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"Synthesis of Ecology and Economics " Towards a New Theoretical Paradigm

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ARTICLE INFO | **ABSTRACT**

This paper explores the synthesis between ecology and economics to establish a new theoretical paradigm for sustainable development Traditional economic models often ignore ecological limits, leading to resource depletion, biodiversity loss and climate change, conversely, ecological systems provide the foundational services upon which all economic activities depend. This research integrates ecological principles into economic thinking, proposing a framework that balances economic growth with environmental preservation the study concludes that the future of development lies in an ecological-economic synthesis.

1. Introduction -

Neither neo-classical economics nor Marxian analysis integrate natural resources and theories of economics, particularly economic activity ideas of free gifts of nature and control over nature dominate economic thought this paper present an analysis of neo-classical thought in response to the ecological challenge, and enunciates the general principles of a new 'ecological economics' it see the macro economy as an open system with a unidirectional flow of entropy. Suggests an accounting of environmental depreciation on the lines of capital depreciation and proposes local level collective control over natural resources.

2. Objectives of the study:-

1. To analyze the interdependence between ecological and economic systems.
2. To review existing theories connecting ecology and economics.
3. To propose a new Integrative paradigm for sustainable development.
4. To suggest policy implications based on ecological economic synthesis.

3. Methodology :-

This study is qualitative and conceptual in nature it relies on secondary data collected from academic journals, books, and reports from institutions like UNEP, world bank and IPCC the methodology includes.
i) Literature review of ecological economics theories.
ii) Comparative analysis of traditional v/s ecological economic models.
iii) Theoretical synthesis based on sys terms and sustainability perspectives.

- **Review of literature :-**

1. Early economic thinking.

Classical economists such as Adam smith and David Ricardo Viewed nature as an abundant resource, assuming infinite substitutability environmental limits were largely ignored.

2. The ecological turn.

The 20th century saw a growing awareness of ecological constrains. The "limits to growth" (Midwest et-al. 1972) report and works by Herman dally introduced the idea of a steady. State economy where growth respects ecological boundaries.

3. Modern Ecological economics :-

Ecological Economics, a discipline emerging in the late 20th century , integrates thermodynamics, systems ecology, and economic analysis, it focuses on natural capital, ecosystem services and sustainability indicators.

4. Sustainable Development Paradigm.

The Brundtland report (1987) emphasized that development should meet their own needs This forms the foundation of ecological-economic synthesis.

The founders of neo-classical economics, on their own testimony, aspired to create a science patterned exactly on Newtonian mechanics could visualize change only as locomotion, which is both quality less and reversible. Despite the various challenges faced by the neo-classical school, this mechanical analogue has come to dominate economic thought. The economic process is seen as a circular flow between production and consumption, with no outlets and no inlets. This flow is isolated, self-contained and a historical neither creating nor being affected by qualitative changes in the environment within which it occurs. Even the classical political economy of Ricardo expressly saw land as a factor immune to qualitative degradation ("the original and indestructible powers of the soil"). And though Marx was a centrally concerned with dynamics, viewing the economic process as essentially historical and qualitative in character, he also did not integrate natural re-sources into his main analysis. It is true that Marx speaks of labour as a "process between man and nature" [Marx 1976: 283]. But the terms of this interaction are: (a) that "man, through his own actions, mediates, regulates and controls the metabolism between himself and nature" (ibid) by(b) working on "objects of labour" that are "spontaneously provided by nature" (op cit, p 284).

This dual conception of 'free gifts of nature' and the imperative to exercise control over nature' runs through the entire gamut of thinking in economics. Progress is seen as co-terminus with the conquest of nature. Allied to this is the presumption that unlimited quantities of waste can be costlessly dumped into the bottomless sink of the environment. Along with the assumption of free gifts goes also the assumption of free disposal.

Following the publication in 1971 of Nicholas Georgescu-Roegen's The Entropy Law and the Economic Process, and especially during the last decade, all this has rapidly begun to change. Indeed, what we are witness to is a revolution in economic thinking which promises to be nothing short of a Kuhnian "paradigm shift" [Kuhn 1970]. That this has as much, if not more, to do with a decisive decline in what Alfred Crosby (1986) has so eloquently described as "ecological imperialism", is a theme to be explored else-where. We limit ourselves here to explicating how the entropy law necessarily compels the abandonment of the mechanistic dogma by forcing the realisation that qualitative and irrevocable changes necessarily characterise the environment of which economic processes are a part-that both the assumptions of free gifts and free disposal are untenable, there being a dynamic, two-way inter-relationship between the economy and the environment.

4. Entropy Law and Biophysical Foundations of Economics

What is known as the entropy law is really the second law of thermodynamics, which poses a fundamental challenge to Newtonian mechanics. The first law of thermodynamics is actually in accord with classical mechanics, stating that 'for all changes, the energy of the universe re-mains constant'. This law, also known as the law of conservation of energy, means, for instance, that when coal is burnt to ashes, the total quantum of energy remains constant. However, as we know, from coal to ashes there is an important change. The chemical energy of coal is no longer available for use. It has undergone a qualitative, irrevocable change.

According to the classical thermodynamics, energy consists of two qualities: (1) free/available/ordered, and (2) bound/latent/disordered. While free energy is available for transformation into useful work, latent energy cannot be so used. Thus, the burning of coal leads to the conversion of energy - from being free, available, ordered, it becomes bound, unavailable, chaotic. In the language of thermodynamics, this is referred to as a rise of in entropy. Indeed, the second law of thermodynamics states that 'the entropy of the universe increases constantly and irrevocably. Free energy always dissipates by itself (and without any decrease) into latent energy. Thus, there is a continuous and irrevocable qualitative degradation of available into disordered energy.

The entropy law can be seen as the systematization of the elementary fact that heat by itself always flows in one direction only, from the hotter to the colder body, never in reverse. This simple fact of unidirectional change implies that there are phenomena which cannot be reduced to locomotion, a decisive blow against the mechanistic dogma of Newtonian physics, which asserts that all change must be reversible.

It is this mechanistic epistemology which lies at the root of the textbook depiction of the macro economy as an isolated sys-tem or circular flow. In such a self regurelating and self-sustaining model, what circulates between firms and households, in a closed loop, is exchange-value abstracted from all physical dimensions. There is no place for materials, energy sources, physical structures and time-dependent processes. The model is inconsistent with physical connectivity and positive-feedback dynamics of energy and information systems. It is much like seeing an animal with only its circulatory system, completely abstracting from its digestive tract. Introducing physical dimensions entails bringing in materials and energy which the macro economy must draw in from the surrounding environment.

For this what is required is to picture the macro economy as an open sub-system of the finite natural ecosystem (the environment) and not as an isolated circular flow of abstract exchange value. In so doing, we take up the cue from Alfred James Lotka, whose 1925 work elements of Physical Biology, has had a formative influence on modern ecological economics. Lotka saw humanity as an active part of an interconnected cosmos. He regarded the organic world and its inorganic parts as a single system. Each part was linked to every other part in some way and it was impossible to understand the working of any one part without an understanding of the whole. According to Lotka "underlying our economic manifestations are biological phenomena which we share in common with other species; the analysis of the biophysical foundations of economics is one of the problems coming within the programme of physical biology" (opcit). Modern ecological (who may also be called biophysical) economists could be described as laying bare precisely these foundations.

5. Entropic Vision of Economic Development. :-

Viewed in the light of the entropy law, the economic process is, in fact, not circular, but unidirectional, involving a continuous transformation of the flow of low entropy received from the environment into high entropy or irrevocable waste which is returned to the environment. This is a one-way flow, not a circular one. The flow of blood is to the circulation of exchange-value as the digestive tract is to the unidirectional entropic flow, beginning with environmental resources and energy, through firms and households, and ending with high-entropy waste into en vironmental sinks.

What is more, this entropic flow has a continuously degrading impact on the environment from which the economy must incessantly draw its low entropy. Each qualitative transformation of the environment within which the economy operates, demands a re-adaptation from the economy. Thus the very sustainability of the economic process depends on its ability to so adapt. No model which seeks to under stand the economy can be complete if it ignores the broader eco-system of which the economy is a part, and the co-evolutionary path of the sub-system and its parent. The changes in the environment are both exogenous and, increasingly in or high-entropy age, caused by the inter-action of the global economy with the environment.

One could say that it is the pace at which low entropy is pumped from the environment into the economy that limits the pace of economic development. Constantly, therefore, the economic process calls upon human beings, much like Maxwell's demon, to filter and direct environmental low entropy towards the satisfaction of our economic goals. Based on such a vision, one could describe the challenge of economy development as not merely the multiplication of the filtering mechanism based on existing sieves, but much more as the imaginative task of the innovation of finer sieves (technologies) to filter and thereby reduce the proportion of low entropy ending up as waste.

6. Neo-Classical Response to Challenge of Ecology.

Markets for externalities and private property: Neo-classical economists have traditionally sought to incorporate environmental considerations (the absence of free gifts and free disposal) into their framework through the concept of 'externalities'. In fact, early contributors saw externalities to be a significant enough problem that led to the breakdown of the market mechanism as an appropriate transmitter of signals necessary to ensure socially (as opposed to privately) desirable outcomes. Beginning with Allyn Young's celebrated 1928 article, the works of Rosenstein-Rodan (1943), Meade (1952) and Scitovsky (1954) became the basic for arguments in favour of planned industrialization and Pigouvian taxes and subsidies, in the fae of uncertainty, indivisibilities, complementarity between industries, etc.

Following the gradual rise to ascendancy of the general equilibrium framework, however, neo-classical economists become increasingly preoccupied with explication the conditions under which the market could adequately deal with questions posed by exhaustible resources and environmental externalities. This led to the conjuring up of devices such as markets for externalities, the rational expectations hypothesis and futures, contingent markets. The largely fictitious nature of these solutions is apparent even to adherents of the tradition. Dasgupta and Heal (1979:48) provide the most comprehensive overview of the neo-classical tradition's attempt to deal with exhaustible resources. They acknowledge that "a precondition for the establishment of a market is the existence of and enforcement of property rights". And for externalities at times it becomes impossible even to define property rights, let alone establish them legally and then enforce them. Take the case of groundwater. White there can be well-defined titles to land owned by farmers. It is an extremely trickily exercise trying to define private property rights in the water underneath. As is well known to students of hydrology and geology, surface and sub-surface water flow patterns can follow very different courses. What is more, the extraction of a neighboring landowner can materially affect your water yield. The neighbor can easily draw away water form below the land that you own. So there is little comfort in stipulating that you own the water which lies beneath your land.

It has been argued further that even where it may be possible to define property rights, this does not automatically ensure that the market solution would work. As Charles Parrings (1987:93) shows "property without possession provides no basic for the generation of prices". For a resource to have a price. It is necessary that positively valued inputs are used in its production. This can only happen when the owner has actual possession of the resource. In the absence of such control, prices are subject to an infinitely large "residuum of indeterminacy", to use a graphic terms first employed by Kapp (1969:345).

The phenomenon being described here is a particular case of what has come to be known as the 'problem of the common'. The problem characterizes a variety of activities impinging upon exhaustible common property resources such as fishing in the sea, grazing in forest and village common land, oil exploration, etc. in each

Instance, individual calculus leads to competitive extraction and the danger of rapid, irrevocable depletion of the resource. That uninformed, unaware profit-based actors will exhaust the resource is easy to see. The real irony is that if an individual involved can perceive the long-run impact of his actions, he will become even more competitive and destructive. For he will realise that if he alone thinks of the 'social good', his competitors could go for the kill, leaving him high and dry, while wiping out the resource at the same time. In a ceritique of those [e g, Shah 1993] who suggest that groundwater markets can contain overexploitation it has been argued that 'purely private exploitation would lead to either monopolistic exploitation or to highly skewed distribution of benefits in favor of the better-off farmers/users and at relatively high social costs" [Vaidyanathan 1996:187]. The real challenge is to develop collective nonmarket institutions that effectively articulate and enforce the common good, while protecting the interests of the resource poor, a theme we develop elsewhere [Shah et al 1997, Ch 9] Rational expectations, contingent markets and discounting: The other critical feature of environment-related phenomena is that their effects are felt with a time lage, at a point when decisions based on price signals have already been made. Any attempt to integrate ecological factors into economic theory must contend with the uncertainty which results from the operation of "historical, irreversible, quality changing time" [Carvalho 1983:266]. The general equilibrium approach has sought to reduce the phenomenon of uncertainty to a metter of assigning probabilities to future outcomes. Following Debreu (1959), the neo-classicals posit the 'rational expectations hypothesis' which presumes that decision-makers in the market know the probability distribution of future outcomes, the future being visualised as stationary and stochastic [Davidson 1982:182]. "At the initial date there should exist a complete set of forward, contingent commodity markets, on which it is possible to buy or sell goods for delivery in any future time-period and state of the world" [Dasgupta and Heal 1979:472]. Such an approach can provide accurate predictions only if the stochastic process is ergodic – but that is ruled out when we are dealing which irrevocable ecological phenomena which produce a whole range of effects unobservable by the price system. Thus, we need to take cognizance of what Shackle (1955) has termed 'surprise' and what Georgescu-Roegen calls 'novelty by combination' in order to emphasise that there are a range of phenomena for which no 'pre-image' exists in our minds. We have no previous observations on the baiss of which probality distributions can be constructed since the phenomena we are dealing with are unprecedented. This means what we cannot have an 'omnicompetent classificatory system' for listing, hypothetical scenarios which are endless and beyond human imagination [Shacle 1972:18]

The other neo-classical device of dealing with the problem of uncertainly is to discount the future. This approach could be said to derive from the contributions of Gray (1914). And Hoteling (1931) The market mechanism supposedly mirrors the preferences of individual economic agents while allocation resources efficiently. When the problem is inter-generational, we run into the ontological difficulty that many of the relevant economic agents are not yet in existence to be able to express their willingness to pay. Worse, in discounting the future it is assumed that future will be brighter than the present. But a high rate of discount will also imply a faster rate of depletion and this could mean that the growth path becomes unsustainable and that the future ends up being bleaker than today. The key problem here is again uncertainty. For "the discounting of time is at one and the same time the discounting of uncertainty" [Perrings 1987:116], the latter being an increasing function of time. And the higher the discount rate, the more we will deplete an exhaustible resource while raising the level of economic activity. This will imply higher disposals into the into the eco-system, which will in turn, bring about environmental changes, raising the level of uncertainty. This will once again raise the discount rate and so on... Thus, the device meant to tackle the problem of uncertainty only aggravates it.

We must also mention the important demonstration by Diamond (1965) that there is no continuous social welfare function which is both Pareto optimal and egalitarian across generations. Faced with this damaging result from within the tradition, the diehard neo-classical feel it is right to drop the insistence on inter-temporal equity and the grounds adduced for doing so speak volumes for the bank ruptcy of their approach. Invoking the classical utilitarianism of Sidgwick, Dasgupta and Heal (1979:262) argue that "one might find it ethically reasonable to discount future utilities at positive rates, not because one is myopic, but because there is a positive chance that future generations will not exist". From a reluctance to face the realities of the present, we move towards an absolute denial of the very reality of the future.

Infinite substitutability of resources: Apart from the fiction of futures markets and from the fiction of futures markets and rational expections, neo-classical economics has sought to face the environmentalist challenge through and abiding faith in the infinite substitutability of natural resources. This ensures that economic growth would occur unfettered. Dasgupta and Heal propose a simple extension of the standard Cobb-Douglas production function, incorporating natural resources as the third factor of production. Thus, the aggregate Cobb-Douglas production function for the economy

Y= KaLB
May be replaced by
Y = KaRbLc, a, b, c > 0
And a + b + c = 1 ....(1)

where Y stands for output, K for capital R for natural resources and L for labour. Dasgupta and Heal (1979:200) conclude that if a (the elasticity of output wrt capital) is greater than b (the elasticity of output wrt natural resources), it follows that "fixed capital is sufficiently important in production to allow for the possibility of a permanently maintainable output level despite the declining availability of the natural resource. The idea is to accumulate capital at a sufficiently fast rate to make this feasible". In such a case, "even in the absence of technological progress, exhaustible resources do not pose a fundamental problem" (p 205). The fact of substitutability by itself ensures that growth can occur indefinitely even if the stock of natural resources is being depleted. And technical progress brightens up the scenario even further.

The critical question, then, is of the possible degree of substitution between inputs. However, the Cobb-Doglas production function does not allow us to explore the limits to the possibilities of substitution among inputs. Rather, it assumes that the elasticity of substitution between inputs is always equal to one. In the fantasy world of Cobb-Douglas production functions, however much one may substitute capital for natural resources, the possibility of further substitution does not diminish.

In any case we must remember that capital goods themselves require natural resources for their production and operation. Any attempt to substitute R by K, is further constrained by this relationship [Bartelmus 1989]. For the sake of completing the argument, let us follow Victor (1991) and use the Cobb-Douglas framework (assuming a > b) to gauge the implications of this relationship for their assertions. We can write:

K = KdReLf d, e, f > 0 and

d + e + f = 1 ...(2)

which is a Cobb-Douglas production function where K, R and L are required to produce capital. Substituting (2) in (1) we get

Y = KadR(ae+b)L(af+c) ...(3)

Now the logic of the Cobb-Douglas production function state that if ad > ae + b, i e, ad – ae

b, i e, a(d - e) > b, then output can grow indefinitely even in natural resources are deplted. The standard Cobb-Douglas assumption is that d and e are both positive and less than one. Thus, d- e < 1. In this event, even with a > b. it does not follow that a(d - e) > b.

This means that even within the Cobb-Doglas framework, and assuming that the elasticity of output with respect to capital is greater than elasticity of output with respect to natural resources, the mere introduction of the fact that R is necessary for the production of K, implies that the neo-classical assertion that growth can occur irrespective of natural resource depletion cannot be sustained. And if we bring in the need of R to operate K, the situation becomes worse.

To complete the argument, we re-express (2):

K = KdReLf

K = R[e/I(1-d]L[f/(1-d)] ...(4)

Substituting (4) in (3), we get

Y = R(e/{1-d}+b)L(fa/{1-d}+c)

Output is wholly expressible as a function of natural resources and labour. There appears no getting away from the natural resource constraint.

On the contrary, it has been insightfully shown that while technology may be able to expand the capital stock of the economy, its capacity to reproduce the resources of the natural environment is far less certain [Krutilla 1967]. Machines worn out can be rebuilt but depleted oil deposits cannot be recreated. And the development of substitutes is hindered by the "counterintuitive relationship that exists between expectations about technology and its likely emergence" [Victor 1991:199].optimism about the emergence of its substitutes will lead to an even more intensive exploitation of the natural resource. This will create a downward pressure on current prices of the resource which would become a disincentive for the development of substitutes.

Two fundamental reasons why finding substitutes for natural resources is difficult have been identified by Georgescu-Roegen: (a) heterogeneity or uniqueness of matter: Unlike energy and mass, matter is heterogeneous. This means that the exhaustion of a resource can force changes both in the technology which utilized this resource and in the output of is uch technologies. As Georgescu-Roegen says: "every chemical element has at least one property that characterizes it completely and hence renders it indispensable for some technical recipes" [Georgescu-Roegen 1979:1035]. Indeed, the relationship between natural resources and manmade (reproducible) capital is often one of complementary. And when two factors are complementary to each other, one become limiting. (b) Degradation of matter: "Just like the thermal energy of the eath not all terrestrial matter is in available form. Matter also continuously degrades into an unavailable from" (p 1032) "Rubbing by friction, cracking and splitting by changes in temperature or evaporation, clogging of pipes and membranes, metal fatigue and spontaneous combustion" all mean that matter is relentlessly "displaced, altered and scattered to the four corners of the world. It thus becomes less and less available for our own purposes" (p 1034). While recycling can reverse this process, there are definite limits to such a possibility.

These limits are set by the infinite regress arising from the fact that materials are, in turn, needed for recycling, which too wear out and require more materials, and so on.
It is, therefore, clear that there is no theoretical basis for disregarding the constraint posed by natural resources for economic growth. A sanguine belief in infinite substitutability cannot allow us to signore the vital questions being posed by the environment.

7. Limits of Western Environmentalism :-

We must clarify, however, that the motivation behind our emphasis on natural resources is not to ring the alarm bells of a cataclysmic neo-Malthusianism, which can only harm the cause of environmental regeneration. Sadly, the 'Doomsday Models' of the early 1970s have already done enough damage in this regard. Careless forecasting methods, faulty exponential extrapolation and narrow empiricism characterized some of this work, which was easy for the mainstream economics profession to shoot down. This kind of globalistic preoccupation has also had the unfortunate consequence of distracting attention away from detailed work on alternatives, towards a vacuous debate between technological optimists and pessimists, with each side, in effect, trying to play god, making huge predictions of dubious scientific merit. Narrow environmentalist obsession with the mere survival of nonhuman species has once again made it easy for the debunkers to get into their act. What is worse, these type of zero-sum formulations are open to dangerous social-Darwinist ecologism. For if there is not enough for everyone, it is easy for the 'superior race' to claim priority in use. There is a definite continuity from the racism of Ernest Haeckel (widely credited with the introduction of the term 'ecology' into science in 1866) and the 'life-boat ethics' of Hardin, a major figure of modern ecologism, who suggests that the higher mortality of certain sections of makind may actually benefit others to prosper and expand.
Even thoughtful environmentalists from the advanced capitalist world have, however, tended to make the issue one of 'growth vs steady state', asking questions about the maximum sustainable scale of the global economic system [Daly 1991]. While thse considerations are undoubtedly of the greatest significance for the western capitalis economies, their insensitive transplantation to large parts of the South would wrongly push aside the much more important issues concerning the nature of the growth path to be chosen in these countries. It is not possible, or desirable, for the third world to, at this stage abandon the goal of economic growth. What is much more critical is to specify the structural features that must characterize the growth process in these regions if it is to be guided by a thoughtful ecological perspective while being committed to the goal of livelihood security to the poor. For it must be remembered that different growth paths would have widely differing implications for the rate of growth, its ecological sustainability, distributive justice (both inter-class and inter-regional) and livelihood security.

8. Principles of a New 'Ecological Economics :-

What we need to do, therefore, is to enunciate the general principles which together constitute the viewpoint of ecological economics. We must then make a concrete application of these principles in specific time horizons of spatially well defined entities such as particular communities (tribal's), agro-climatic, topo-ecological regions (dry lands), units of intervention (watersheds), human settlements (cities), etc. For the way forward lies in abandoning global, aggregative approaches and tackling the problems of particular regions, each line of production and specific technologies. We summaries these principles and contrast them with the approaches of both conventional economic and conventional ecology.
The macro economy must be viewed as a sub-system of the larger eco-system, which comprises not merely human beings but also natural resources and nonhuman species. Unlike the closed isolated, self-contained circle of conventional economics, the economy is seen as an open system, engaged in a unidirectional flow of entropy-drawing in low entropy from the environment and dumping high entropy waste into it.
Bringing in the environment means the way we measure growth has to necessarily undergo a change. It is customary to deduct depreciation of manmade capital from national income. But forms of investment which cut down forests, erode top soil, mine natural resources and cause pollution are all regarded as positive contributions to national income. The notion of sustainability is implicitly present in the treatment of depreciation of manmade capital but is inconsistently forgotten when it comes to natural resources. A pioneering attempt has been made to adjust the US GNP, factoring resource depletion and degradation, as also income distribution effects, into economic trends to produce an 'index of sustainable economic welfare' (ISEW) this shows that while the GNP rose continuously between 1956 and 1986, the ISEW remained constant after 1970 [Daly and Cobb Jr 1989].
The 'preanalytic vision', to use Schumpeter's term, of the economy also changes-it is that of sub system in convolution with the larger eco-system of which it is a part. Unlike the static equilibrium framework of the neo-classicals, evolution implies a dynamic and adapting disequilibrium system, without necessarily suggestion either endless progress or impending doom.
Evolution includes both biological and cultural evolution. The slower pace of biological evolution imposes a built-in long-term constraint on the growth of the economy. Conventional economics ignores all species other

than the human, overlooking the fact that for cultural evolution to be sustainable, it has to evolve institutions which reflect the wisdom of fine tuning development projects to the constraints posed by the environment. Unlike the ecologists, however, who at the other end of the spectrum, exclusively concern themselves with the biological process, we must centrally deal with the human agency and its unique role in shaping the course of this co-evolutionary process. This is not by privileging human needs over those of other species, but due to the recognition of the overwhelming responsibility vested with humanity, of making a rational and equitable use of the planet's resources.

A commitment to equity must, before anything else, be a commitment to the livelihood security of the poorest of the poor. This entails adequate, stable and sustainable access to food, fodder, fire wood, potable drinking water, health, housing and education.

Because we regard resource depletion and waste disposal as significant phenomena, the concept of equity must include the interests of the generations yet to born, it must incorporate considerations of inter-generational equity. For the decisions of the present generation regarding rates of exploitation affect the overall growth path of the macro-economy and, therefore, the kind of future bequeathed to coming generations.

It is quite apparent that such considerations can be taken care of only if collective control can be exercised over natural resources. That this is not automatically co-terminus with state control is also fairly clear, especially following the long years of experience of various communist regimes. The crucial question is how we can devise collective institutions and legal provisions which protect the social interest while being accountable to their members. The members are provided rights to use the resource under collective regulation, according to ecologically sound and equity-based principales. The only feasible alternative to markets and the state acting in isolation seems to be local communities in a context of active grass roots mobilization (power from below) and strong administrative-legal action by honest and committed representatives of the state (power from above.) this would open up a path of participatory development base on the ative involvement of the people at every stage.

Considerations of inter-generational equity also mean that we cannot escape the question posed by the natural resource constraint on the sustainability of the overall growth path of the macro economy, as also the feasibility assessment of specific development project. Unlike conventional economists, we cannot simply assume that the natural resource base is effectively limitless, following infinite substitutability and technical progress. In so doing, we ignore the fact that the environment performs the role of a life-support system for the economy, and that we may irreparably harms this faction in our in our mindless pursuit of growth. Complementarily between natural resources and manmade capital and the fact that production and operation of the letter require inputs of the latter require inputs of the former, imply that natural factors can become a binding constraint on the growth process.

However, this is not merely a question of the scale of economic growth. Much more crucially for the nations of the South, it is a question of the structure of the economic process (incorporating different kinds of development projects) to be adopted by smaller economies and regions, each bounded by their won micro and milli-ecosystems. Essentially, it implies an emphasis on devising location specific interventions which fine-tune the development effort, to optimize the match between varying natural resource (as also socioeconomic) constraints and the proposed solutions.

The real challenge before the economy can be seen as the innovation of technologies which, on the one hand, efficiently draw low entropy from the environment, and on the other, minimize the pollutions caused through the expulsion of high entropy waste into the environment. The central concern of sustainable growth theory becomes the creativity with which an economy adapts to continuous changes in the environment, which can be exogenous, as also those caused by the interaction of the economic machine with the larger ecosystem.

The creativity required is not merely in finding ways of increasing supply but much more critically in reducing demand and regulating end-uses. Modern consumerist society is characterized by an explosion of desire and demand. So long as we do not question the emerging pattern of end uses and pose the central question of efficiency of utilization of our resources, it will be absolutely impossible to endlessly augment supply. We must realize that all steps to augment supply will come to nothing, if demand continues to rise at the rate it has, especially in the last three decades. An integral element of the conservationist approach has, therefore, to be a quantitative and qualitative regulation of end-uses and demand.

In order, therefore, to operationalise the nation of sustainability some basic guidelines can be enunciated:

(a) The rate of regeneration of a renewable resource must be greater than or equal to the rate of harvest:

(b) Waste emissions should not exceed the renewable assimilative capcity of the micro-environment;

(c) The rate of exploitation of non-renewable resources must always be less than or equal to the rate of creation of renewal able substitutes; and

(d) In case an existing renewable resource is to substitute for a depleting non-renewable resource, the rate of harvest of this resource must be strictly less than its rate of regeneration, to the extent necessary to to permit this substitution.

Finally we must emphasize the need to adopta multi-disciplinary approach which involves life sciences, physical sciences, earth sciences, social science other than economics, and insights also from the arts, philosophy and the humanities. Without such an orientation, we are likely to overlook critical aspects of the economy environment interface, leading to flawed policy decisions.

9. Theoretical Frame work: Towards a New Paradigm :-

i) System twinkling :-

Both ecology and economics can be seen as systems An economic system is embedded with the ecological system, not separate, not separate from it this nested relationship highlights dependency on natural capital and energy flows.

ii) The concept of Natural capital

Natural Captial-Forest, water, soil, atmosphere – provides the resources and services upon which economics depend. Depletion of natural captila leads to long term economic instability.

iii) Thermodynamic foundations :-

Ecological economics applies the laws of Thermodynamics to economic processes energy and material throughput cannot Increase indefinitely on a finite planet

iv) The study state economy

A study state economy maintains a balance between resources use and ecological regeneration economic success is measured not by GDP growth, but by well being, equity and environmental health.

v) Ethical and Social dimensions :

The paradigm shift involves ethical considerations inter generational equity social justice and stewardship of nature.

10. Conclusion :-

The synthesis of ecology and economics offers a pathway toward sustainable and equitable development. The new paradigm recognizes that economic prosperity depends on ecological integrating ecological principles into economic models leads to more resilient societies capable of addressing climate change, resource scarcity and social inequality the future of economic theory must therefore evolve in to an ecological encomiast paradigm grounded in systems thinking and sustainability ethics.

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