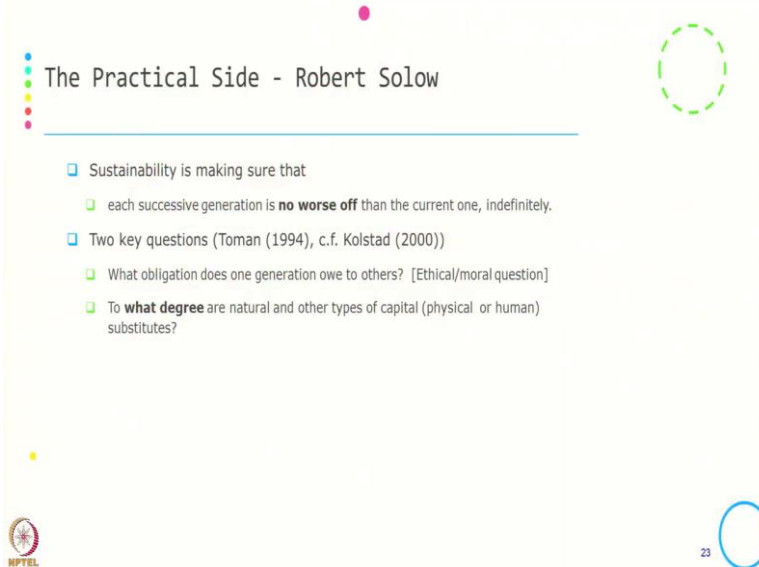


Business and Sustainable Development
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Lecture - 06
Robert Solow's Conceptualization of Sustainability

So, welcome to the session. In this session we will try to see or try to review or try to understand the lecture given by Nobel Laureate Robert Solow on understanding the practical side of the sustainability.

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The Practical Side - Robert Solow

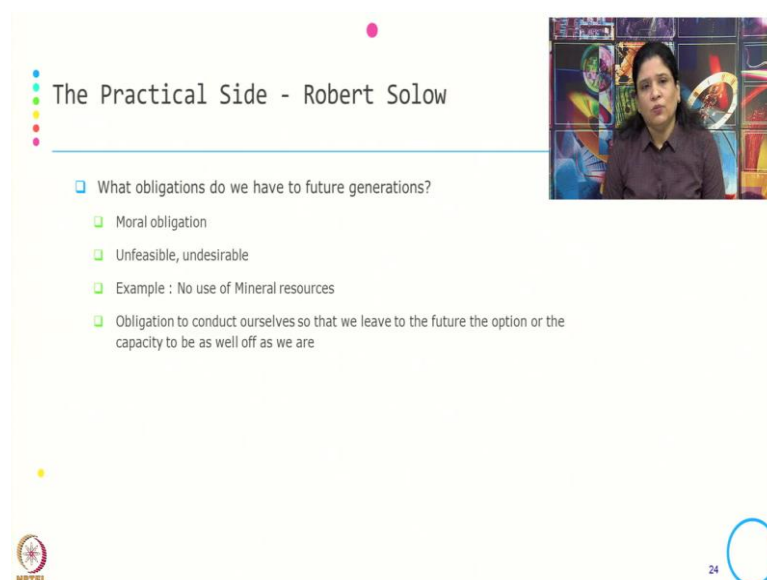
- Sustainability is making sure that
 - each successive generation is **no worse off** than the current one, indefinitely.
- Two key questions (Toman (1994), c.f. Kolstad (2000))
 - What obligation does one generation owe to others? [Ethical/moral question]
 - To **what degree** are natural and other types of capital (physical or human) substitutes?

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So, he has raised many dimensions when it comes to the operationalizing sustainability or the practical side of it. Mostly we will take we will discuss two questions; one what obligation does one generation owe to others, whether it is a ethical questions or whether this is a moral question.

And second to what degree are natural and other types of capital that is physical or human substitute, how long we can substitute or how much we can substitute. So, Professor Solow has given a very interesting way to understand the sustainability is, sustainability is making sure that each successive generation is no worse off than the current one for the indefinite period of time.

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The Practical Side - Robert Solow

- What obligations do we have to future generations?
 - Moral obligation
 - Unfeasible, undesirable
 - Example : No use of Mineral resources
 - Obligation to conduct ourselves so that we leave to the future the option or the capacity to be as well off as we are

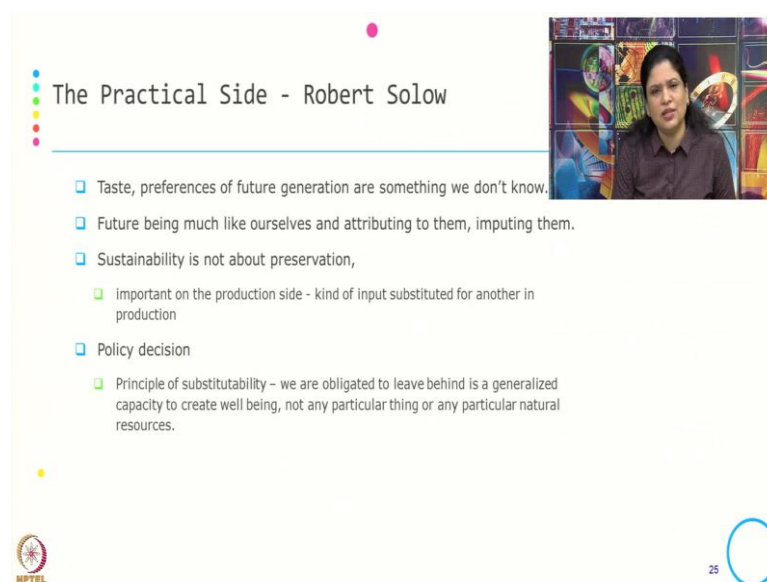
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Now, first to understand whether this is ethical or moral obligation. So, the discussion goes like this. If it is moral obligation, so we should have a moral obligation to our future generation, but the fact is it is unfeasible, it is undesirable. Why it is unfeasible? Unfeasible with the ground that we cannot, it is not that we should not be using mineral resources, because we need to preserve this for the future generation. And undesirable that we will discuss in the next slide that why this can be undesirable.

Obligation to conduct ourselves. So, mostly rather than putting this in the ethical or the moral obligation, it is about the obligation to conduct ourselves, so that we leave the future the option or the capacity to as well as or as we are.

So, it is not about keeping something for the future generation rather the way we behave, the obligation what we should have that we should keep the option for the future generation or the capacity to the future generation to be as well off as we are.

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The Practical Side - Robert Solow

- Taste, preferences of future generation are something we don't know.
- Future being much like ourselves and attributing to them, imputing them.
- Sustainability is not about preservation,
 - Important on the production side - kind of input substituted for another in production
- Policy decision
 - Principle of substitutability - we are obligated to leave behind is a generalized capacity to create well being, not any particular thing or any particular natural resources.

MPTEL 25

And why we should not preserve or keep anything for the future generation, because we do not have any idea about the taste, preference what the future generation will be having. The typical example is that our past generation was not sure that what would be our taste preferences. So, similarly the logic applies to us also that we do not know about the taste preference of the future generation.

And future much like ourselves attributing to them, imputing to them. Possibly that is not the way what we should understand the need of the future generation. And he has given the idea or he has given the opinion that sustainability is not about preservation, it is important on the production side that what kind of input can we substituted for another when the particular inputs is not available.

And ideally the policy decision should be like this that we are obligated to leave behind a generalized capacity, it is not resources generalized capacity which is to be, does not mean only resources we should keep for the future rather we should keep the capacity to create wellbeing not any particular thing or not any particular natural resources.

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An Economic Perspective: Robert Solow

- Weak Sustainability
 - holds that "human-made (constructed) capital **can effectively substitute** for natural capital and the services provided by ecological systems."
 - "... developed from economic models of growth and technological change in the context of limited resources."
 - Natural capital may be used up if we invest in other forms of capital that will support well-being
- Strong:
 - Holds that **certain ecosystem functions cannot be replaced** by human-made capital and must be maintained

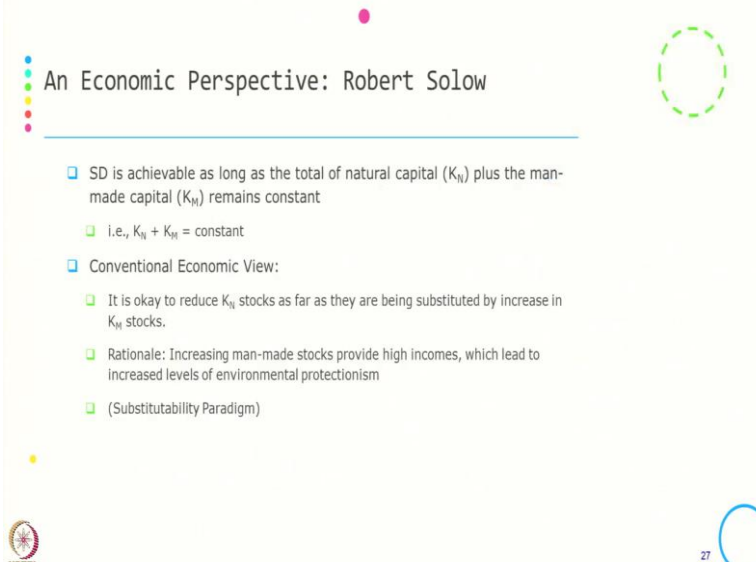
Now, he has, on that basis based on the capacity or based on the resources; natural resources or the ability he has defined two types of sustainability.

One is weak sustainability and second one is the strong sustainability. Now, what is weak sustainability? It holds that human made that is the constructed capital can effectively substitute for natural capital and the services provided by the ecological system and it is developed from economic model of growth and technological change in the context of limited resources. So, according to weak sustainability natural capital may be used up if we invest in the other form of capital that will support the well-being.

So, it is about if I am using the natural capital, if I am able to invest in lieu of that then I should be using natural capital. And according to weak sustainability natural, all the human made capital can substitute the natural capital. Strong sustainability says that certain ecosystem function cannot be replaced by human made capital and it must be maintained.

So, it is not that all natural capital can be substituted by human made capital. Certain thing cannot be replaced by human made capital, so few things we need to maintain.

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An Economic Perspective: Robert Solow

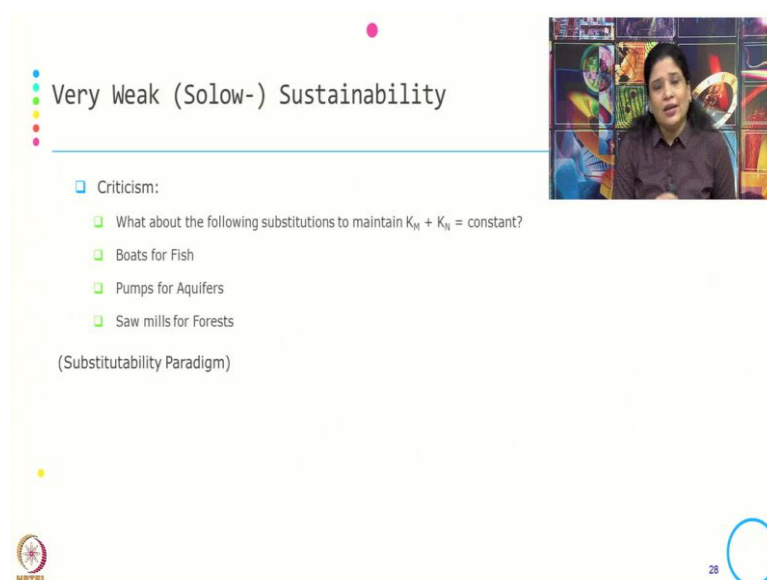
- SD is achievable as long as the total of natural capital (K_N) plus the man-made capital (K_M) remains constant
 - i.e., $K_N + K_M = \text{constant}$
- Conventional Economic View:
 - It is okay to reduce K_N stocks as far as they are being substituted by increase in K_M stocks.
 - Rationale: Increasing man-made stocks provide high incomes, which lead to increased levels of environmental protectionism
 - (Substitutability Paradigm)

NPTEL 27

So, sustainable development is achievable as long as total natural capital that is your K_N plus the man-made capital K_M remain constant. Conventional economic view says that it is ok to reduce K_N stock as far as they are being substituted by increasing K_M stock.

So, it is ok till the time we are reducing the stock of natural capital till the time we are able to substitute that in the form of the human build capital. And the rationale over given over here is that increasing manmade stock provide high income which leads to increase the level of environmental protectionism. This is typically known as the substitutability paradigm.

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Very Weak (Solow-) Sustainability

❑ Criticism:

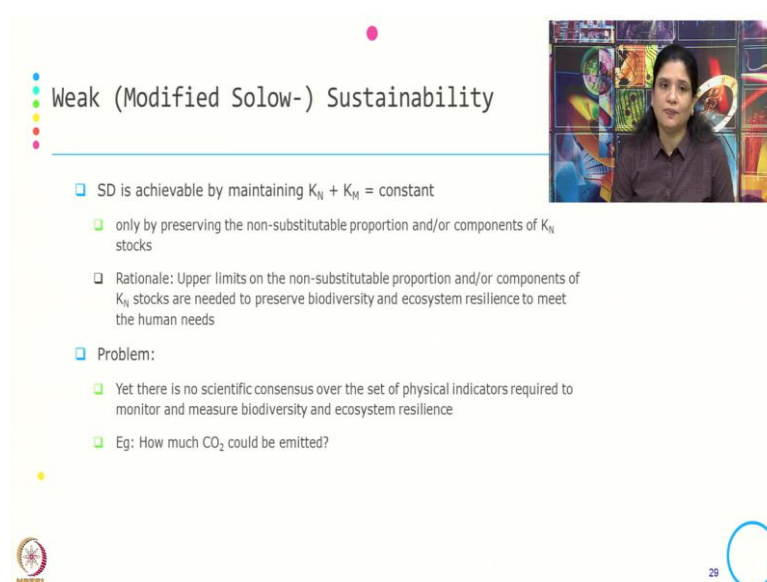
- ❑ What about the following substitutions to maintain $K_M + K_N = \text{constant}$?
- ❑ Boats for Fish
- ❑ Pumps for Aquifers
- ❑ Saw mills for Forests

(Substitutability Paradigm)

NPTEL 28

The criticism over here is that what about following substitutions to maintain K_M K_N remain constant. Can we invest in boat when we use more of fish? Can we use on pumps when we use more of aquifers? Can we use on can we invest on saw mill when we use more of forest? Possibly no, this is what the criticism. You cannot substitute everything by investing in the human made capital.

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Weak (Modified Solow-) Sustainability

❑ SD is achievable by maintaining $K_N + K_M = \text{constant}$

- ❑ only by preserving the non-substitutable proportion and/or components of K_N stocks
- ❑ Rationale: Upper limits on the non-substitutable proportion and/or components of K_N stocks are needed to preserve biodiversity and ecosystem resilience to meet the human needs

❑ Problem:

- ❑ Yet there is no scientific consensus over the set of physical indicators required to monitor and measure biodiversity and ecosystem resilience
- ❑ Eg: How much CO_2 could be emitted?

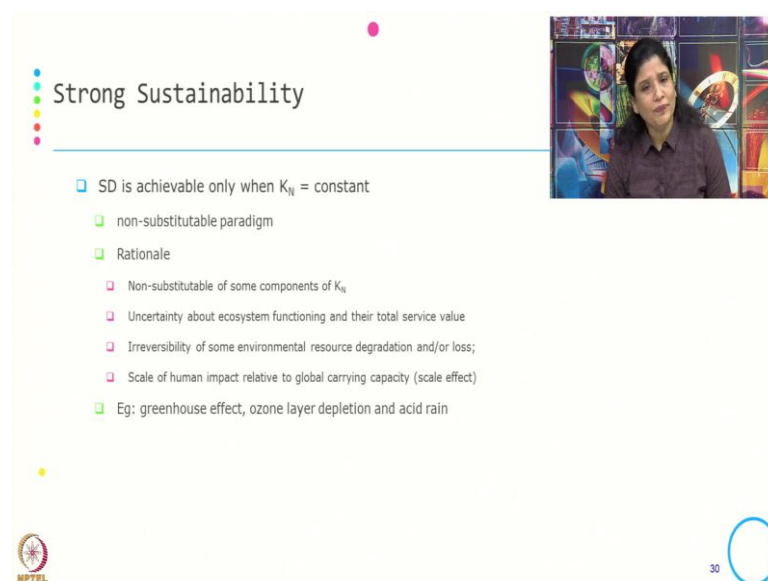
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Then from there from the very weak sustainability because of this criticism we moved into weak that is the modified Solow sustainability they say that SD is achievable by

maintaining K_N and K_M constant. Only by preserving the non-substitutable proportion and component of K_N stock. So, that part of K_N which cannot be substitute can be preserve and the rationale given over here is that upper limit on the non-substitutable proportion or the component of K_N stocks are needed to preserve the biodiversity and ecosystem resilience to meet the human need.

But the problem over this weak sustainability is that, there is no scientific consensus over the set of physical indicator required to monitor and measure the biodiversity and ecosystem resilience. Typical example is that how much CO_2 to be could be emitted.

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Strong Sustainability

- SD is achievable only when $K_N = \text{constant}$
 - non-substitutable paradigm
 - Rationale
 - Non-substitutable of some components of K_N
 - Uncertainty about ecosystem functioning and their total service value
 - Irreversibility of some environmental resource degradation and/or loss;
 - Scale of human impact relative to global carrying capacity (scale effect)
 - Eg: greenhouse effect, ozone layer depletion and acid rain

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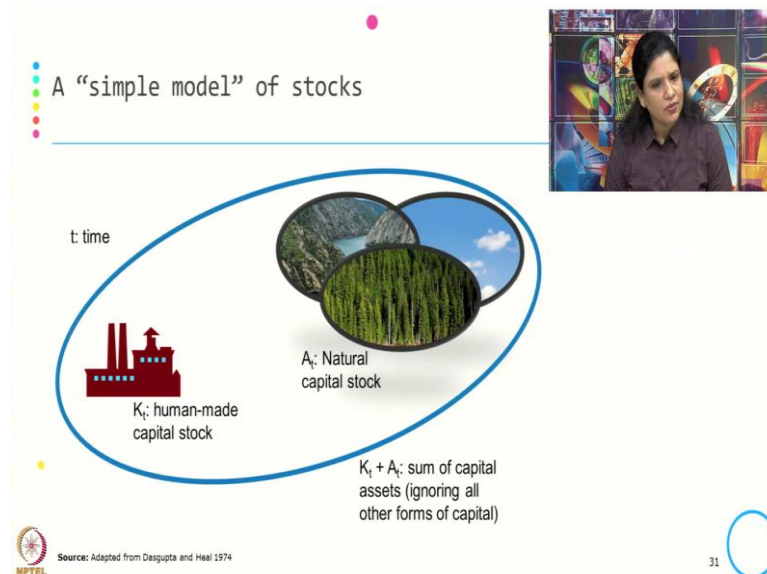
Now, the strong sustainability says that sustainable development is achievable only when K_N is constant, this is strong sustainability. This is based on the non-substitutable paradigm.

The rationale given over here is that non substitutable component of there would be always some component of K_N . There is always uncertainty about the ecosystem functioning and their total service value. So, what is the total service value for the ecosystem is now we do not know whether the same value can be maintained over 20 years, 50 years or 100 years.

There is some irreversibility of some environmental resource degradation and loss, and scale of human impact relative to global carrying capacity or that is a scale effect works

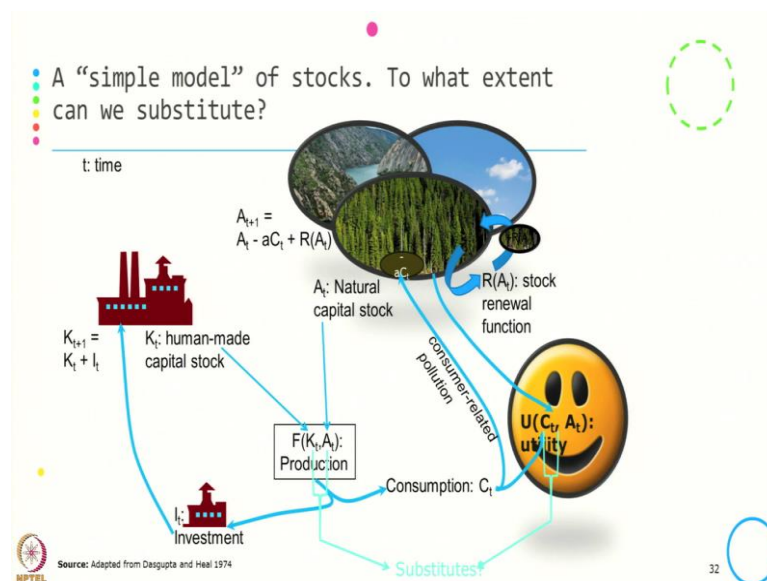
here. Typical example is greenhouse effect, ozone layer depletion and acid rain. So, we need to keep the K_N constant then only we can achieve the strong sustainability

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Let us have a pictorial explanation of this weak sustainability and strong sustainability. So, K_t which our human made capital stock, A_t is our natural capital stock. K_t and A_t the sum of capital assets we have ignore all other form of capital. This is the total stock.

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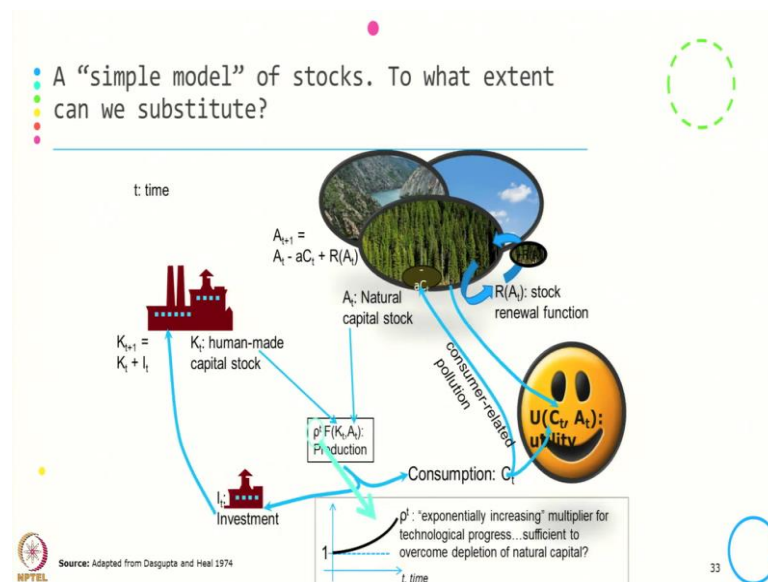
Now, to what extent we can substitute. So, we can do the investment from human made capital stock and we can do the consumption from the natural capital stock. So, K_t plus 1

is equal to K_t plus I_t including the investment, and this becomes production investment and then the production, production which is a function of K_t and A_t right. And this natural capital stock is gets reduced when we use the consumption part of the natural capital stock, but also the stock renewal function gets added into the natural function, because natural resources also get renewed over a period of time.

$$K_{t+1} = K_t + I_t$$

$$F(K_t, A_t) = \text{Production}$$

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The simple model of stock is that to what extent we can substitute. So, this depends on how much is the progress we are making or the typical ρ^t over here which is exponentially increasing multiplier for the technological progress is it sufficient to overcome the depletion of the natural resources. So, the idea over here is that we can substitute certain portion of it, but to how much substitute and how much substitute which would be enough for the future generation that is not clear.

So, Professor Solow in a this is in the part of one of his lecture, he has tried to give the operationalization of the different sustainability definition and he has brought the concept of weak and strong sustainability, where weak sustainability says that the human made capital can replace whatever the consumption of the natural capital is being done,

but strong sustainability says that it is not possible to invest in human made capital and get all the natural capital what has being consumed.

Thank you.