UNIT 3 SOCIETY AND ENVIRONMENT

Structure

3.0 OBJECTIVES

After reading this unit, you will be able to:

- discuss the analytical framework in which poverty-environment interactions are embedded;
- describe the impact of environmental degradation on poor with its implications for conservation of natural resources;
- explain the factors that links population and environment;
- state the common policy objectives for addressing the population-poverty-environment interface;
- analyse the theory of 'affluence' in relation to post-materialistic value hypothesis;
- specify the formulation of IPAT and KAYA identities;
- delineate the major considerations involved in the reformulation of IPAT;
- critique the different methodological frameworks adopted in the population focused studies for estimating the IPAT coefficients;
- illustrate Commoner's application of the IPAT framework to agriculture; and
- indicate the direction in which future work on assessing the environmental impact on society should proceed.

3.1 INTRODUCTION

Principles of 'inclusive development' requires focusing on the development of the poorer and other marginalised sections of the society. Studies have shown close positive relationship between the lifestyles of the poor and environmental conservation. In one of the conclusions of the Bruntland Commission report (which has been accepted as the blueprint for environmental conservation), it is explicitly stated that poverty is a major cause of environmental problems and amelioration of poverty is a necessary and central condition of any effective program to deal with environmental concerns. Beyond the concerns of 'sustainable development', protecting the present means of lifestyle sustenance of the poor itself demand both conservation and efficient utilisation of available environmental resources. These priorities often clash with the requirements of economic growth which makes the poor particularly more vulnerable on account of the exploitative tendencies of the more powerful on the one hand and their own limitations for protecting their interests on the other. Timely inaction (or inadequate action) on the part of the governments result in 'market failure' and sub-marginalisation of the poor. In the face of these hard realities, the present unit discusses the issues and linkages on two fronts viz. 'poverty and environment' and 'population and environment'. In respect of the latter, the hypothesis of 'whether there is enough evidence to support the claim that population growth (or its dynamics) results in (or contribute to) environmental degradation' is examined. Two main empirical formulations viz. IPAT and KAYA, both identities defined in terms of three key determinants viz. population, affluence and technology (impacting environment) are discussed. Within this, many methodological approaches are outlined so as to provide a critical appraisal of their findings including further work needed to be undertaken to generate more empirical backing to the contentious views involved.

3.2 POVERTY AND ENVIRONMENT

There has been a vast literature on "poverty–environment nexus' referring to a set of mutually reinforcing links between poverty and environmental damage. In this, poverty reduction and environmental protection have often emerged as complementary goals. The nexus concept is provided as a defence against environmental damage argument. This is based on the 'Environmental Kuznets Curve' which states that in the early stages of development there is an unavoidable conflict between poverty reduction and environmental protection. The general consensus, during the intervening period of development, is that poverty is a major cause of environmental degradation. In fact, both poverty and environmental degradation have been increasing in many developing countries. In view of this, there is an urgent need to first evaluate and analyze the poverty-environmental degradation nexus and, second, to prescribe policy options to mitigate or eradicate both these problems.

The interaction between poverty and environment is explained by a flow diagram (Figure 3.1). The diagram relates four blocks of variables viz. (i) assets of the rural poor; (ii) household behaviour pertinent to environment-poverty links (e.g. income generation, investment, consumption); (iii) categories of natural resources (soil, water, etc.); and (iv) conditioning variables (e.g. market, prices, etc.). The asset categories of poverty affect household and village behaviour, which in turn affects the (quality and quantity of) natural resources as well as household/village assets. The conditioning variables influence the links between the types of poverty and behaviour, as well as the links between behaviour and natural resources.

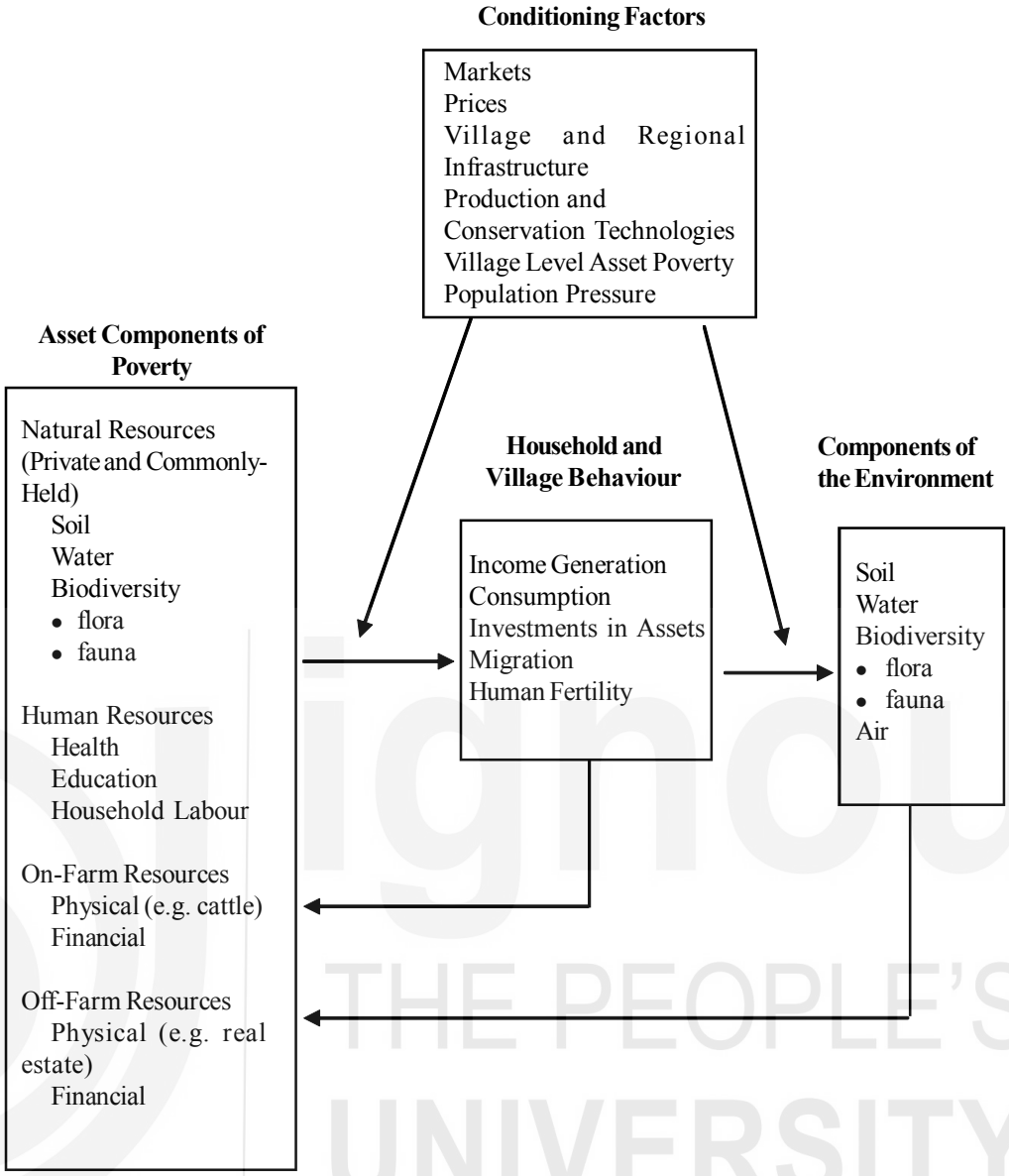

Figure 3.1: Poverty and Environment Changes

Source: Reardon and Vosti (1995)

3.2.1 Analytical Framework

Since the late 1980s, it has been widely accepted that the interaction of agricultural development with the environment must be explicitly considered, both to ensure the long-term sustainability of production systems and to mitigate the negative effects on the local and the globally important ecological goods and services (an approach called by Conway (1997) as the 'double-green revolution'. Since environmental degradation in turn leads to issues of (or negative consequences of) declining consumption, human health and food security, the following three situations could be logically construed to arise: (a) no environmental degradation; (b) no endogenous poverty; and (c) the possibility of the existence of exogenous poverty. Endogenous poverty is here defined as poverty caused by environmental degradation while exogenous poverty is defined as poverty caused by factors other than environmental degradation. It is, therefore, clear that condition (b) follows from condition (a). In light of this, possible relations in poverty-environmental degradation nexus can be construed in terms of the following analytical framework.

- Exogenous poverty → environmental degradation
- Power, wealth and greed → environmental degradation
- Institutional failure → environmental degradation
- Market failure → environmental degradation
- Environmental degradation → environmental degradation (in the sense that once environmental degradation sets-in, there is likely to be continued environmental degradation for some time till it is reversed by proactive policies)
- Endogenous poverty → environmental degradation

In view of this, to break the nexus between environmental degradation and poverty all of the left-hand side factors needs to be simultaneously focused upon with institutional and policy mechanisms.

3.2.2 Impact of Environmental Degradation on the Poor

The poor's exposure to environmental degradation is distinctive for two reasons. First, locations inhabited by the poor are often environmentally vulnerable or degraded (e.g. urban slums with inadequate water and sanitation facilities are often most vulnerable to severe health hazards). Second, being poor entails a lack of means to avoid the impacts of environmental degradation i.e. a lack of resources makes it difficult for the poor to buy out from their exposure to environmental risks (by investing in alleviating the causes of environmental degradation as the non-poor can do). In light of this, the following two hypothetical situations would arise.

H_1: Pollution Damages the Health of the Poor: Several types of pollution have the most pervasive and serious consequences for the health of the poor. In order of severity, the most important is pollution of water for disease causing vectors rendering the poor vulnerable to infectious and parasitic illnesses. Second is indoor air pollution from the use of biomass as a household energy source, principally in rural areas. Third is outdoor air pollution, which is mostly an urban problem.

H_2: Environmental Degradation Lowers the Poor's Productivity: In addition to affecting their health and capacity to work, environmental degradation depresses the poor's ability to generate income through two channels: first, it requires the poor to 'divert an increasing share of their labour' to routine household tasks such as fuel wood collection; and second, it also 'decreases the productivity of those natural resources' from which the poor wrest their livelihood. Moreover, environmental degradation can lower the labour productivity of the poor even when they are healthy. For instance, as fuel-wood becomes scarce, poor households must spend an increasing amount of time in collecting it. Where family labour is not abundant, greater time is spent on fuel-wood collection reducing the time available for other productive activities resulting in lower incomes. Further, environmental degradation reduces the productivity of natural resources thereby perpetuating impoverishment. Productivity declines of this kind are caused by a number of factors, some of which are beyond the control of the common people. Examples include: (i) destruction of inland and coastal fisheries by industrial water pollution and municipal sewerage; (ii) degradation of wetlands and flood plain soils as a result of upstream dam construction; (iii) deforestation by settlers, loggers, and ranchers destroying the livelihoods of indigenous forest dwellers and exposing them to the risk of uncertain incomes.

More frequently, productivity decline is more intricately related to the poverty-

population-environment interaction. Where the poor depend on biomass fuel and confront increasing fuel-wood scarcity, they often shift to using animal dung, fodder, and crop residues for fuel. Because reduced quantities of these materials are returned to the soil, fertility of soil declines. Where rural population growth is putting pressure on land resources such that fallow periods are shortened, poverty may constrain farmers' ability to maintain soil productivity through more intense application of variable inputs. The productivity of open access natural resources or of resources under deteriorating common property management often declines because of over-use.

3.2.3 Impact of Poverty on Resource Management

The following two hypothetical propositions can be put forward in this regard: Poverty Imposes Short Time Horizons (H_1); and Risks Further Contribute to the Poor's Short Term Focus (H_2). The very poor, struggling at the edge of subsistence levels of consumption, are pre-occupied with survival on a day-to-day basis. The ability to plan ahead is often restricted to a critically short time horizon, measured in days or weeks. But these short time horizons should not be viewed as an innate characteristic of the poor, but rather the consequence of complex interactions among policy, institutional and social failures. Under most circumstances, people tend to be risk averse, preferring to trade some of the value for potential outcome for a greater certainty of its happening. To the extent that outcomes become less certain (i.e. the more distantly in the future they are), risk aversion tends to imply a preference for outcomes that will happen sooner. Studies on risk and farmers in India (e.g. Binswanger, 1989), Central America (e.g. Walker, 1981), Thailand and the Philippines have confirmed the predominance of risk aversion, albeit with a great deal of heterogeneity. The results also suggest that in their attitude to risk the poor are not distinguished from the non-poor by innate or acquired characteristics such as education. Rather, in this regard, poor farmers are distinguished by their higher levels of risk and greater constraints to coping with that risk.

Check Your Progress 1 [answer the questions in about 50 words in the space given]

1) What is 'poverty-environment nexus'? In what way, Kuznets's postulation offers defence against environmental damage arguments for developing economies?

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2) What are the factors that need to be focused upon in order to break the poverty-environment nexus?

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3) State the two hypotheses that emerge from the vulnerability of the poor to the consequences of environmental degradation.

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4) Illustrate with examples how productivity declines of poor could be a consequence of market failure.

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5) Do you unconditionally agree that 'poverty imposes short time horizons' on the poor? Explain.

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6) Is it true that the poor are more vulnerable in their attitude to risk aversion? What do the results of the study across countries reveal in this respect?

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3.3 POPULATION AND ENVIRONMENT

The dynamics of population potentially exacerbates the impact of other factors such as poverty, inadequate property rights and consumption levels on environmental degradation. The impact intervenes along three main dimensions: (i) its scale in relation to the resource base; (ii) its rate of growth; and (iii) its redistribution across resources through migration. Population's impact on the environment is critical in some countries or regions within countries, but is less important in others. Moreover, the three dimensions will not be equally important for the environment in different places and points in time. Thus, assessments of population's impact on the environment, and the appropriateness of addressing such impact through direct population interventions, need to take local circumstances into account. Once again, we can perceive the impact on vulnerable sections of the population in terms of the following two propositions.

***Poverty and Environmental Feedbacks*:** Sustained economic growth leads to decreasing incremental per capita emissions of pollution after a certain critical point. But it is not good enough to avert potential environmental crisis of global proportions.

***Poverty and Common Property Resources*:** Environmental damages tends to affect the poor particularly severely as they heavily rely on fragile natural resources for their livelihood. Although in normal situations returns on natural capital are greater than on

the human capital, polluted areas being cheap or free, the poor choose to reside there as squatters. Because of their status as squatters, access to safe drinking water and sanitation is usually denied in the first instance and provided later (due to political compulsions) after long gap of time. Regarding poverty and deforestation, lessons from Mexico and Indonesia indicate that export-oriented tree crops play an important role in deforestation relative to shifting cultivation.

3.3.1 Factors Explaining Population and Environment Linkages

Three key factors can be pointed out to explain the dynamics of population-environment linkages.

***Local Endowments*:** The impact of natural resource change in agricultural environments has the potential to influence the bio-physical conditions of a region. This happens by the changing relationship between population growth and natural resource availability. Key factors which bring about these changes are: (i) soil characteristics (affecting crop choice, cropping frequency and input use); (ii) rainfall and consequently the ground and surface water resources (affecting crop product choice, risks of soil degradation and land use intensity); and (iv) topography of land (affecting the spatial distribution of production systems). Further, landscape differences and resource management challenges would also arise from variations in settlement history, past history of degradation, crop mix and quality of livestock products. All these factors would together bring about variation in the mix of commercial and subsistence enterprises in the region.

***Use of Resource-Conserving Technology*:** Researchers have demonstrated that poor farmers, in the absence of systematic assistance, end up adopting such resource-conserving practices which are often less efficient. Although such practices also contribute to some amount of increased productivity or output stability, they are generally an economic threat to the viability of farmers' interest in the face of growing risk of depleting natural resource stock. In such situations, use of dual-purpose resource conserving technologies are essential to achieve poverty reduction on the one hand and environmental protection objectives on the other. By determining the distribution of physical and social infrastructure between rural and urban sectors, large and small farmers, etc. implementation of suitable public investment policies would enhance the comparative advantage of poor farmers in agricultural production and small service enterprises.

***Institutions Supporting the Interests of the Poor*:** Local institutions often strengthen the social fabric within which the dynamics of poverty–agriculture–environment interactions are determined. Effective resource management, whether of private, communal or public resources, often requires collective regulation (e.g. use or management restrictions on privately-held resources to influence environmental externalities) and collective investment (e.g. establishment of community drainage systems or trees for public use) strategies. Good local organisational and management skills often underpin the success of such resource management activities. Cultural, demographic, market and leadership factors together act as institutions to protect the local resource base.

3.3.2 Population-Poverty-Environment Interface: Policy Implications

The environmental needs of, and pressures on, poor farming communities will certainly intensify in coming decades. Although the relationship between population-poverty-

environment interface is dynamic, the 'downward spiral' is both avoidable and reversible in many circumstances. Poor people have an unrecognised potential for adaptation and innovation. Public policies can positively influence the micro-scale factors that determine how farmers adapt to environmental pressures. However, more pro-active policies are required to achieve environmental and anti-poverty objectives simultaneously, enhancing the access to and productivity of poor people's natural resource assets and engaging them as partners in public resource management. Research efforts and methodologies to support such policies are yet in a formative stage. To reiterate, therefore, the common objectives of environment protection and tackling the poverty of poor dependent on natural resource endowments should focus upon the following.

1. Increase poor people's access to natural resources essential to their livelihoods.
2. Work with the poor to increase the productivity of the natural resources so that they can take advantage of existing or emerging economic opportunities. This can be by way of co-investing in on-farm natural resources of the poor, promoting agricultural technologies with environmental benefits and promoting low-risk production in poor and marginal areas, etc. and
3. Involve the poor in promoting good environmental management practices under conditions when economic incentives for doing so are not in place. This can be done by compensating the poor for conserving or managing resources important to others i.e. by employing the poor to improve the public natural resources.

Check Your Progress 2 [answer questions in about 50 words in the space given]

1) Why is it important to consider local circumstances while assessing the impact of population dynamics on environmental degradation?

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2) What are the key factors responsible for bringing about the desired changes between population growth and natural resource availability in agricultural environments?

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3) In what way public investment strategies could be of help in enhancing the comparative advantage of poor farmers?

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4) How can local institutions strengthen the regional natural resource base thereby contributing to protecting the interests of the poor?

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5) What are the common objectives on which policy focus is needed to achieve all round improvement in respect of poverty alleviation and environment protection?

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3.4 AFFLUENCE AND ENVIRONMENT

The idea that population growth affects environmental resources and human welfare is as old as civilization or written history. In view of this, the idea of a causal link between concern for natural environment and increasing population pressure has also been equally old. The various UN resolutions and Protocols like – Convention on Climate Change, the Kyoto Protocol, Intergovernmental Panel on Climate Change reports, etc. have all raised global awareness on anthropogenic climate change. Likewise, numerous grassroots movements, environmental non-governmental organizations, books & documentaries, etc. have focused on the myriad of environmental issues facing citizens around the world. The question that, therefore, arise is: does a nation's level of affluence have a causal impact on individual-level environmental concern within that nation? Towards this, we begin by looking at some of the theoretical postulations.

3.4.1 Theory of Affluence and Exposure to Degradation

A common assumption regarding environmental concern is that only those who are affluent enough to care about concerns beyond immediate survival are able to devote energy to environmental problems and to engage in actions that demonstrate such concerns. These assumptions are supported by the presence of green parties and environmental group memberships in affluent nations with an emphasis on development aid (as opposed to environmental protection assistance) to the countries of the Global South. Such an attitude has, however, been met with serious resistance as they not only limit development but also ignore issues of global inequality. However, with the rise in environmental awareness in the Global South across classes, with transnational environmental movements, the existing explanations of environmental concern as related to 'affluence in some instances and degradation in others' have needed a relook to capture transitions in and nuances of environmental concern across the globe.

One of the main affluence theories is that of Inglehart's post-materialist values. The theory posits that in the past, societies and individuals had to remain focused on survival. However, with the rise of the welfare state and the economic growth of advanced industrial and post-industrial societies, survival needs have yielded to concern for environment, freedom of expression and choice. Going by this sequence, if the post-materialist values hypothesis requires first affluence, and then to acquire environmental

concern, the Global South cannot be explained by post-materialist values because many of these societies have not undergone the transformation Inglehart identifies. Dunlap, therefore, argue that the emergence of widespread concern for environmental quality in non-industrialized nations poses an anomaly as these nations have yet to experience the economic security needed to generate the post-materialist values. Others (e.g. Dunlap and York, 2008) have also found evidence against the 'affluence hypothesis' at the national level and the 'affluence-based post-materialist values' at the individual level. The 1992 Health of the Planet (HOP) survey found that national affluence correlates inconsistently with environmental concern. In response to the growing environmental concern in the Global South among members of all classes Inglehart, therefore, coined the alternative 'objective problems subjective values (OPSV)' hypothesis to explain that people who have more direct exposure to environmental problems could also be more willing to act for environmental causes. Public support for environmental protection policies is, therefore, stimulated by two completely different types of factors. The result is that, in global perspective, neither high pollution levels nor high levels of post-materialism have a significant impact on public support for environmental protection. However, it is only by analytically disentangling their joint effects the importance of either factor can be accorded greater cognizance. Here, Inglehart implies that data for countries of varying levels of affluence should be separately analysed in order to see significant effects of affluence or degradation manifesting in environmental concern. A reasonable criticism of these arguments is, therefore, that they are difficult to test empirically as they are not falsifiable and as it is they are positioned to explain environmental values differently (i.e. with affluence explanations limited to the Global North and exposure to degradation explanation limited to the Global South). Not only is this a problem with the structure of the two theoretically derived hypotheses, but it is also a problem because affluent societies also experience environmental degradation and citizens of less affluent societies could be concerned about the environment even without direct exposure to degradation.

3.4.2 IPAT and KAYA Identities

The vehicle used to begin the discussion of technological change, though phrased mathematically, is largely a conceptual expression of what factors create environmental impact in the first place. The equation used represents environmental impact (*I*) as the product of three variables: population (*P*); affluence (*A*); and technology (*T*). That is:

Impact = Population × Affluence × Technology (called the IPAT equation) where affluence (or consumption) is measured as gross domestic product (GDP)/population, and technology as impact/(population × affluence). The genesis of IPAT equation and related developments could be traced to the environmental movement around 1970. Although first used to quantify contributions to un-sustainability, the formulation has been reinterpreted to assess the most promising path to sustainability. The revisionism can be seen as part of an underlying shift among many environmentalists in their attitudes toward technology. This simple equation emphasizes the verity of multiple drivers of environmental change whose effects are multiplicative.

Yoichi Kaya (and other collaborators) further developed an essentially identical equation to investigate the drivers of greenhouse-gas emissions as:

Total emissions = population × (GDP/population) × (energy/GDP) × (emissions/energy)

i.e. **Total emissions = population × affluence per capita × energy used per unit of affluence × emissions per unit of energy used.**

The Kaya identity continues to be used to project future greenhouse-gas emissions in most climate projections such as those of the Intergovernmental Panel on Climate Change. Although the two equivalent formulations have advanced the generational thinking, they have their own limits. For instance, both assume unit elasticity i.e. percentage change in one of the right-hand-side variables produces an equal change in stress on the environment. In other words, both in Kaya and IPAT, a 10 percent increase in affluence will increase estimated stress by 10 percent. In view of this, they cannot be used to test hypotheses on the relative contribution of driving forces as the elasticities are assumed to be equal.

Empirical analyses have found such a proportionality assumption questionable i.e. most studies have found that the effects of increased population are more than proportional and hence IPAT and Kaya identities, used with unit elasticities, underestimates the effects of population size. And because they do not take explicit account of culture and institutions, they cannot be used to examine the potential influence of these drivers. IPAT and Kaya have, therefore, been found useful as good starting points but further progress requires a new generation of models that estimates, rather than assume, the effects of each driver net of the others.

3.4.3 A Methodological Critique on Population Focused Studies

Three methodologies were employed in the Population Commission report (of US) and subsequent studies of population, affluence and the environment. The most common is a simulation/projection (S/P) approach. Resource demand or pollution generation is estimated as a function of per capita income. Projections of population and income are then used to estimate future resource demand or pollution. In the more sophisticated models, input-output analysis is used to account for inter-sectoral demand for goods and services. These demands are also translated into impacts on resources and pollution generation.

The final estimated outputs from each sector of the economy are multiplied by coefficients representing the impact per unit output at the most recent point in time for which data are available. In some models, these coefficients can be adjusted to take account of environmental policies or increased efficiency resulting from technological improvement. The S/P model is used to project environmental impacts under various scenarios of population and economic growth. These projections then provide the basis for determining the effects of population and economic growth. The basic logic of the S/P models is to first establish a linkage between total economic activity (per capita activity multiplied by population) and environmental impact. Then alternative scenarios of population and economic growth are projected to assess environmental impacts.

In some models, like the Limits to Growth studies, the structure is a set of linked differential equations and multipliers. In others, the linkages become much more complex. Also, they disaggregate economic activity by sectoral output. But all S/P models make assumptions about environmental impacts on per unit output and then extrapolate into the future under different scenarios of growth. Thus, they do not provide a historical or comparative assessment of the contribution of various driving forces but rather a projection of what may happen, given the assumptions of the model.

The conclusions drawn vary across the several S/P models. Some studies [e.g. the Population Commission results (of US)] suggest only moderate impact of population growth on the environment. The 'Limits to Growth' models and their successors see far greater population impact. Bongaarts (1992) partitions CO_2 emissions into components

for population, affluence, energy intensity due to affluence and the carbon intensity of energy to find that in the less developed nations, affluence changes will dominate the growth in emissions with population growth as the second most important factor. In the more developed countries, growing affluence also drives emissions but changes in energy intensity are more important than changes in population.

The second common approach is that of accounting analysis (A/A) in which the form of the **IPAT** model used is: **I = P*A*T** where **I** is environmental impact, **P** is population, **A** is per capita economic activity (referred to as affluence) and **T** is the impact per unit of economic activity (referred to as technology). Data are obtained on impact, population and affluence and the equation is solved for **T** as: **T = I/(P*A).** This approach has also been applied to the CO_2 efficiency and energy efficiency of economies. When the model is used to assess the relative impact of population and affluence as driving forces, data for two points in time are usually translated into percentage increases for each term in the model. Change in **I** is then allocated to percentage changes in **P**, **A** and **T**.

3.4.4 Commoner's Illustration of IPAT Analysis to Agriculture

Commoner (1992) calculated that the use of synthetic organic pesticides in the U.S., from 1950 to 1967, increased by 266 percent (a ratio of 3.66). During the same period, population grew 30 percent (a ratio of 1.30), crop production per capita by 5 percent (a ratio of 1.05) and pesticide consumption per unit crop production – the technology factor for Commoner – by 168% (a ratio of 2.68). That is:

3.66 = (1.30)*(1.05)*(2.68).

Commoner attributes most increase in the use of synthetic pesticides to technological change, with increased consumption per capita and increased population, each responsible for a smaller share in the increased value of **I** – here the use of synthetic pesticides.

The key problem with this approach is that the relationship is definitive. Once three of the variables are fixed, the fourth is also fixed. In view of this, Ehrlich & Holdren (1972) suggest that Commoner's calculations underestimate the effect of population on the environment by attributing to the **T** term changes that could more properly be allocated to **P** or **A**. Thus, the accounting model is useful for developing efficiency or intensity measures but does not provide an adequate basis for testing hypotheses about the human driving forces of environmental change.

An alternative approach uses historical or cross sectional data on **I**, **P**, **A** and **T** to assess impacts. In its simplest application, this approach uses simple graphs of bi-variate relationships between I and driving forces (or of historical trends in I and driving forces). In more sophisticated methods, the stochastic modelling (S/M) approach has been used most often in studies of deforestation. Despite using slightly different specifications and data sets, all these studies find that population size, growth rate or density has a stronger effect on deforestation than does the economic activity. Rudel (1989) also finds population growth to have a stronger effect than a common measure of trade dependency. These preliminary applications and their findings suggest that the stochastic approach to assessing the impacts of population, affluence, technology and other factors on the environment is a useful way to ground the debate about driving forces in stronger theory and empirical evidence.

3.4.5 Reformulating IPAT: Major Considerations

Anthropogenic global change is being viewed as a real and challenging problem needing systematic investigation. The IPAT model, first proposed two decades ago, represented the efforts of population biologists, ecologists and environmental scientists to formalise the relationship between population, human welfare and environmental impacts. There have since been some new developments to revisit the IPAT model particularly in the context of global environmental changes. These are as follows.

First, the model does not provide an adequate framework for disentangling the various driving forces of anthropogenic environmental change. As a consequence, the IPAT model stifles efforts toward cumulative theory and empirical findings. Second, the argument that population growth would have a strong adverse effect on human welfare has since been revisited. On this, four distinct positions on the effects of population and economic growth on environment are indicated. One view is that the anticipated population growth will have very severe, even catastrophic, impacts on the natural environment and human welfare. A second view acknowledges that while the population growth and economic growth create increased demand for resources, the anticipated scarcity would drive technological progress and with it the search for substitutes and increased efficiency. Thus, the net effect of population and economic growth on resource scarcity, human welfare and the state of the environment is either neutral or even positive. A third position suggests that technologies used to stimulate growth are often selected without regard to their environmental impact. Thus, adverse environmental impacts are more a function of the political economy of technological choice than of population or economic growth per se. To the extent population has an effect on environment, it is an indirect effect that could be mollified by institutional or technological change. The fourth position is a middle ground in which population is not seen as the dominant driving force, but as a contributor to environmental impact acting in consort with affluence, technological choice, institutional arrangements and other factors. While these are the dominant views, there has been little empirical work on the impact of population on the environment. The most extensive literature (found in a series of papers prepared for the U.S. Commission on Population Growth) offers a general conclusion that population growth contributes to environmental degradation but its impact is generally less than the impact of economic growth.

Despite the paucity of strong evidence regarding the effects of population and economic growth on the environment, strong conclusions about the relative importance of the driving forces have continued to appear in the literature. In order to move the debate to more solid ground, it is necessary to reformulate the **IPAT** model in the following six directions.

First it must be considered a stochastic model rather than an accounting scheme so that it can be used to test hypotheses. ***Second***, it would be helpful to employ a variety of indicators of environmental impact and consider the possibility of creating general indices from individual indicators. ***Third***, modelling should incorporate effects of the rate or pace of growth of population distribution and of the composition of the population in addition to the effects of population size as these may have greater environmental impacts than size per se. ***Fourth***, alternatives to gross national and gross domestic product including distributional measures should be considered as measures of affluence. ***Fifth***, technology needs to be assessed directly rather than as the residual of the accounting format. One approach is to incorporate operational measures of technology, such as the efficiency of energy conversion. Another could be to reconceptualise technology to include a variety of driving factors that influence how human activity

effects the environment, including culture, social structure and institutional arrangements. ***Sixth***, because the various driving forces interact in complex ways, it will ultimately be necessary to move from a single equation model – one that estimates only direct effects net of other variables in the model – to a systems model that estimates both direct and indirect effects of driving forces. That is, the model must acknowledge that the driving forces influence each other.

3.4.6 Towards Further Work

With all these modifications, it may seem that the **IPAT** model is losing out in its importance altogether. Indeed, the elaboration of theory about the forces driving anthropogenic environmental change may eventually lead to models that have little relationship to **IPAT**. But **IPAT** is a useful starting point for theory building and testing for three reasons. *First*, any viable theory of anthropogenic environmental change must consider population, affluence and technology as determinants of environmental change. There are other potentially important driving forces that may have strong direct or indirect effects. But **P**, **A** and **T**, almost everyone would agree, must be part of any serious effort to understand human impacts on the environment. *Second*, the **IPAT** model is at the heart of the debates regarding the driving forces. Research that elaborates on it is more likely to influence those debates than research that rejects it. *Third*, the **IPAT** model offers a general framework that can structure both research and discussion, thus providing a means for integrating disparate literatures.

The recognition that humans are causing untoward impacts on the bio-physical environment, a perception once confined to the industrial nations, has now spread across the entire globe. One cannot deny the importance of deepening our understanding of the anthropogenic linkages and causes of environmental impacts. While there is a singular vision of a common destination, there continues to be considerable debate about the best route to get there. Part of the debate stems from the 'trained incapacity' of scholars working within a discipline to recognize affinities in other disciplines, and part stems from the fact that a defining feature of different disciplines is a difference in meta-theoretical assumptions. Such tacitly accepted presuppositions about the proper approach to comprehending a problem allow knowledge to advance within a domain of inquiry, but block attempts to integrate and learn from the interface between disciplines. Split-level dialogues between the social and biological sciences on the topic of population growth have been taking place for over a century. This is precisely why an integrative, human ecological approach has not emerged but which is crucially needed.

Check Your Progress 3 [answer questions in about 50 words in the space given]

1) What is the main argument behind the 'affluent hypothesis'? What is the alternative proposed to this view in the OPSV hypothesis?

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2) What is the main criticism on the Inglehart's affluent hypothesis?

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3) State the common assumption made for both the IPAT and KAYA identities. In what way this assumption limits its application?

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4) How are the 'S/P Approach' applied in practice? What is the basic drawback of this approach?

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5) State the one basic problem pointed out for the IPAT model. In light of this, what purpose it serves and what it does not?

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6) In the varied studies carried out with population as the focus, what four distinct positions are expressed on the effects of population and economic growth on environment?

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7) In the proposed alternative directions in which reformulation of IPAT model is suggested as required, what approaches are indicated for dealing with 'technology'?

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8) Despite the IPAT's limitations, for what reasons IPAT is still considered useful for advancing knowledge by theory and testing?

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3.5 LET US SUM UP

The unit has addressed to delineating the poverty-environment-population linkages. Two simple formal specifications viz. IPAT and KAYA identities are explained. A reformulated **IPAT** model is then indicated to provide a useful compass for setting us on the journey toward a deeper understanding of anthropogenic environmental change than we possess at present. The model is simple, systematic and robust: simple because it incorporates key anthropogenic driving forces; systematic because it specifies the mathematical relationship between the driving forces and their impacts; and robust because it is applicable to a wide variety of environmental impacts. A reformulation of the model to stochastic form would enable the testing of hypotheses with conventional statistical procedures. First approximations for some impacts, such as CO_2 emissions and deforestation, can be obtained immediately with the application of these statistical procedures to available data. However, key challenges for the model remain, such as the choice of the most appropriate indicators for the primary variables. Limitations on the availability of relevant data as well as quality problems on existing data also remain. Towards this, some strategies for meeting these challenges are indicated in the unit. The unit has aimed at generating a keen interest in this direction to help prod on towards a deeper understanding of one of the most challenging intellectual problems of our age viz. the anthropogenic environmental change.

3.6 KEY WORDS

Endogenous Poverty and Exogenous Poverty : Endogenous poverty is poverty caused by environmental degradation while exogenous poverty is poverty caused by factors other than environmental degradation.

IPAT : Is a conceptual expression to suggest what factors create environmental impact (I) in the first place. The factors considered are: population, affluence and technology. The equation indicates the verity of multiple drivers of environmental change whose effects are multiplicative.

KAYA Identity : Is the modified version of IPAT in which the multiplicative drivers are considered as: population, GDP per capita, energy consumption per capita and emissions per unit of energy used. The identity is mainly used to project future green house gas emissions in climate projections.

3.7 SUGGESTED REFERENCES FOR FURTHER READING

1. Bongaarts, John (1992), 'Population Growth and Global Warming', *Population and Development Review*, 18:299-319.

2. Commoner (1992), Making Peace with the Planet, New York, The New Press.

3. Chertow, Marian R (2001), The IPAT Equation and its Variants: Changing Views of Technology and Environmental Impact, *Journal of Industrial Ecology*, Vol. 4, No. 4, pp 13-29.

4. Dunlap, R. E., & York, R. (2008), 'The Globalization of Environmental Concern and the Limits of the Post-materialist Values Explanation: Evidence from four Multinational Surveys', *The Sociological Quarterly*, *49*(3), pp 529-563.

5. Inglehart, R. (1997), Modernization and Post-modernization: Cultural, Economic, and Political Change in 43 Societies, Princeton, NJ: Princeton University Press.

3.8 ANSWERS/HINTS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress 1

1) See 3.2 and answer.
2) See 3.2.1 and answer.
3) See 3.2.2 and answer.
4) See 3.2.2 and answer.
5) See 3.2.3 and answer.
6) See 3.2.3 and answer.

Check Your Progress 2

1) See 3.3 and answer.
2) See 3.3.1 and answer.
3) See 3.3.1 and answer.
4) See 3.3.1 and answer.
5) See 3.3.2 and answer.

Check Your Progress 3

1) See 3.4.1 and answer.
2) See 3.4.1 and answer.
3) See 3.4.2 and answer.
4) See 3.4.3 and answer.
5) See 3.4.4 and answer.
6) See 3.4.5 and answer.
7) See 3.4.5 and answer.
8) See 3.4.6 and answer.