Natural Resources Management (NRM)
Professor Sudip Mitra, PhD
Center for Disaster Management & Research (CDMR)
Head, School of Agro & Rural Technology (SART)
Discipline - Agriculture Engineering
Indian Institute of Technology, Guwahati, Assam, India
Week - 07
Lecture - 43
Environmental Impact Assessment (EIA) Part 3

So, in continuation with Environmental Impact Assessment, we till now have discussed EIA methods, LCA, and then GMP. Two methods we have discussed in detail. So, now we will discuss the third method, which is known as Fuzzy Arithmetic method.

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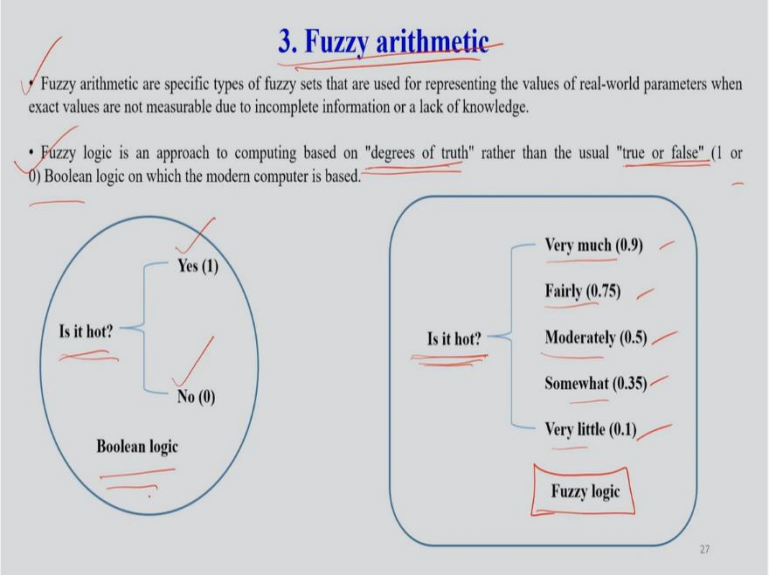

Now in fuzzy arithmetic's are specific types of fuzzy sets that are used for representing the values of real-world parameters. When exact values are not measurable due to incomplete information or a lack of knowledge, then you use this kind of fuzzy arithmetic system. Fuzzy logic is an approach to compute based on degrees of truth rather than the usual true or false cases, that means, which is Boolean logic 1 or 0. Instead of that fuzzy logic goes on the basis of degrees of truth.

So, is it hot? Suppose, a question, there could be binary answer, yes or no. That is how Boolean logic works in computational system. But in case of fuzzy, how you answer this, is it hot? Very much, fairly, moderately, somewhat, very little. See, 1, 2, 3, 4, 5different way you are explaining this question, is it hot? And this kind of system comes under fuzzy logic. This

is the simplest example that I can give you to see the difference between the Boolean logic and fuzzy logic.

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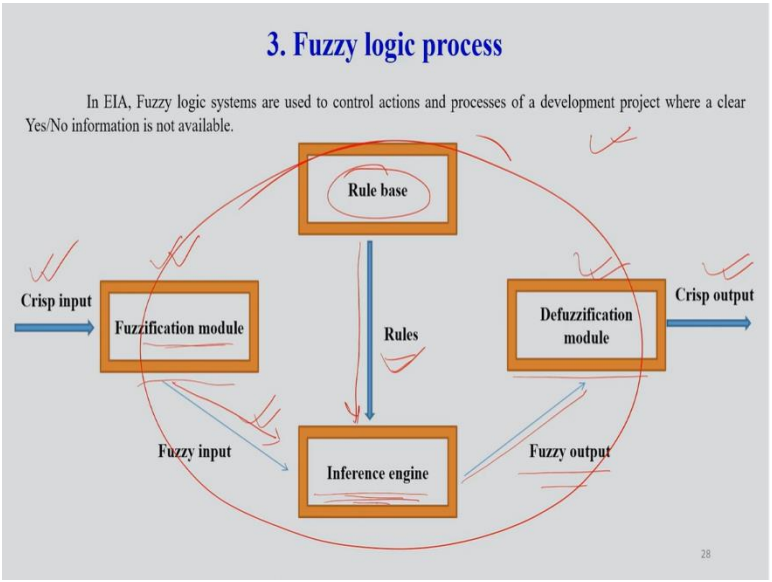

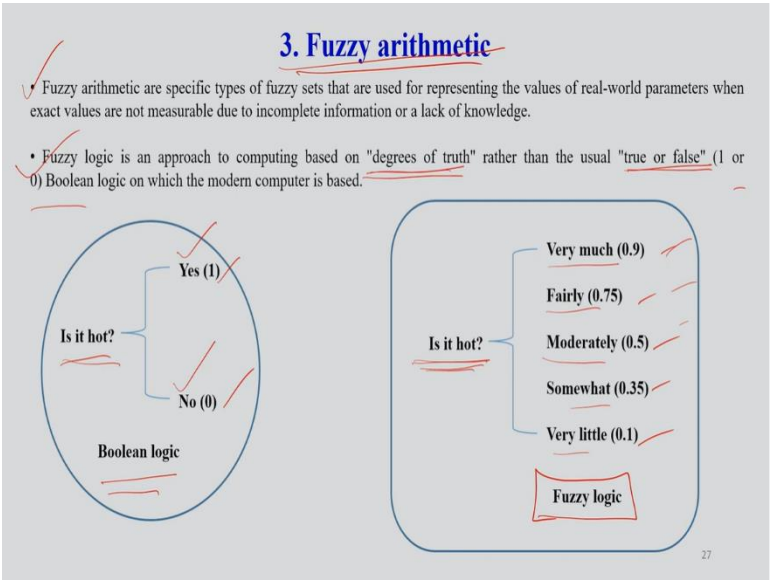

Now, in environment impact assessment, fuzzy logic system are used to control various actions and processes of a development project, where a clear yes or no information most of the time are not available. Now, you see in this particular diagram, so, suppose you get a very crisp input, very clear input or information. Now then it comes to your fuzzification module, from fuzzification module you give certain fuzzy input into the inference engine. And in this inference engine, there are certain rule base which also comes in.

Now on the basis of this rule base and the fuzzy input which is coming through fuzzification module, inference engine processes certain fuzzy output. And that output basically goes into defuzzification module. From fuzzification module, it finally goes to defuzzification module and you give a crisp output. That is a very simplistic way to explain to you that how an

information which is crisp information passes through the fuzzy system and finally, it goes out also as a very crisp output.

Now, entire this process which takes place we call a fuzzy logic processes. And as you have seen that in case of Boolean logic, we only say yes or no hot or not hot. But here we can also talk about the level of hotness. So, that is why fuzzy logic actually can capture, much more information and can give also much more information about a particular impact or particular event.

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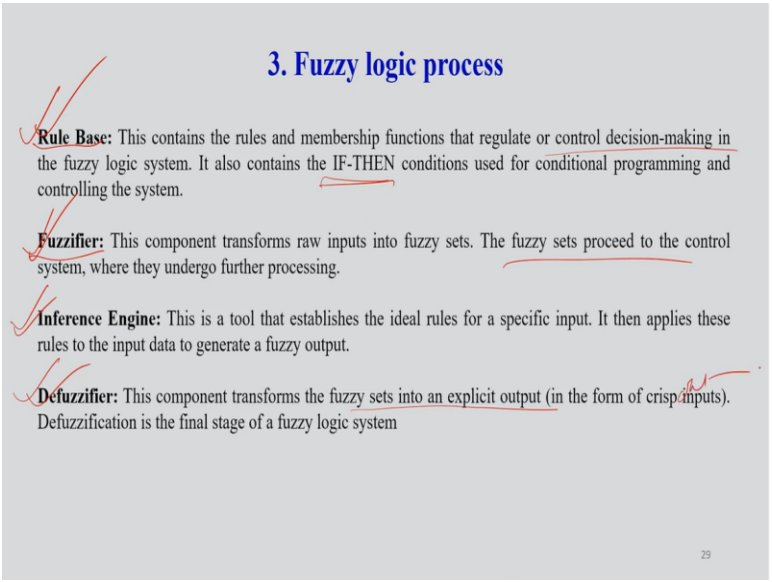

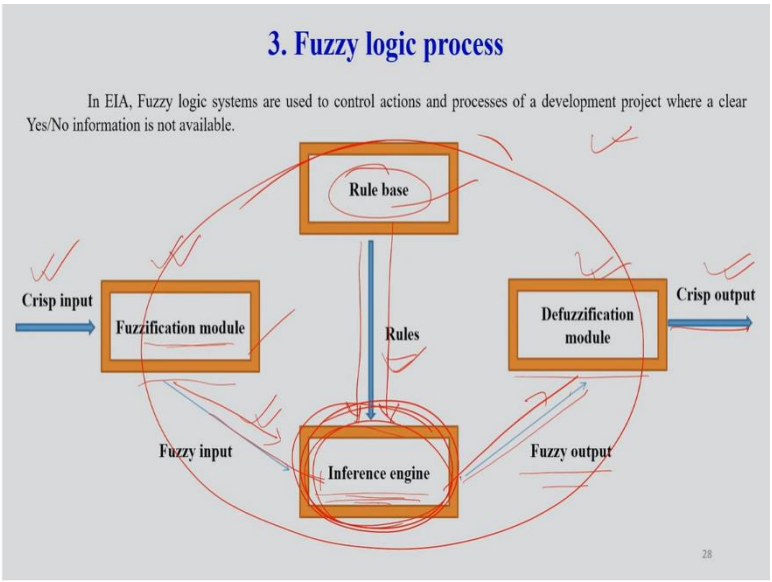

In case of fuzzy logic process, as you have just now seen that there are a few inputs like rule base fuzzification modules, so how actually they are defined or what are their role? Now, if you look at rule base, this contents the rules and membership functions which regulate or

control the decision making in the fuzzy logic system. You see here. The rules are coming in into the fuzzy logic inference engine and already some information are already here. So, finally, they can give a output which goes into defuzzification module and then finally gives a clear output. So, rule base is actually contains the rules and membership functions which will regulate or control the decision making in a fuzzy logic system. This also contains the IF and THEN conditions, used for conditional programming and controlling the system.

So, people, whoever has used this fuzzy logic system for their various kinds of research or activity, will be able to understand that what actually I am here explaining, but for others, I am trying to simplify the entire concept as much as possible, that how different information actually through this particular methods of EIA can help us to get certain information as an output.

Fuzzifier, this component transform the raw input into fuzzy sets, and then the fuzzy sets proceed to the control system where they undergo further processing is here. Inference engine, this is a tool that establishes the idea rules for a specific input. It then applies these rules to the input data to generate a fuzzy output, like here.

Now defuzzifier, see you get fuzzy output that fuzzy output maybe a little confusing at times. So, you can also defuzzify, this component transforms the fuzzy sets into an explicit output in the form of crisp output. Defuzzification is the final stage of a fuzzy logic system. So that means a simple input content to the system and it also go out as a simple output.

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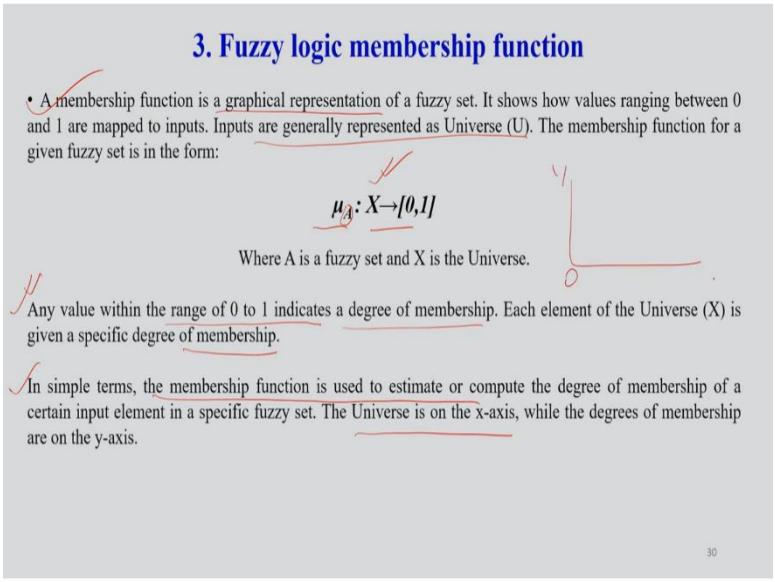

Now, fuzzy logic membership function. A membership function is a graphical representation of a fuzzy set. It shows how values ranging from 0 and 1 are mapped to inputs, and inputs are generally represented as universe U and the membership function for a given fuzzy set, is in the form of mu A X to 0, 1

μA is a function from the set X to the closed interval from 0 to 1

Where A is a fuzzy set and X is the universe.

Any value within the range of 0 to 1 indicates a degree of membership and each element of the universe X is given a specific degree of membership. In simple term, the membership function is used to estimate or compute the degree of membership of a certain input element in a specific fuzzy set and the universe is on the X axis while the degrees of membership are on the Y axis.

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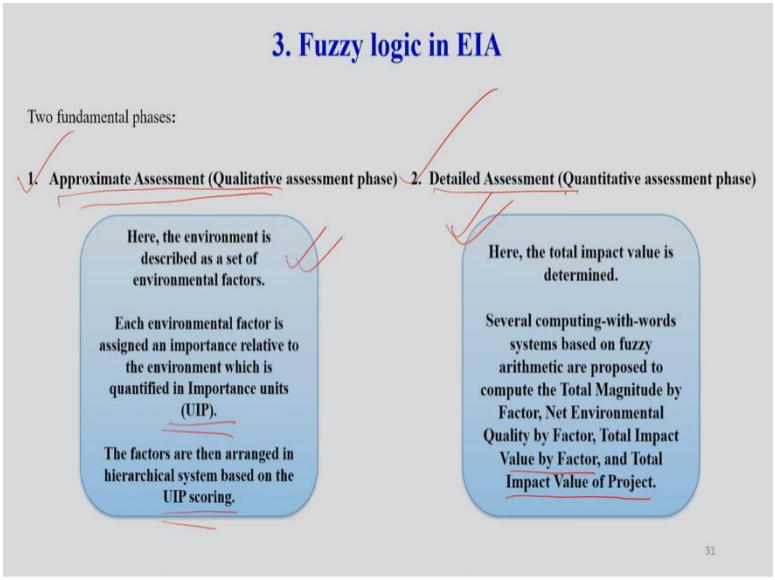

There are two fundamental phases in fuzzy logic system or fuzzy logic methods in EIA. What are those? First one, approximate assessment, which is a qualitative assessment and the other one is detailed assessment, which is a quantitative assessment, which, clear. Now, in approximate assessment or qualitative assessment phase here, the environment is described as a set of environmental factors. Each environmental factor is assigned an importance relative to the environment, which is quantified in Importance Unit, UIP.

Now the factors are then arranged in hierarchical order based on the UIP scoring, clear. Now see the detail assessment phase. Here the total impact value is determined and several computation also takes place with what system based on fuzzy arithmetic, the total magnitude by factor, net environmental quality by factor, total impact value by factor and total impact value of project. So, these are the differences between your approximate assessment and detail assessment under fuzzy logic of EIA.

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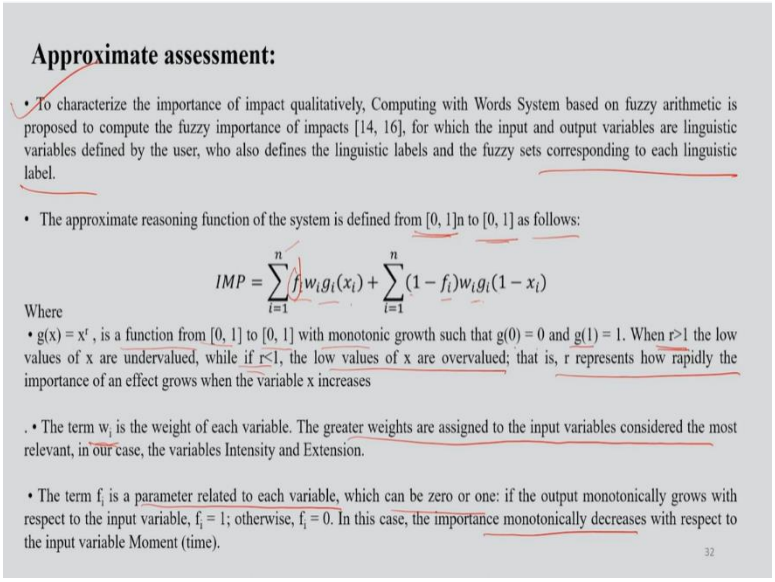

Now, let us discuss how you actually carry on this approximate assessment and detailed assessment. Now, in case of approximate assessment, we try to characterize the importance of impact qualitatively. We try to compute the words system based on fuzzy arithmetic, which is proposed to compute the fuzzy importance of impact and for which impact an output variables are kind of linguistic variables defined by the user, who also will define the linguistic levels and the fuzzy sets corresponding to each linguistic level.

Now, the approximate reasoning function of this particular system is defined from 1 to n to 0 to 1 as follows.

IMP is equal to the sum from i is equal to 1 to n of fi times wi times gi of xi , plus the sum from i is equal to 1 to n of (1−f i) wi times gi of (1−xi)

Where g of x equals x raised to the power of r is a function from the closed interval from 0 to 1, to the closed interval from 1 to 0,with a monotonic growth such that g gets a value of 0 and 1, where r is greater than 1, the low values of x are undervalued, while r is less than1, the low values of x are overvalued. That is r represent how rapidly the importance of an effect grows when the variable x increases.

The term w_i is the weight of each variable, the greater the weights are assigned to the input variables, it consider the most relevant one. In our case, the variables intensify and get extension. The term f_i is a parameter related to each variable which can be 0 or 1, if the output monotonically grows with respect to the input variable, where f_i is equal to 1, or f_i can be equal to 0, in this case, the importance of monotonically decreases with respect to the

input variable moment or time, which time the importance of the monotonically factor will get decreased. And all these things basically will give you an approximate assessment of the event.

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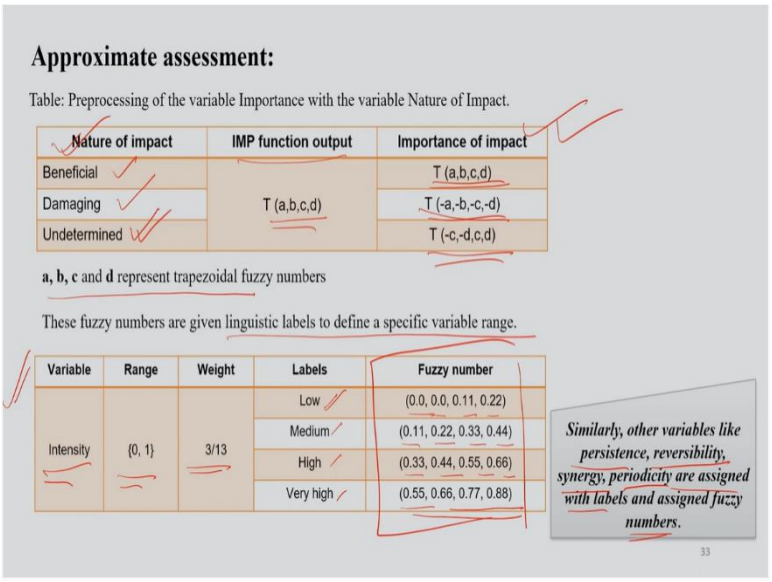

Now the result or reprocessing of the variable importance with the variable nature of impact in case of approximate assessment, if you carry out, then you get nature of impact and importance of impact. Either it would be beneficial or damaging or there could be another condition undetermined. And in this case the IMP function output normally we get as T could be a, b, c, d in case of beneficial, it will be all positive, in case of damaging, it will be negative. And in case of undetermined of course, you may get some values or some kind of calculated output which may not give you any clear-cut direction.

Here a, b, c, d represent trapezoidal fuzzy numbers. These fuzzy numbers are given linguistic labels to define a specific variable range. And how are they given? Look at here in this table. Suppose you have a variable to measure the intensity of a particular process and the range you give 0 to 1, weight you give say anywhere between 3, or 13 something like that. And then you label it as low, medium, high, very high.

But how you will associate this linguistic label with some number? That is where is the challenge. Now, if it is low, most of our fuzzy numbers will look like this. If they are of medium, then they will look like this. If they are of high, then they will look like this, and if very high, then they look like this. Similarly, other variables like persistence, reversibility, synergy, periodicity are assigned with this kind of level and assigned a fuzzy numbers as well.

So, assigning these fuzzy numbers requires little bit of experience, little bit of knowledge about the system for which actually you are applying this particular methodology or method. So, overall, this actually can give you information about the system and its performance and its impact on the environment.

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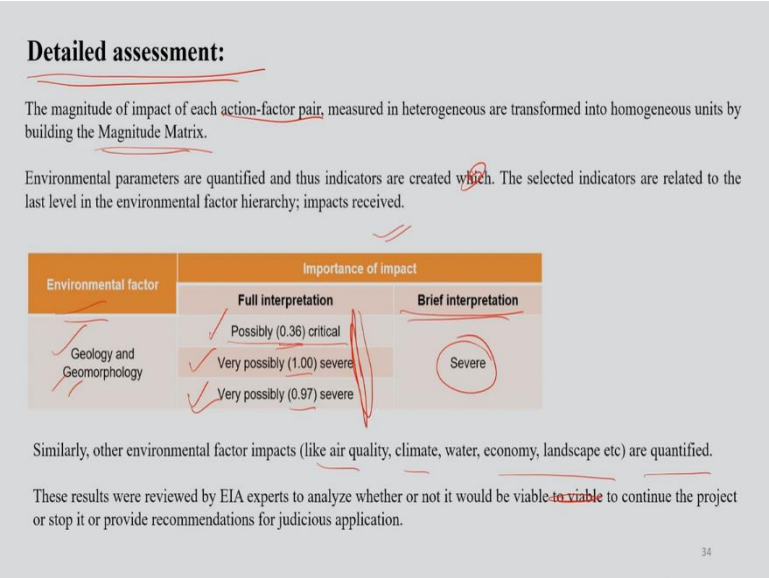

Now, detail assessment, approximate assessment we discussed, next is detailed assessment. The magnitude of impact of each action-factor pair is measured in heterogenous kind of manner and transformed into homogeneous units by building the magnitude metrics. Now, environmental parameters are quantified and thus indicators are created, which actually will be selected on the basis of indicators, which are related to the last level in the environmental factor hierarchy on the basis of the impacts that it receives.

Now environmental factor for say, geology and geomorphology. What kind of impact? Say, if you have kind of full interpretation of the importance of the impact of an environmental factor with regard to geology and geomorphology, you can have one condition possibly critical, you can have another very possibly, or severe, and another one you will have very, very possible severe.

Now the value that you see that it changes from zero point three six and then one and then again zero point nine seven. So, if you get this kind of information, then your ultimate or brief interpretation of the impact or importance of impact in one word will be severe. Similarly, other environmental factor inputs like air quality, climate, water etcetera are also quantified, to understand the impact on the surrounding system.

And this kind of results are reviewed by EIA experts and they analyze whether or not it would be viable to continue the particular project or to stop it or provide certain recommendation for judicious applications or certain modification in this process development methodologies so, that it can minimize the impact on the environment. That is the ultimate goal.