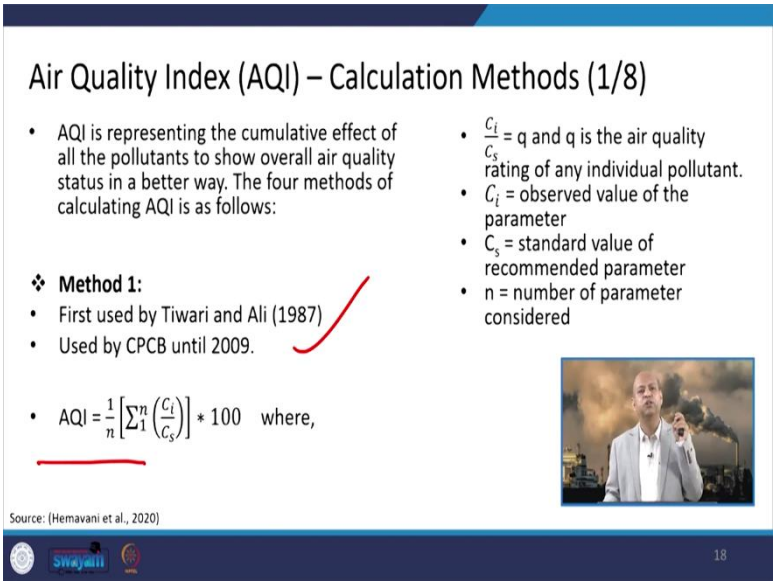


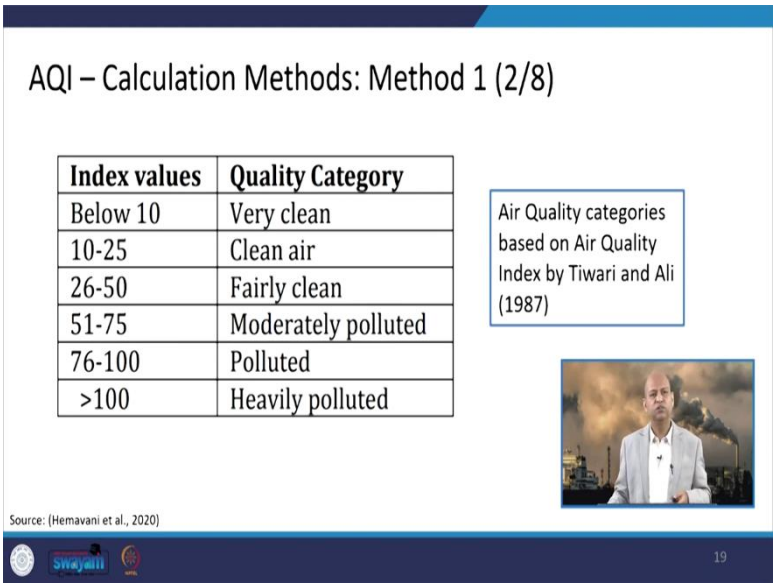


Well, when we talk about calculation methods, we can go for different methods like this method 1 is from Tiwari and Ali in 1987, they published. So, this is a AQI 1 by n, summation of 1 to n, $C_i$ upon $C_s$ into 100, where $C_i$ upon $C_s$ is the small q and this q is air quality rating of any individual pollutant and $C_i$ is observed value of that particular parameter and $C_s$ is standard value of recommended parameter, n is the number of parameters.

$$\text{AQI} = \frac{1}{n}\left[\sum_1^n \left(\frac{C_i}{C_s}\right)\right] * 100$$

So, that kind of again integration is there and possible. And for that particular purpose, there are a range like, if it is below 10, then it is known as very clean. If it is between 10 to 25, then it is known as clean air, if it is 26 to 50, then it is known as fairly clean, 51 to 75 signifies

moderately polluted, not very high, 76 to 200 polluted and more than 100 heavily polluted. So, those kind of differences there as per the range of those indices values.

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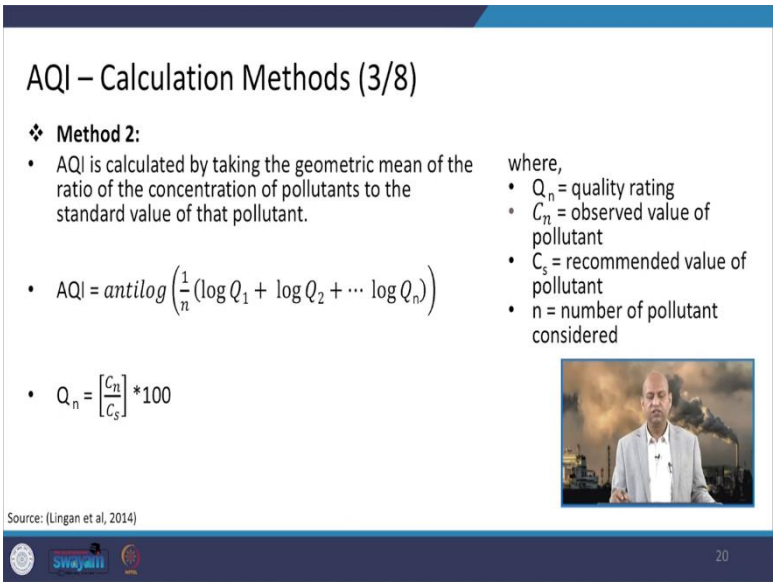
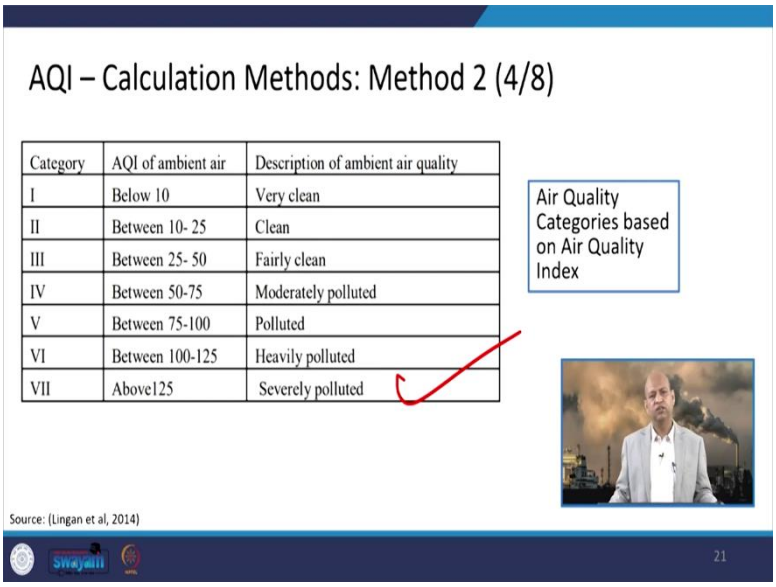



$$antilog\left(\frac{1}{n}(\log Q_1 + \log Q_2 + \cdots \log Q_n)\right)$$

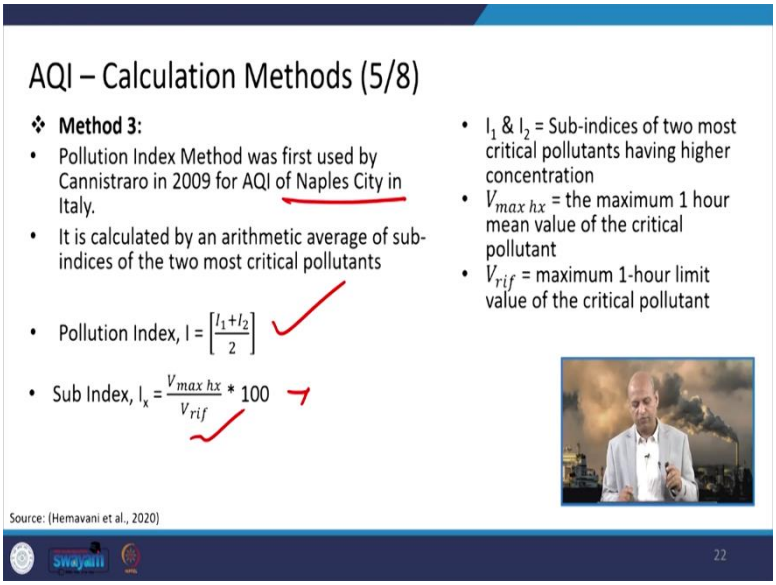
Second method is like geometric mean of the ratio of concentration of pollutants to the standard value. So, AQI is by antilog of this 1 by n, log $Q_1$, log $Q_2$, log $Q_n$ and where this $Q_n$ value comes? $Q_n$ is nothing but $C_n$ upon $C_s$ into 100. So, $Q_n$ is quality rating, $C_n$ is observed value of

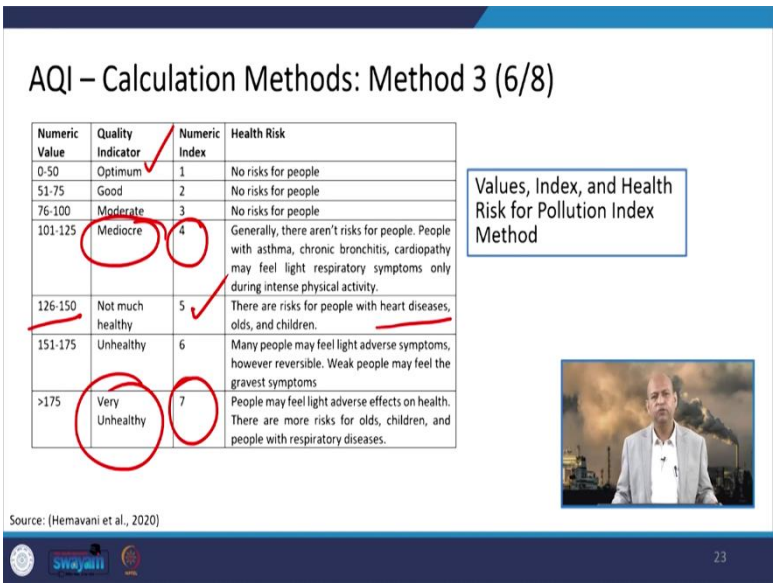
that pollutant and $C_s$ is recommended value of the pollutant and is number of pollutants considered.

AQI =

$Q_n = \left[\frac{C_n}{C_s}\right] * 100$

Then according to this method, there are again range similar to the earlier one like below 10 very clean, 10 to 25 clean, 25 to 50 fairly clean and then, there is another range like beyond 100, 100 to 125 heavily polluted and above 125 severely polluted. So, this kind of next level of pollution, it also gives them information about. (Refer Slide Time: 19:06)



When third method is there, which is known as pollution index method and this was used in this Naples City in Italy. So, this is the method like pollution index is $I_1$, $I_2$ upon two and sub-index $I_x$, $V_{maximum}$ $h_x$ upon $V_{rif}$ into 100 and the values of $I_1$, $I_2$, these are nothing but sub-indices of two most critical pollutants having higher concentrations.

$$I = \left[\frac{I_1 + I_2}{2}\right]$$

$$I_x = \frac{V_{max\,hx}}{V_{rif}} * 100$$

So, means there are many pollutants, but select those two highly critical pollutants. Then V max $h_x$, the maximum 1 hour mean value of the critical pollutant and V rif maximum one hour limit value of the critical pollutants. So, these values are used for calculation purpose of sub-indices and then AQI can be calculated and according to this, 0-50 gives the quality indicator it is optimum. So, no risk for the people.

So, you can see 51 to 75 is good no risk, 76 to 200 moderate no risk. Then 101 to 125 then it is like mediocre and the numerical index is four and this is generally associated with kind of like asthma, chronic bronchitis, cardiopathy, light respiration symptoms and during intense physical activities. So, those kinds of things are there within the AQI range of one, 01 to 125.

Similarly, there are other values like 126 to 150 not much healthy. There are risk for people with heart disease, old people, children. And this numerical value is 5 here, 151 to 175 it is unhealthy. And many people feel light adverse symptoms and weak people may feel the gravest symptoms. Then more than 175 very unhealthy and the seven is the numerical index. And this is like very adverse health impacts may be there, it may be very risky to old people, children and respiratory diseases may be very high in those particular situations.

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## AQI – Calculation Methods (7/8)

❖ **Method 4:**

- Linear Segmented Principle is used to calculate the sub-indices based on breakpoint concentrations.
- Adopted by CPCB
- $I_p = \left[\left\{\frac{I_{HI}-ILO}{B_{HI}-BLO}\right\} * (C_p - BLO)\right] + I_{LO}$
- AQI = Max ($I_p$) (where p = 1, 2, 3...n; denotes n pollutants range)

- $I_p$ = Sub Index for a given pollutant concentration
- $B_{HI}$ = Breakpoint concentration greater or equal to give concentration ($C_p$)
- $B_{LO}$ = Breakpoint concentration smaller or equal to give concentration ($C_p$)
- $I_{HI}$ = AQI value equivalent to $B_{HI}$
- $I_{LO}$ = AQI value equivalent to $B_{LO}$

Source: (Hemavani et al., 2020)

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## AQI – Calculation Methods: Method 4 (8/8)

| AQI | Remark | Colour Code | Quality rating |
|---|---|---|---|
| 0-50 | Good | Dark Green | Minimal impact |
| 51-100 | Satisfactory | Light Green | Minor breathing discomfort to sensitive people |
| 101-200 | Moderate | Yellow | Breathing discomfort to the people with lungs, asthma and heart diseases |
| 201-300 | Poor | Light Orange | Breathing discomfort to most people on prolonged exposure |
| 301-400 | Very Poor | Dark Orange | Respiratory illness on prolonged exposure |
| 401-500 | Severe | Red | Affects healthy people and seriously impacts those with existing diseases |

Index values, Remarks, and Quality rating of the method adopted by CPCB

Source: (Hemavani et al., 2020)

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Then method four, which is also used in India and adopted by CPCB basically. This is linear segmented principle, which is used to calculate the sub-indices. In this case, you can see this formula, earlier also we have seen this. So, Ip equals IHi minus ILO, BHI minus BLO into CP minus BLO plus ILO, we have already seen Ip sub-index for a given pollutant p concentration.

BHI breakpoint concentration for greater or equal to given concentration that is Cp. BLO breakpoint concentration is smaller or equal to given concentration CP. IHI AQI equivalent to BHI, ILO, AQI value equivalent to BLO. So, those values, we can get from certain studies like these kinds of tables are there. So, we are AQI 0-50 good and colour scheme is dark green for that, this is minimal impact means there is no impact you can say. 51 to 203 satisfactory and this is light green colour scheme, then minor breathing discomfort, maybe they are too sensitive people. Otherwise, normal people will not have any problem.

So, this way you can see AQI go 0 to 50, 51 to 100, 101 to 200 and ultimately for O1 to 500 which is severe and this affects even healthy people. So, this is very serious, red colour is there for that. Before that dark orange is there 301 to 400 that is very poor quality. So, according to the range the quality of hair is given some name, the colour scheme is given name and health impacts are associated which are also tabulated.

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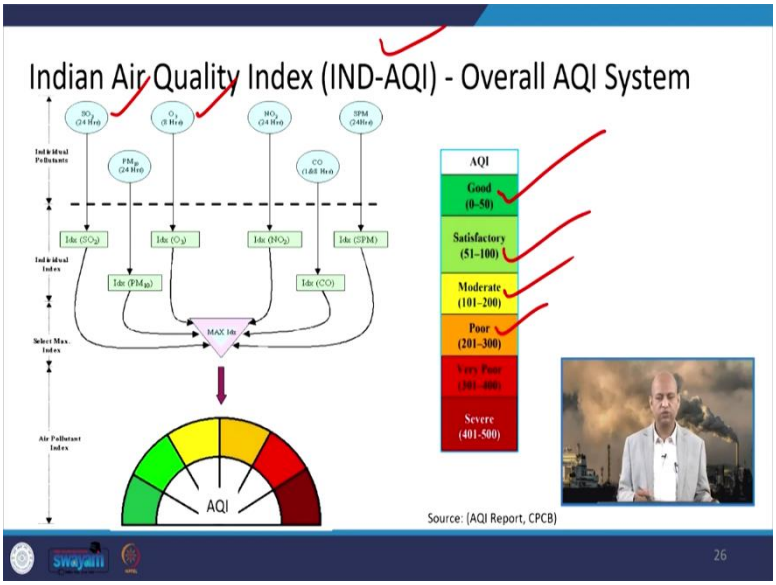


So, Indian Air Quality Index or IND-AQI, you can go for short, the overall AQI system is basically like this we talk good 0 to 50 dark green, satisfactory 51 to 100, the moderate 101 to 200 yellow. Then this poor to 201 to 300 then very poor, so you can have these colour schemes also and different pollutants are there, SO2, 3, NO2, all these pollutants, their concentrations are included when we calculate the AQI.

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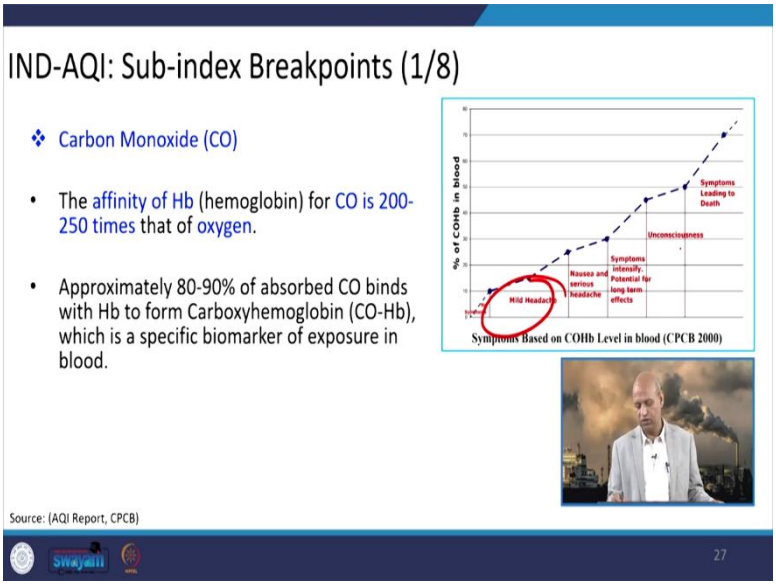


So, like for example, if we consider CO, carbon monoxide and we have, we know that CO is problematic because it has tendency to get absorbed into the blood and it reduces the capacity of getting the oxygen into the blood. So, that is the reason it is dangerous, and you can see its healthy impacts like mild headache, when the percentage is less than 20 or so, it goes on increasing, then its impact is also increasing and unconscious can be there, if it is 50 percent or so, and it can also lead to death, in fact it is very high concentration in the blood.

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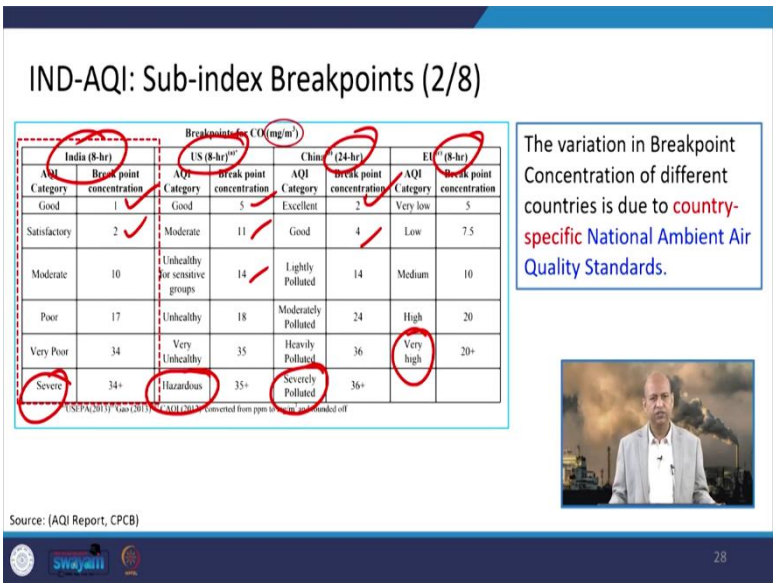


So, when we talk about its breakpoints, you can see the values and different countries have different values. Like AQI category good, breakpoint 1, satisfactory 2, this is for India. 8-hour concentration please note it. In us 8 hour concentration, good 5, 11, those values are there.

China, they have 24-hour concentration. And they are categories are like excellent, good and they have different values, breakpoint concentration like 2, 4.

In European Union, this is again 8-hour concentration and they have different names like very low, low and ultimately very high. In China it is severely polluted, we also have like severe at last and US considers hazardous. So, different nomenclatures are there depending upon the values of those indices and those breakpoint concentrations values.

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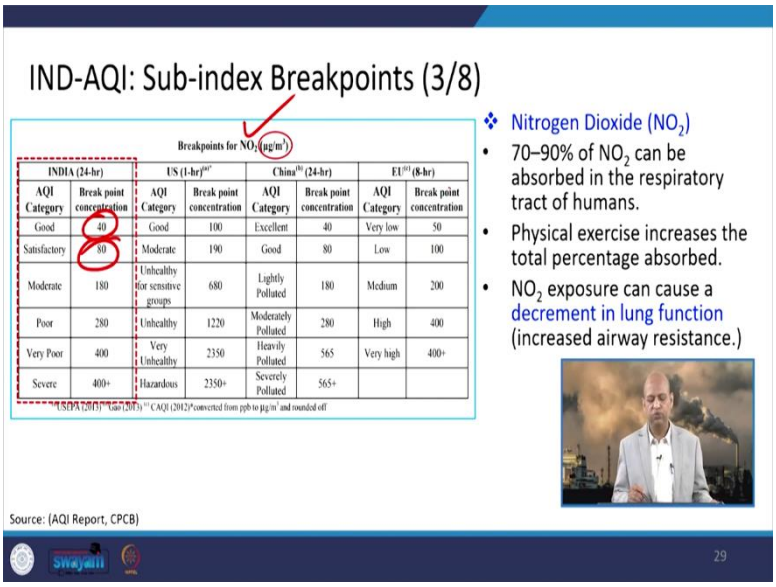


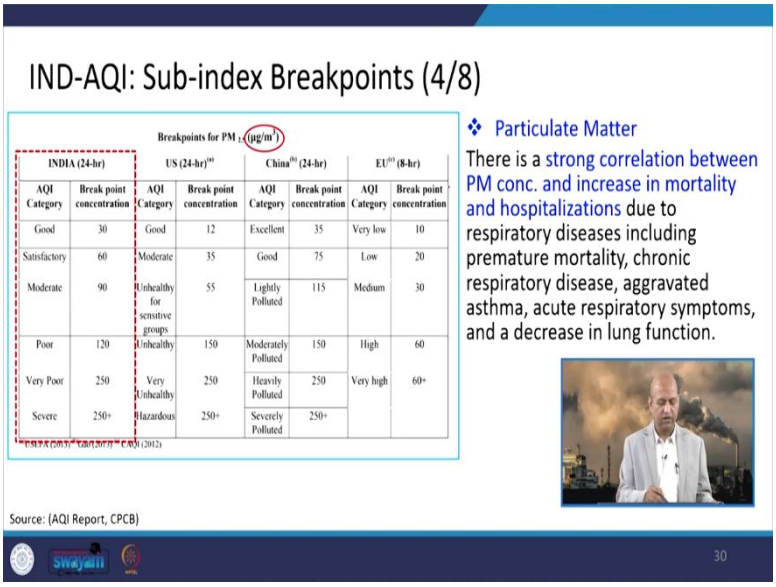

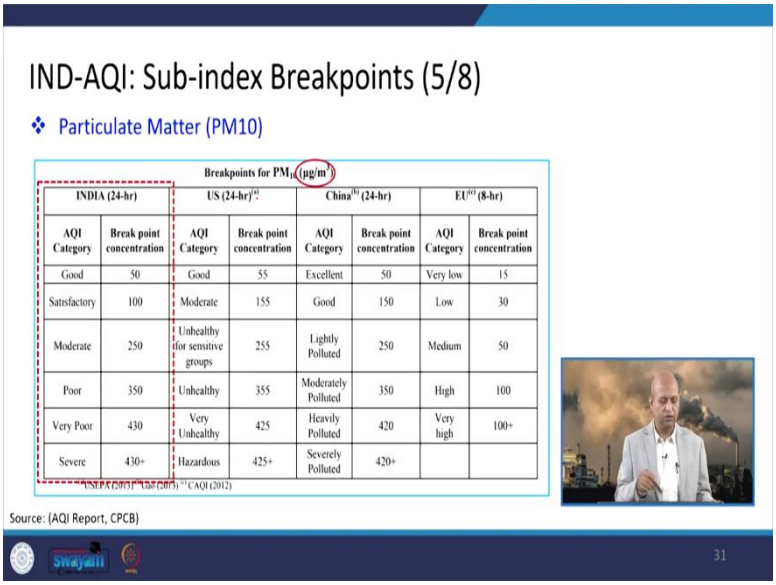


Now, if you go for NO2, like CO, different values are there for this, like break point 40 for good, satisfactory 80. So, different values are there. Similarly, for US, China and EU, it is given and similarly, PM 2.5 and PM 10, all these tables give those values of their breakpoints as well as their name whether it is good or bad, something like that.

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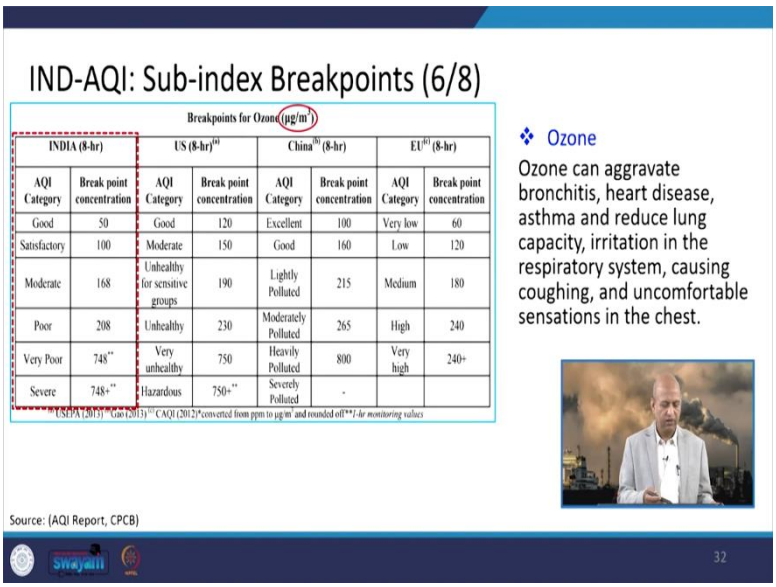

## IND-AQI: Sub-index Breakpoints (7/8)

❖ Sulphur Dioxide ($SO_2$)

- $SO_2$ is soluble in aqueous media and affects mucous membranes of the nose and upper respiratory tract. Reduction in mean lung function values among groups of healthy individuals have been observed for 10-minute exposures at 4000 ppb (11,440 µg/m³) (Linn et al. 1984) and at 5000 ppb (14,300 µg/ m³) (Lawther et al., 1975).

Breakpoints for $SO_2$ (µg/m³)

| INDIA (24-hr) | | US (1-hr)[25] | | China[26] (24-hr) | | EU[27] (8-hr) | |
|---|---|---|---|---|---|---|---|
| AQI Category | Break point concentration | AQI Category | Break point concentration | AQI Category | Break point concentration | AQI Category | Break point concentration |
| Good | 40 | Good | 95 | Excellent | 50 | Very low | 50 |
| Satisfactory | 80 | Moderate | 200 | Good | 150 | Low | 100 |
| Moderate | 380 | Unhealthy for sensitive groups | 485 | Lightly Polluted | 475 | Medium | 350 |
| Poor | 800 | Unhealthy | 795 | Moderately Polluted | 800 | High | 500 |
| Very Poor | 1600 | Very Unhealthy | 1580 | Heavily Polluted | 1600 | Very high | 500+ |
| Severe | 1600+ | Hazardous | 1580+ | Severely Polluted | 2620 | | |

USEPA (2013)*, Yadav (2013)**, CAQI (2012)#converted from ppb to µg/m³ and rounded off

Source: (AQI Report, CPCB)

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## IND-AQI: Sub-index Breakpoints (8/8)

❖ Lead and Ammonia ($NH_3$)

- Most of the countries have not taken Lead and Ammonia and only six pollutants (described above) for the formulation of AQI.
- Increased inhalation of ammonia may result in cough and an increased respiratory rate as well as respiratory distress.
- 1µg/m³ of annual lead level will result in 5µg/dL (on an average) of blood lead level (WHO 2000) which will cause hematological changes (blood-related issues).

Table 3.10 AQI Breakpoints for $NH_3$ and Pb (24-hr)

India (Pb from gasoline phased out in 2000)

| AQI Category | $NH_3$ µg/m³ | Pb µg/m³ |
|---|---|---|
| Good (0-50) | 200 | 0.5 |
| Satisfactory (51-100) | 400 | 1.0 |
| Moderate(101-200) | 800 | 2.0 |
| Poor (201-300) | 1200 | 3.0 |
| Very poor (301-400) | 1800 | 3.5 |
| Severe (401-500) | 1800+ | 3.5+ |

Source: (AQI Report, CPCB)

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So, ozone related, SO2 related, all these values are their tables, you can go through at leisure and see different values are there for different pollutants please remember. So, the different sub index will be calculated for each pollutant, then we will aggregate them. Lead and ammonia also, some countries do not consider, but in India we are considering these also and these are the values, good 200 for ammonia, 0.5 lead because that is heavy metal and very problematic.

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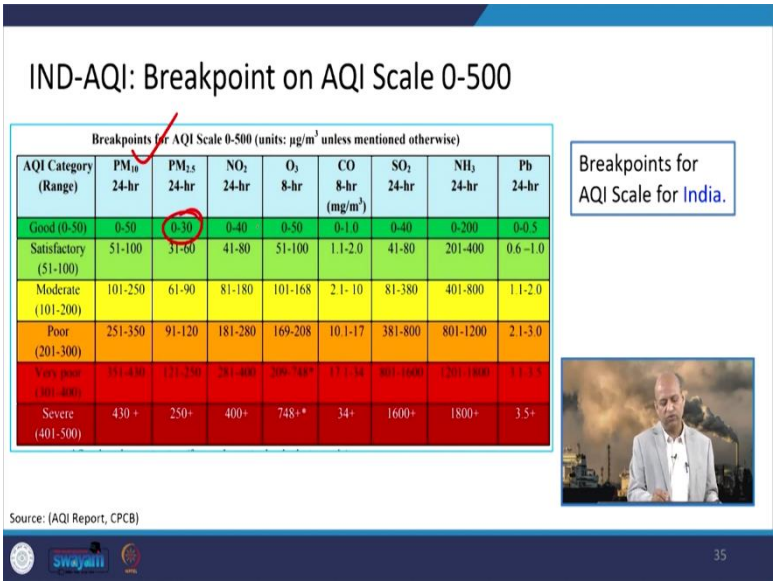


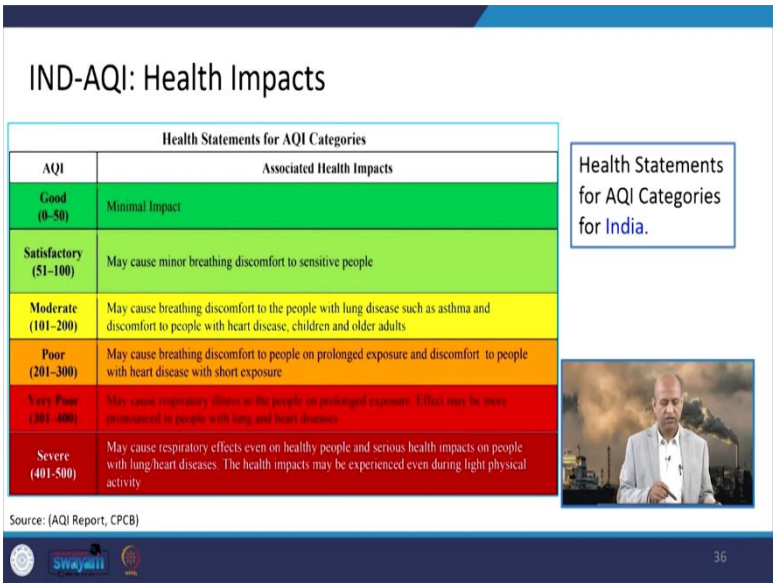


So, you can see this coloured representation of Indian Air Quality Index breakpoint, AQI scale 0 to 500 so, PM 10, 24 hour, good. 0 to 50, PM 2.5 0 to 30, NO2 to 24 hour, 0 to 40. So, different value ranges there. These AQI related breakpoints.

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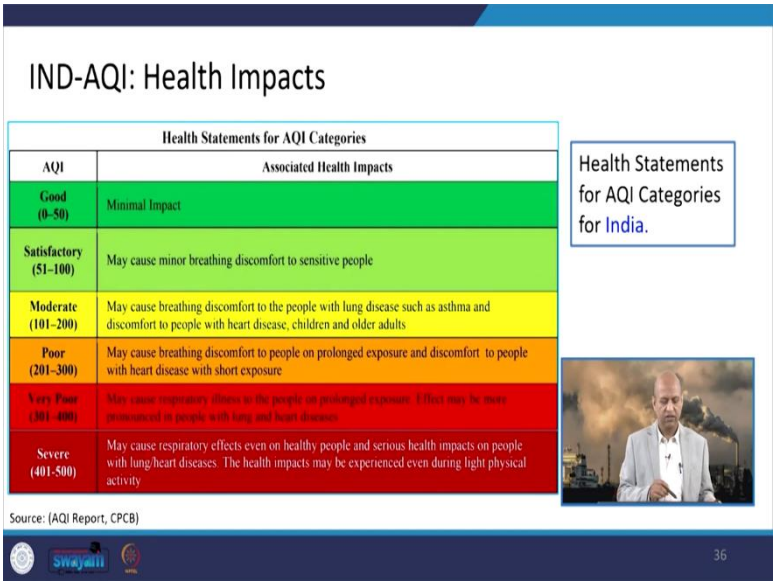


Then there are health impacts also because good means minimal impact, satisfactory it may cause little minor breathing related issues discomfort to sensitive people, we have seen. Poor air quality, it can cause breathing discomfort to people for prolonged exposure. When it is severe, then it is very dangerous. When we are exposed to this severe Air Quality means highly polluted.

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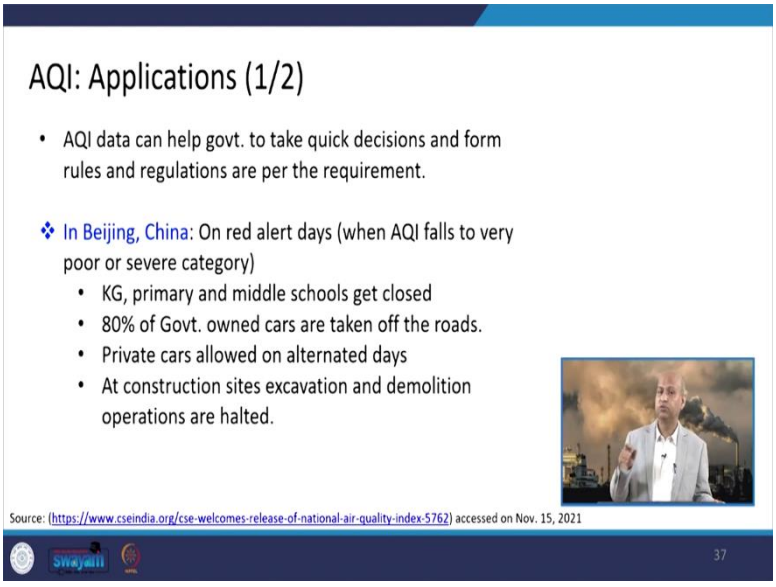


Then what is the application? So, application are many as I briefly discussed initially also. This can give to policymakers a way of quick decision making in the form of rules and regulations as per the requirement. You might be, in these days when winters are there and in Delhi, this poor air quality is becoming very big issue. So, you might have read in newspapers that the

judiciary is asking the government that even if you have to do the lockdown, reduce this air quality index, it is very high now.

So, what are the different ways which can be implemented? So, these air quality indices help in decision making for these kinds of interventions like in Beijing in China, on red alert days when AQI falls to very poor or severe category, they stop school functioning. Even in Delhi like for few days schools, colleges have been shut down, because air quality is very poor. This AQI is giving this range that it is very very poor or kind of sever kind of thing.

Then 80 percent of government owned cars are taken off the roads in Beijing when this red alert is there for severe category of air quality. Private cars allowed on alternate dates like odd and even we did last time in Delhi, if you recall. At construction sites, excavation and demolition related operations are stopped because they emit a lot of particulate matter and that contributes to the poor air quality in winter, it is very problematic because of inversion etc.

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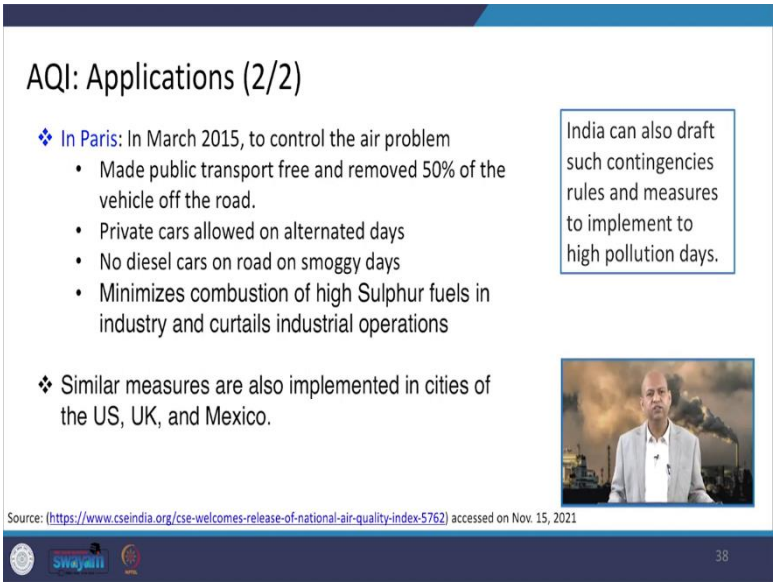


In Paris, this AQI related application have been made, like in March 2015 to control the air problem they made public transport free and removed 50% of the vehicle of the road, those privately owned. So, that people can go for public transportation if it is not costing. Then private cars allowed on alternate days and no diesel cars on the road, on the smoky days were allowed.

And then this minimizes combustion of high sulphur fuels in industry and curtails industrial operations. Similar measures have been implemented in different cities of the US, UK and Mexico.

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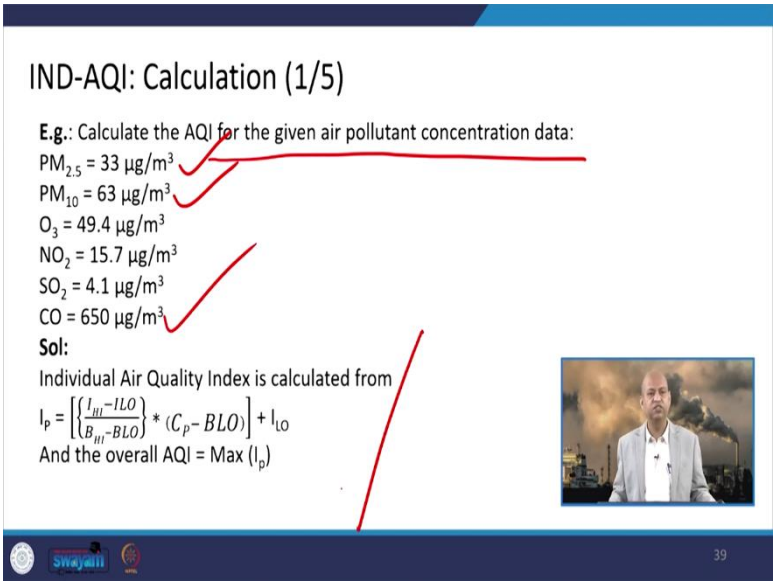


So similarly, if we go for this demonstration or example, how to calculate when different pollutant related concentrations are available. So, this is one example. You can see, calculate the AQI for given air pollutant concentrations, different values are there, like PM 2.5 33 micrograms per cubic meter, PM 10 is 63 micrograms per cubic meter, ozone is around 49 microgram per cubic meter, NO2 15, SO2 four, CO is 650.

So, we use this particular relationship to calculate the individual pollutant related sub-indices and then we will go for its aggregation.

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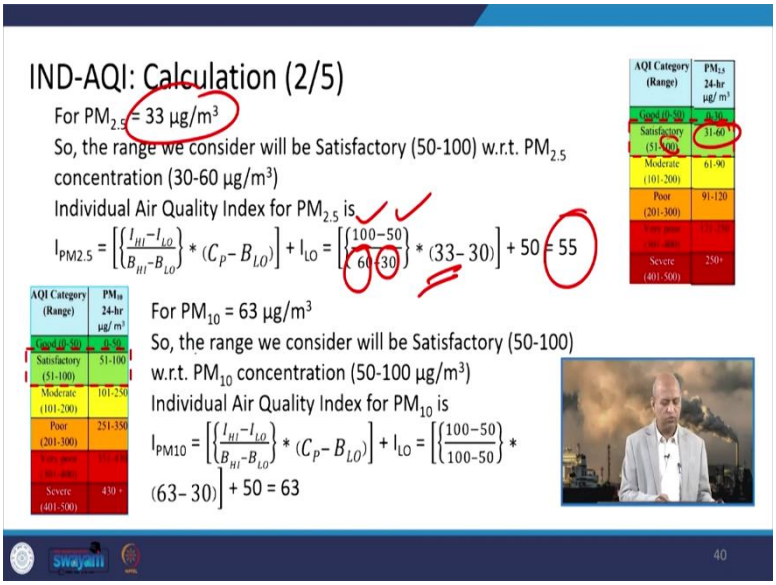


So, here you can see, for an example for PM 2.5 33 micrograms per cubic meter. So, where it lies? 33 here, 31 to 60, within this range. So, 51 100 is the basically this range of the AQI and 30 will be the minimum, 60 will be high. So, 60 is BHI and BLO is 30. And 150 is because this range, IHI, ILO this 50 is the lowest. This ILO and IHI is 100 so these values are here.

So, you can use concentration is 33, BLO is 30 because the lower concentration value in the range of 60 and 30. So, you can go for this ILO is 50 again as I said. So, you calculate the 55, this IPM 2.5. This is the sub-index of PM 2.5.

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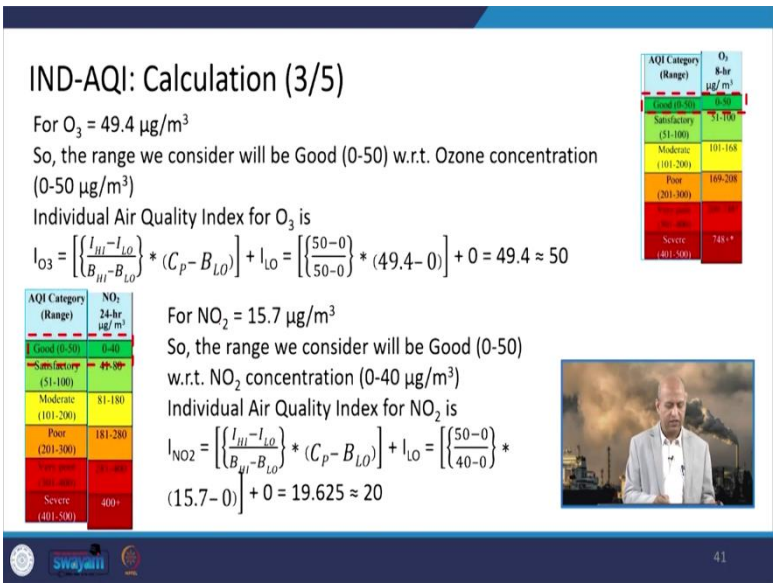

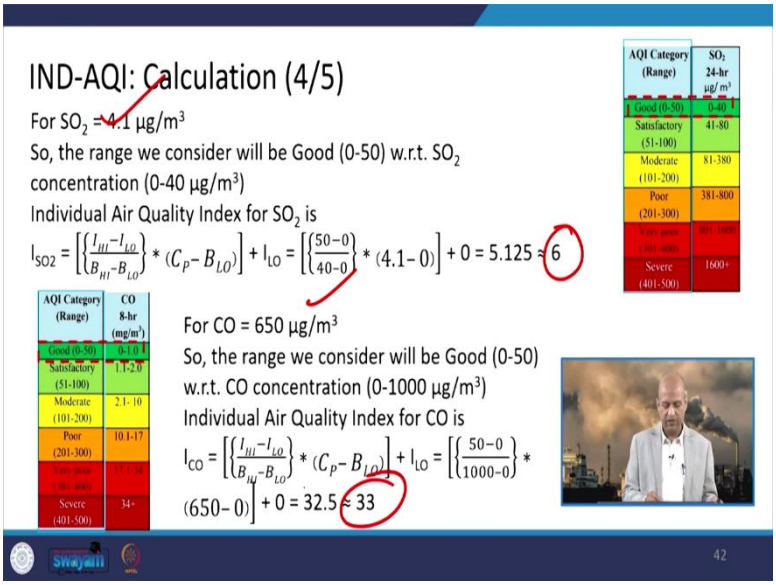


Similarly, you can go for PM 10 and then NO2, ozone and then SO2, CO, all different values are there ISO2, came only 6, CO, it came 33. You go for this ozone it came 50, NO2 it came 20. So, different pollutant different sub-indices.

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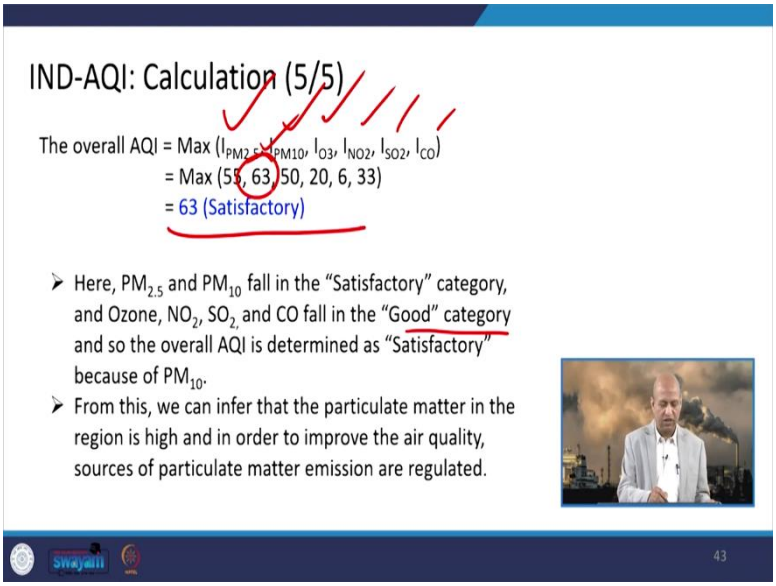


Then we go for overall AQI, so, maximum of these. What is the maximum value? We go for IM 2.5, IM10, IO3, NO2, all those. So, 63 is the maximum value. So, we go for this particular method, the last method where we choose the maximum value. Otherwise, you have seen those issues with when we go for these statistical problems like ambiguity, etc that happens when we go for aggregation.

So, to avoid that we go for this highest value approach. So, 63 is satisfactory, why satisfactory? You can see the overall value, this is 51 to 100, in between this range. So, this is satisfactory.

So, that is why we call, even overall value is satisfactory but ozone, NO2, SO2, CO, all these values fall in good category if you compare individually. For example, let me tell you, the CO is 33 so 33 is in good, 0 to 50 within this range. This is good quality, but overall, it is satisfactory.

So, individual pollutants maybe bad quality or good quality and overall concept is dependent upon the highest value of a particular index. And then we see in the overall scheme, where does it lie. So, overall, it is satisfactory although individual pollutants, it may vary good or satisfactory or something like that.

So, that way you can see particulate matter in the region is high and in order to improve the air quality sources of particulate matter emission are to be regulated. Because this value is related to PM 10. This 63 is PM 10. So, those particulate emissions, if we can reduce then the Air Quality Index can improve.

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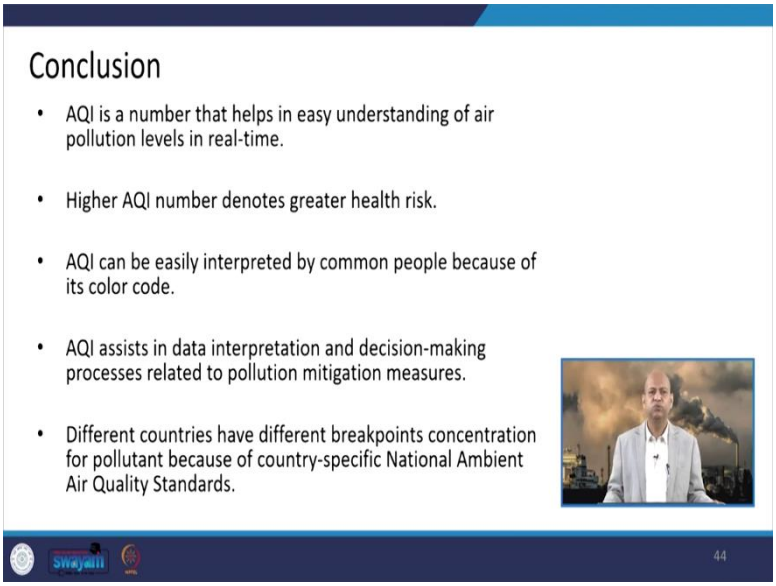


So, in conclusion we can say, that Air Quality Index helps in easy understanding of air pollution levels in real time. It can really help us whether to visit a place or not. If the air quality is poor then we can refrain from going to that particular place. Particularly the sensitive people or old people those who are already unhealthy, they should not get exposed to the poor air quality. So, Air Quality Index gives quick information about that.

And, higher AQI, we know that it has higher health risk and AQI can easily be interpreted buy common people because it can also be colour coded. So, it is very easy to understand and it can assist in data interpretation for decision making. Like, whether we should stop private cars, we

should stop diesel cars, depending upon, what kind of pollutant is in high concentration. Then different countries have different break point concentrations depending upon their national ambient air qualifiers and health risk related issues.

So, they can have different Air Quality Indices also. So, this is all for today related to air quality management through Air Quality Index. So, the larger part is basically, air quality management, how to improve the air quality and how to know whether it is polluted or not and Air Quality Index is very easy and simple and quick way to know whether Air Quality is good or bad or satisfactory or unsatisfactory, those kinds of things. So, this is all for today and thank you for your kind attention.

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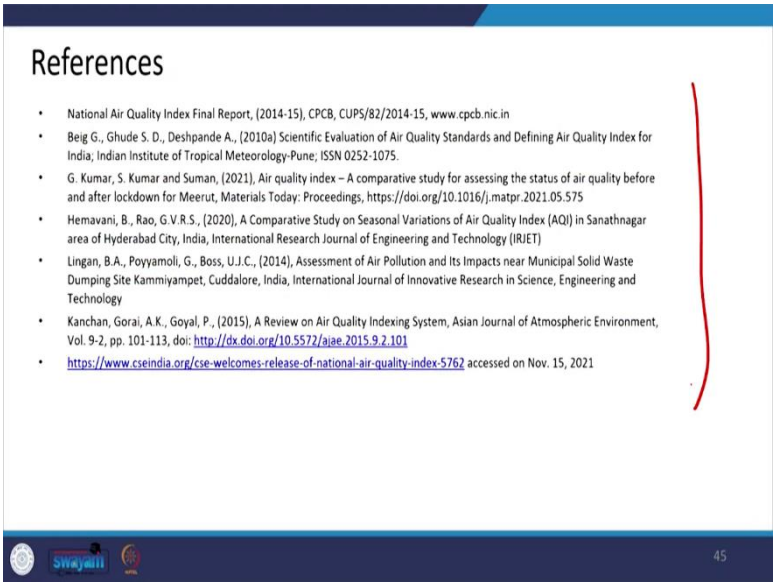


These are the references that you can go through to have more information about Air Quality Index, their calculations, their uses, applications, etc. So, see you in the next lecture, thank you till then. Thanks a lot.