Municipal Solid Waste Management
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Lecture - 05
Estimation of Solid Waste Quantity

So hello students. Today we are starting the module 3, Generation of Solid Waste.

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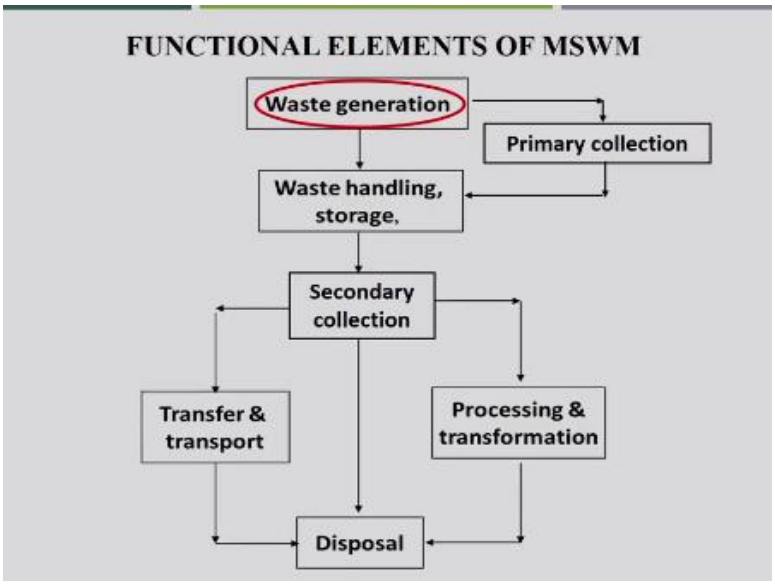

So if you see these are the six functional elements of Municipal Solid Waste Management, which I discussed in the introduction and the first lecture also. It is separated into six functional elements which start from the waste generation to the disposal. So I think the basic idea was that before starting the functional element I talked about in previous lectures about different sources, types, and also characteristics of solid waste.

These are a very important issue before starting solid waste management and to understand the entire Solid Waste Management System. In the previous class also I talked about the characterization of solid waste. So most of our Indian schemes, policies for the Solid Waste Management do not discuss the characterization of solid waste.

So you have seen the Swachh Bharat Mission also most of the ULBs or urban bodies or corporations area they purchased a lot of compactor vehicle which can hold seven

to eight tons of waste in a single trip compared to the one or two tons in the normal vehicle. But without understanding the characteristics is very difficult to compact such ways because 50 to 60% is a wet waste in the waste.

Once you will compact that lot of water excess water or leachate is coming out and because of that lot of corrosive issues are coming into such kind of compactor vehicle which are very costly vehicles that cost around 30 to 40 lakhs for one particular vehicle. So is good I think you properly understood how important to understand the characteristics of the solid waste and also the sources and type of waste before starting the functional elements of Municipal Solid Waste Management.

So today we will discuss the waste generation. This is another very important issue because when you design any collection system or any disposal system even the treatment system also needs to understand the generation. In the previous lecture, we already discussed the type and sources of waste sources. Now here we will talk about the waste generation and why it is very important to understand to know the generation rate or waste collection rate.

So in the first lecture in the generation, we will discuss the estimation of solid waste quantity. When I say quantity most people will understand the quantity means weight. But also the quantity can be measured in the volume. And I will discuss a few issues about weight and volume both where exactly the weight is important and where exactly the volume is more important.

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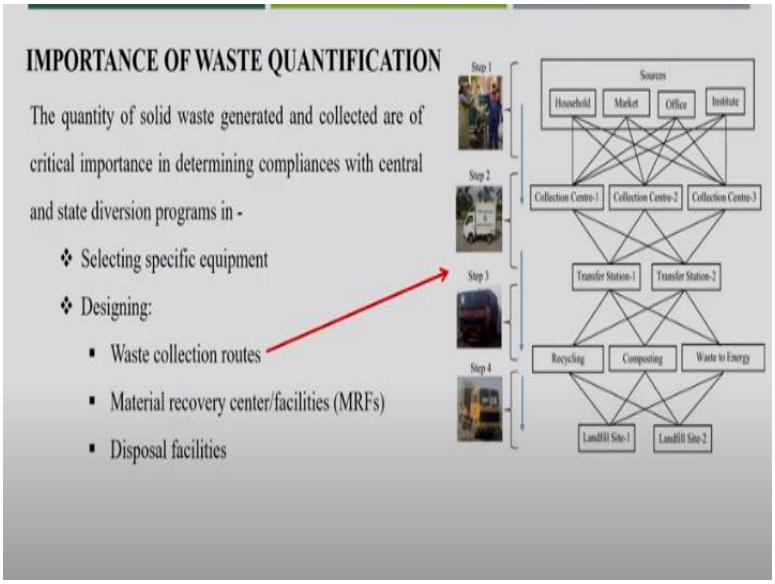

So the first the what is the importance of quantification. Is very important to determine compliance with the center and state diversion program. See most of the ULBs are not only discussing the collection and disposal. Also, most of our policies or scheme discussing how we can diverse such waste to the disposal site for recycling, for treatment processes.

So very important to know the quantity of solid waste to design the waste collection routes. See here. The waste collection route also is very important to understand to know the quantity of solid waste. Not only route but also volume is very important because based on that we can change the vehicle. What kind of vehicle? Whether we will be able to compact such kind of waste?

Can you collect the waste from the compactor vehicle? To know the particular quantity, then only you can finalize the route, trips, how many vehicles, how many manpower will be required.

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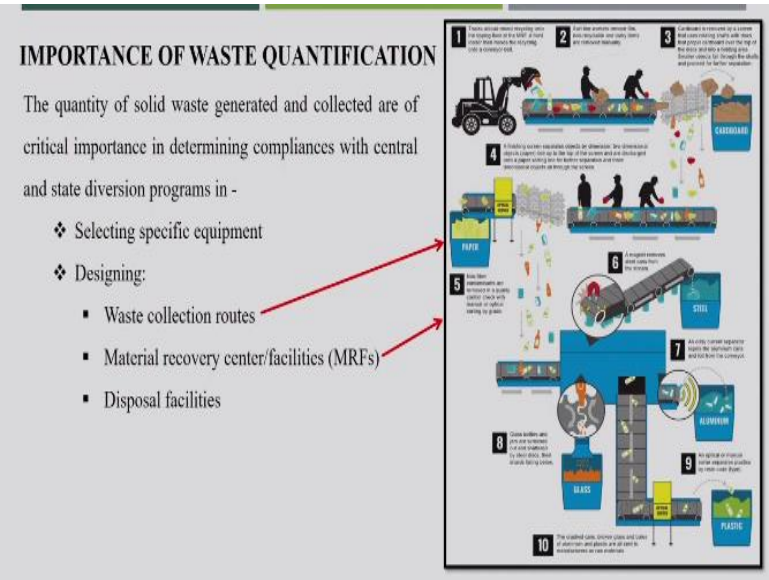

Also for the MRF facility or Material Recovery Facility, whether it is a recycling facility or any biological treatment facility, quantity is very important to know about the manpower requirement or resource requirement. Even the land requirement for supposing for compost plant if you are designing and if you do not know the quantity is very difficult to finalize how much is the land will be required for the composting facility.

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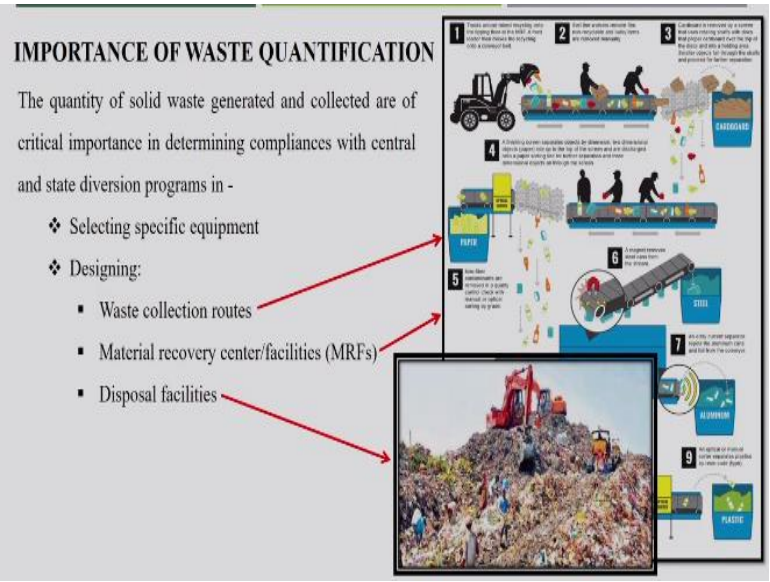

So and similarly, especially for the disposal facility, the volume is very important to know that. And most of the cases you see in the city, wherever the disposal site is located and within a few years maybe 5, 10 years those though whatever the area is available in the landfill area that is getting old and the corporation is always worried about to finalizing the new locations.

Like most of the ULBs are worried about to finalize the new locations. So the major problem because of that, because we are not aware of how much volume is receiving at the disposal site. So these are very important for quantification not only in the weight wise or also in the volume-wise is very important to know that.

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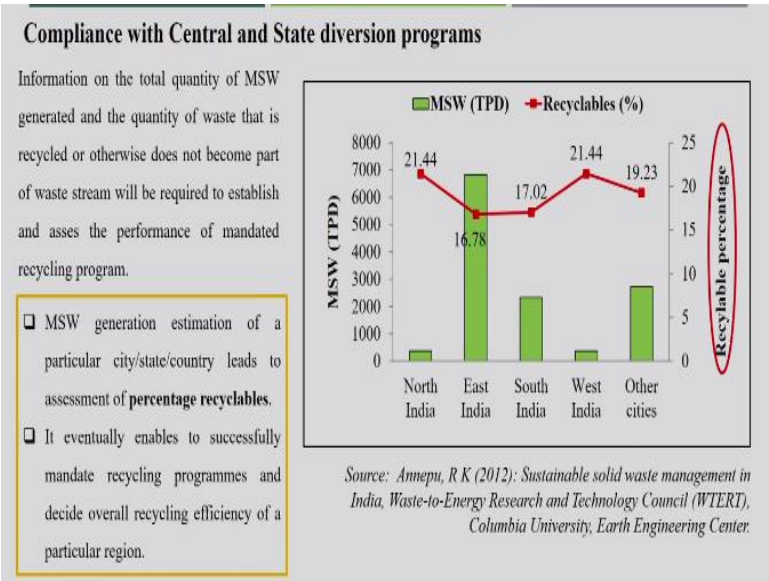

So again I think this graph is showing that you see here, entire India if you segregate in North India, East India, you see the recycling is only 17% in the year 2020. This is very important to know about the weight of the waste, quantity of the waste so that how much amount of waste is getting collected, getting disposed of in the landfill, and how much amount of is getting recycled.

So you know in recent years, the compositions of solid waste have been changing. And most of the recyclable matters like paper, plastic, these are coming into our solid waste disposal site. So it is good to provide the recycling facilities and also to know how much is the efficiency of the particular MSW program.

This efficiency, to know the efficiency of the particular Waste Management Program is also very important to know that how much amount of waste is getting recycled, how much amount of waste is getting treated before it is reaching to the disposal site. And how best will be reduced the waste on to the disposal site so that the small disposal site itself can work for a longer period?

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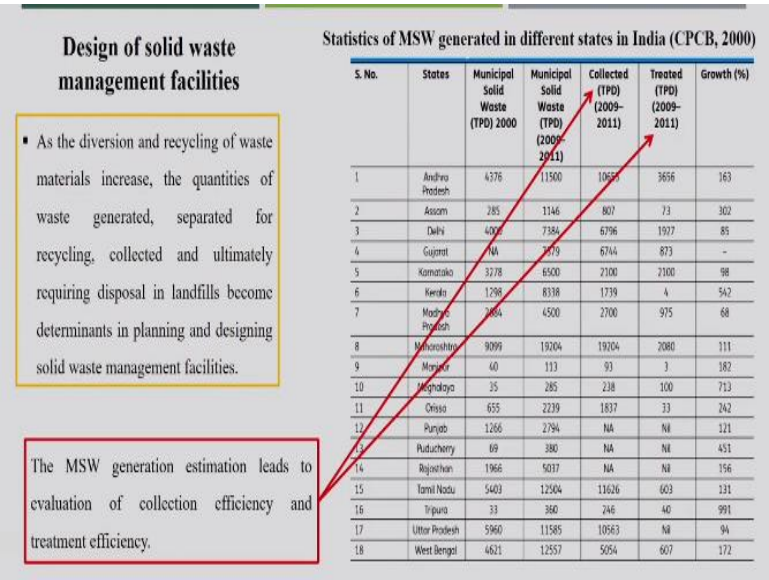

And also it is very important to design solid waste management facilities. So like here, you see in the one table it is shown that how much amount of waste is produced in the different states of India and how much is the collected and treated. Based on that, we can analyze how much is the growth of the waste generation could be possible to know that and also to know the efficiency of the particular city of the waste management program.

So MSW generation estimator leads to the evolution of collection efficiency and treatment efficiency. This is also a very important one when I say collection efficiency. So currently none of our city can have the collection efficiency 100% means I think we are not able to collect 100% of waste from the urban centers. So to know that how best will we increase our collection efficiency.

Also, the treatment efficiency is important for the quantitative analysis of solid waste.

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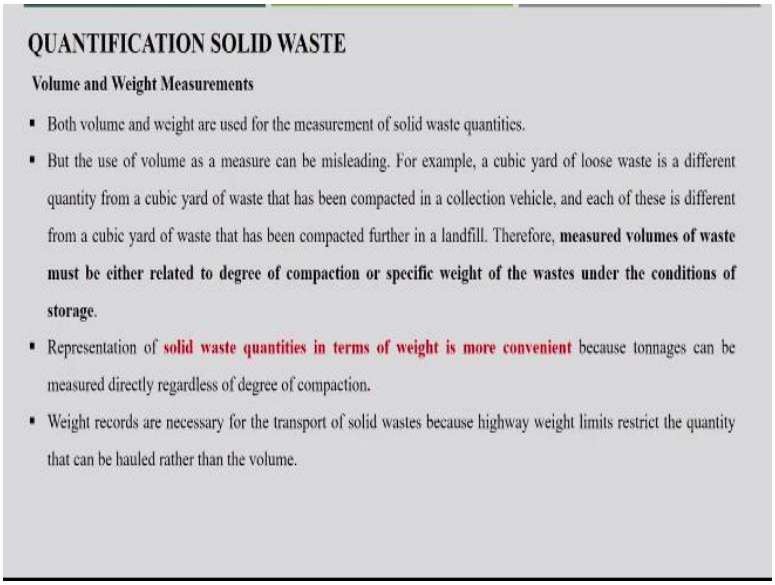

Now the quantification of solid waste in both ways which I was talking in the early slide, that volume, and weight measurement. So both volume and weights are very important for the waste quantity measurement. And but when you say the volume, the major volume of waste must be either related to the degree of compaction or specific weight of the waste under the condition of the storage.

Now I think there is a major problem to measure the volume because they need to understand how much is the compaction, how best is the compaction is possible. Because, when the waste is coming to the disposal site there also some kind of compaction is possible maybe 20, 30% compaction is possible. And if you are getting more amount of dry concentration dry kind of waste is very easy to get compact very easily compared to the wet waste.

So, the volume is always problematic to quantify the waste. So is a better representation of solid waste generation is by the representation of a solid waste quantity in terms of weight is more convenient. So based on that weight is very easy. I think there no need to worry about the compaction if you know the particular tons of waste is getting collected and disposed. And it is very easy to analyze the weight also.

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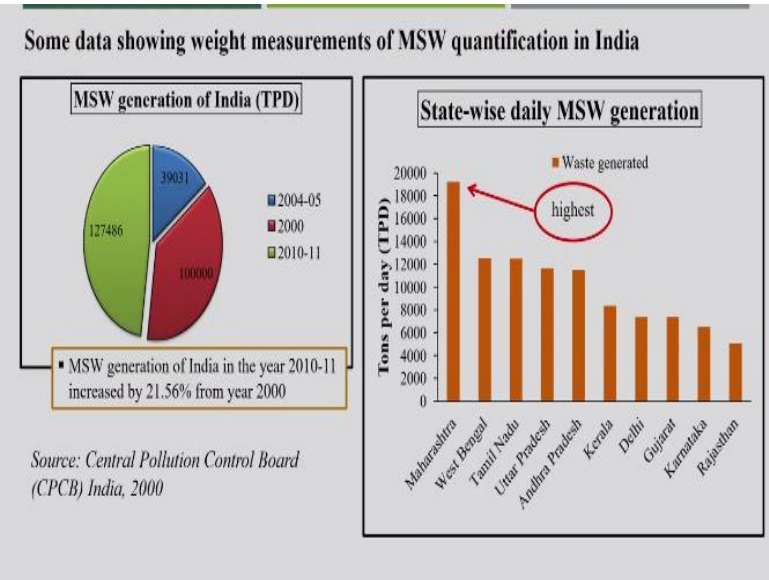

Some data are showing the weight measurement of MSW quantification in India in 2004-5, the quantity was 39,000 tons per day. In 2010-11 was 1,27,000 tons per day. Currently, India is generating around 65 million tons of waste per day with some of the data from the CPCB. And this generation in India by 2010, 11 major increase by 21.56% from the year 2000.

So it is a worrying point now that the generation increase is more than 20% every 10 years. So here if you see the state-wise MSW generation, where in Maharashtra waste generation is highest, which may be because of not only the population but also because of commercialization of the state and also the industrial development of the state.

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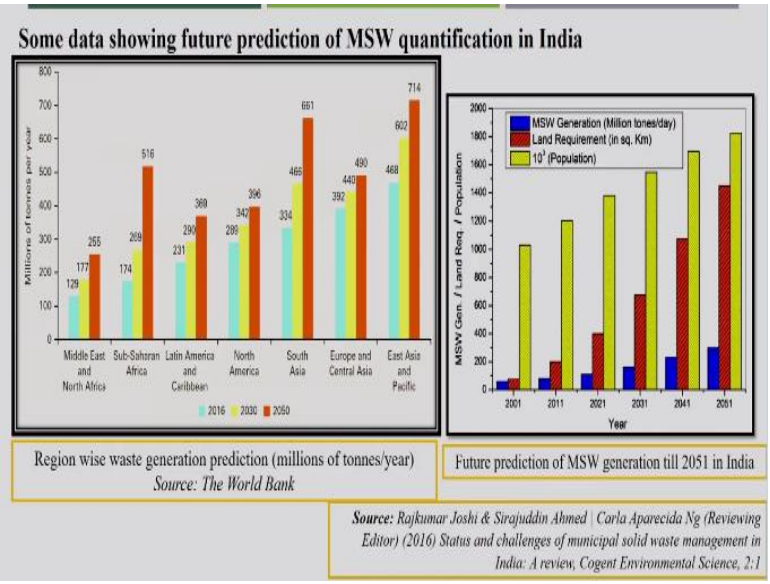

Now this another very important discussion about the future prediction of solid waste generation. This is also very important because if you just compare the data of every 10 years, the population is increasing by 5% annually. Also, the way our commercialization is increasing, most of the cities are getting commercialized now.

And also, the number of industries is getting installed in the city area. So obviously, there is a lot of waste getting produced or getting generated. Now for designing some kind of treatment facility, it should run for a longer period. You have to design for 20 years or 30 years. So those kinds of treatment facilities or disposal facilities can behold that kind of waste, which is producing the next 10 years or 20 years.

So there is some data about the global data from the Middle East or North American countries. Like we will focus here the South Asia, whereby 2050 the waste generation will be second largest from the other content of the earth. And only East Asia and the Pacific will be the highest one.

Because why this kind of data is future prediction is coming by 2050 because not only the population is changing in the especially in South Asia and the East Asian countries, but also a lot of industrial growth is coming up now. And new kinds of materials are coming to the urban areas and more commercial facilities are increasing in such kind of country.

That is why the future prediction shows that especially the South Asian countries or Middle Eastern East Asian countries or Pacific countries will have the highest waste generation globally. If you just see the Indian prediction here, and here very important data by 2051 MSW generation in million tons per day and also the land requirement in a square kilometer.

You just see that currently in 2021 will we required almost 400 square kilometer areas for the land disposal, for the solid waste disposal facilities. By 2051 we will be required a 1500 square kilometer area for the waste disposal. Now is a very important and very serious issue by the next 20 to 30 years will be required a huge amount of land and you know India the land availability is a very important issue now in the especially in the urban areas.

So is a very serious issue about waste generation and quantification of waste generation.

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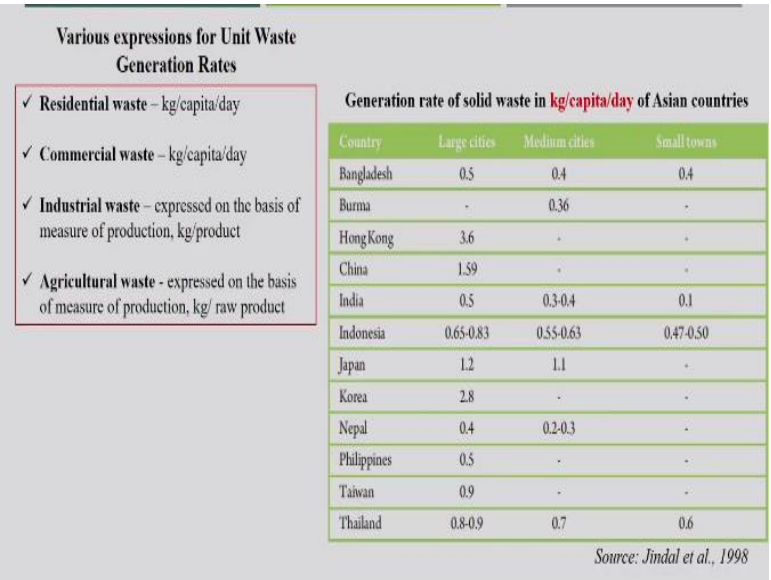

Now various expressions are for the waste generation rate. For residential normally we measured by kg per capita per day. Here capita is a person. So how much is the kg or many places is writing like gram per person per day or kg per capita per day. For commercial waste also we will express the generation rate by kg per capita per day and industrial waste is expressed based on the measure of production.

How much is the kg of waste is produced per product production? And similarly, with the agriculture waste also is expressed based on the measure of production like kg per raw product or raw material utilized for the production process. So these are the different expressions for the waste generation rate. So here one data about a few Asian countries where the data is segregated in large cities, medium cities, and small towns.

You see in India where a large city is only 0.5 kg per capita per day or just 500 grams per kg per capita per day and compared to medium city and the small towns are only 100 grams. But if you see that the other country like Hong Kong 3.6 kg per capita per day. And see Korea 2.8, Japan 1.2 these are all developed countries where generation rate is very high. Very high, but still India is not in the developing nations.

Our generation rate is still very low. And if you see the other countries like Nepal, Philippines, also with a similar waste generation rate like India. But I think is a worrying point because our urban centers are getting a lot of commercial facilities are coming up now. A lot of industries are getting small scale industries are coming up now. So a lot of waste is getting generated in India in the larger cities also.

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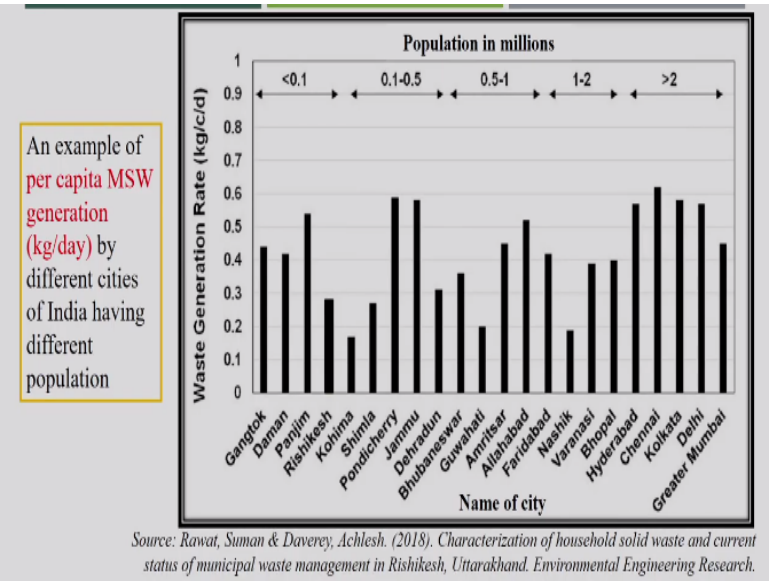

Source: Rawat, Suman & Daverey, Achlesh. (2018). Characterization of household solid waste and current status of municipal waste management in Rishikesh, Uttarakhand. Environmental Engineering Research.

This is another example of MSW per capita generation in different cities of India having different populations. Now is a very surprising data, you just see some data about Gangtok is a 0.42 or 0.43 kg per person per day or capita per day waste generation compared to the cities having population more than 20 lakhs like Chennai, Kolkata, Delhi is having 0.5 to 0.6 kg per person per day.

This is not so very different data. I think nowhere the population is also very high. Here the population is less, but the data is almost similar, not much that difference. So now is understand that the waste generation is not only because of the population increase but also the commercial facilities and daily utilization of the materials also is very important for the waste generation rate.

Now but if you just compare to the entire city, our waste generation rate is changing from 0.2 to 0.6. And most of the textbooks or most of the reports you see that India's waste generation rate is 0.4 to 0.6 normally is understand in kg per capita per day.

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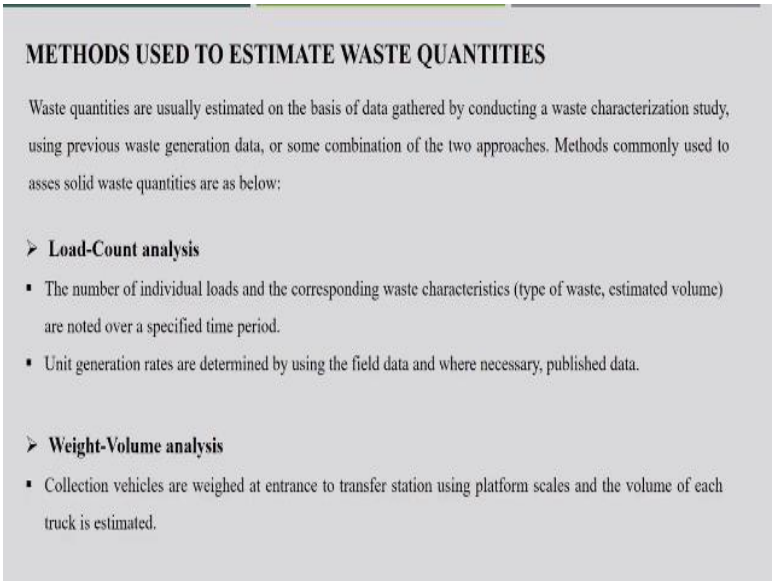

Now there are different ways to estimate the waste quantity. So there is the first method is load count analysis. So in this case the number of individual load or corresponding waste characteristics is noted over a specified period. So here is a very simple method. Then whenever a vehicle is entering the disposal site, the weight is getting measured with the full vehicle and empty vehicle.

So that by that way we can analyze how much quantity is getting entering the disposal site. Similar way the volume method. So if you have the special kind of vehicle and you know that what is the volume of that particular vehicle, you will be easily we can come up with how much amount of volume is getting hauled into that particular vehicle.

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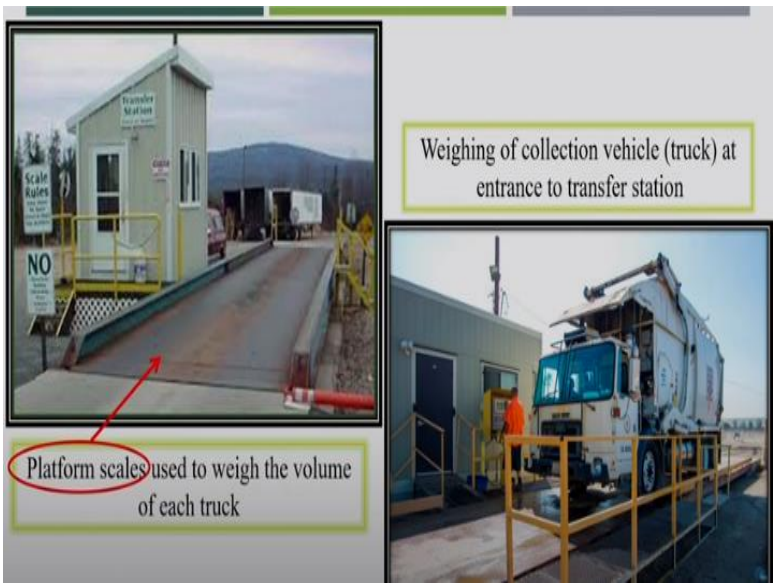

So I will show you some of the photographs in that way. This is the one particular weighing platform where the vehicle before entering the disposal site is getting weighed in this particular platform with the completely full vehicle and with this is like one photograph and also while coming back from the disposal site they empty weight also is getting measured.

So that we will come to know how much quantity is coming to the disposal site. So these are very important discussions about the by this method we can understand how much amount of waste is coming to the disposal site. We can say that I would not say is this is a generation rate we can measure from these. But this is the collection, how much waste is getting collected.

And there is always discussion about the generation rate and collection rate, both are different. And in India, most of the reports or most of the textbooks are writing like that whatever amount of waste is coming to the disposal site that normally is understood by the to how much amount of quantity is getting produced in the city. But that is not completely true. Because your collection efficiency was never 100%.

So is very difficult to say that whatever waste is reaching the disposal site that is a total waste is getting generated in the city that is not true. So normally, what we do for them to know that particular generation rate from this method, we will know how much is the collection rate, how much is waste is getting collected.

And normally some of the textbooks reported that the difference between generation rate and collection rate will be always 5 to 15% changes. And I think these we can easily resolve this issue if you know the collection efficiency of that particular city. If your collection efficiency is supposed 90% and whatever waste is reaching to the disposal site that would not be 100%.

So you can we can multiply this value by or we can add that 10% which is not getting collected from the city by increasing that amount 10% in the collection rate that we can consider is a generation. How much is the generation? So this point always has to remember that whatever data is getting proposed that whether is a generation data or collection rate.

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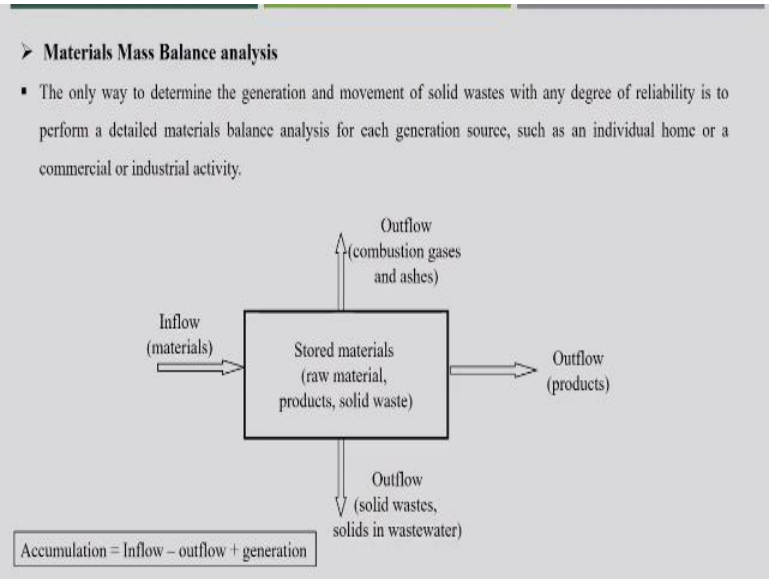

This another one more method. In that way, we can analyze the quantity that is material mass balance analysis. This is somewhat difficult for the city, but in a small commercial area or institutional area, or industrial areas, this method is very useful. So in this case, we will come to know how much is the inflow of the material in that particular locality, a particular industry, or particular commercial areas.

And how much is the outflow through the combustion gases or ashes? Outflow in the form of solid waste or the wastewater form. And finally outflow. In that way, we can know how much waste is getting generated in a particular locality. Whether it is a commercial or industrial or institution locality. There is one example of that. So for that accumulation will be inflow minus outflow plus generation. That is the particular accumulation in that particular location.

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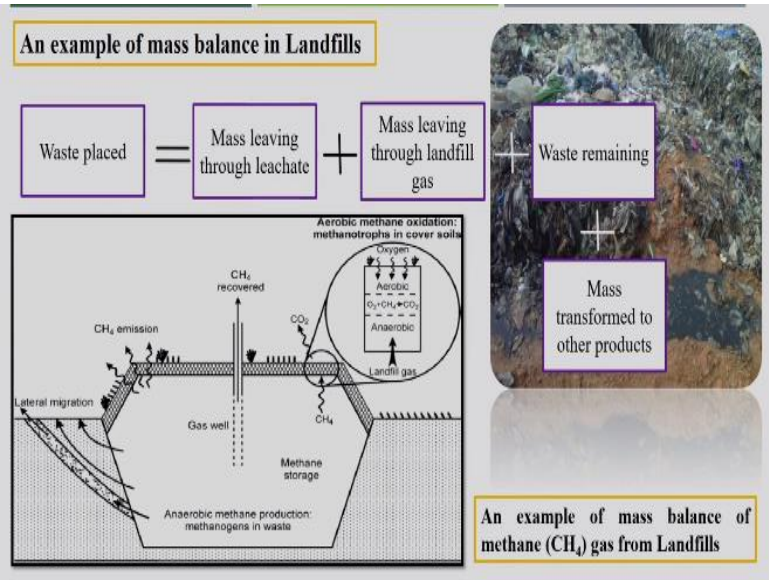

So there is an example of mass balance in the landfill. So how to calculate the waste placed into the landfill. That we can measure that mass leaving through the leachate. So the leachate is getting produced. So if you know that how much is the leachate is getting produced into the landfill site that will include plus the mass leaving through the landfill gases.

How much are the gases produced and how much is the waste remain plus mass transport to the other product. Whether is a maybe there will be some composting facility or some recycling facility into the dumpsite. So finally, we will come to know that how much amount of waste is getting placed into the disposal site by this particular example where we can come up with the mass balance of maybe methane gas or leachate production into the particular landfill site.

So these are the few methods by that way we can quantify the waste. So very important that to measure the quantity, quantity of solid waste whether is a weight quantity or is a volume quantity. So today we will finish this lecture here with the quantity.

Next lecture we will talk about what are the different factors are affecting the waste generation rate and those are a very important factor to be understood that and our always proposal will be that how best you will be able to reduce the waste or production of the waste or whatever the quantity is getting generated inside the municipal area. Thank you. Thank you for today's lecture.