CHAPTER 1

SOCIAL COSTS IN ECONOMIC DEVELOPMENT*

Introduction: The Meaning and Significance of Social Costs

The concept of social costs refers to a wide variety of harmful effects of productive activities which are not reflected in entrepreneurial cost accounts and, hence, tend to be neglected in private decision making. That is to say, social costs may be identified as those harmful effects of private action which, under given conditions and institutional arrangements, tend to be shifted to and borne by other sectors, third persons, or the economy as a whole. Since the entrepreneur is not held accountable for these negative consequences, output is not affected and, hence, is independent of these costs. Social costs may take the form of a variety of tangible and intangible losses. They may be reflected in higher costs of production of some sectors of the economy, and sooner or later, they may call for additional outlays for remedial measures as well as public policies and public investments.[1]

Governments in developed countries have responded to some of the social costs of production by means of social and other protective legislation; however,

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*From Economics and Development (Eds. G. P. Sicat, et al.) (Quezon City: U. of the Philippines Press, 1965), Ch. 12

[1]The literature on social costs goes back to the critics of the Industrial Revolution in England and on the Continent. Today our knowledge of social costs is based on the results of an essentially interdisciplinary research effort in which economists and other social scientists, as well as specialists from various technical disciplines, have succeeded in tracing some of the processes which give rise to social costs in developed countries including, significantly, the Soviet Union. For a recent discussion of the more important cases of social costs, see K. William Kapp, Social Costs of Business Enterprise (Bombay and New York: Asia Publishing House, 1963). [Reprinted Nottingham, England: Spokesman Press, 1978. Ed.]

it is in no way certain that such legislation has as yet succeeded in either eliminating social costs or even reducing them. Economic history and, more particularly, the history of economic development and social legislation in many advanced countries, could be written (or re-written) as the history of the success or failure to reduce the social costs of production.

However, social costs are not confined to developed economies; they play an important role in less developed countries where the development process is just getting under way. To illustrate: under certain conditions, lumber operations may be highly profitable, at least in the short run, despite the fact that they may set the stage for a serious deforestation of considerable areas of timberland which in turn may give rise to a cumulative process of soil erosion, land-slides, increased frequency and severity of floods as well as premature silting of reservoirs and the loss of life and property. This example shows the inherently cumulative character of the emergence of social costs in a much more far reaching sense than the term has been used in theoretical discussions of business fluctuations and economic instability. The principle of cumulative or circular causation stresses the fact that social processes are marked by the interaction of several variables, both "economic" and "non-economic," which in their combined effects move the system away from a position of balance or equilibrium. In fact, instead of calling forth a tendency toward automatic self-stabilization, social processes may be said to be subject to a kind of social inertia which tends to move the system in the same direction as the initial impulse.[2]

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[2]The concept of cumulative social causation in this sense was systematically used and developed by Veblen. More recently it has been given greater precision by Gunnar Myrdal: "The system is by itself not moving towards any sort of balance between forces, but is constantly on the move away from such a situation. In the normal case a change does not call forth countervailing changes but, instead, supporting changes, which move the system in the same direction as the first change but much further." Economic Theory and Under-Developed Regions (London: Duckworth, 1957), p. 13; see also Chap. 3.

Before turning to a more detailed analysis of social costs, it is important to realize that, just as there are social costs of production which may be shifted to other sectors or third persons, there are important social benefits of productive activities which tend to be neglected in the ordinary course of events characteristic of market economies. Social benefits include a wide variety of inappropriable utilities which tend to diffuse themselves throughout society. They are "inappropriable" by private producers in the sense that they cannot be withheld and offered for sale in markets. While these social or public benefits can be shown to be of considerable importance, private entrepreneurs cannot be reasonably expected to concern themselves with the production of these social benefits since they cannot ordinarily recoup the costs involved in their production.[3]

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[3]Both classical and neo-classical economists were not unaware of the significance of these social benefits without, however, systematically incorporating them into their theoretical models. Indeed, Adam Smith was one of the first to develop a doctrine of social benefits in his treatment of "public works" which "though. . . in the highest degree advantageous to a great society, are, however, of such a nature that the profit could never repay the expense to any individual or small number of individuals and which it, therefore, cannot be expected that any individual or small number of individuals should erect or maintain." An Inquiry into the Nature and Causes of the Wealth of Nations (New York: Modern Library, 1937), p. 681. Lord Lauderdale and Friedrich List pointed to an even wider range of social benefits in their critical doctrines of "public wealth" and "productive forces." J. B. Clark developed a theory of non-competitive economics based upon the principle of "inappropriable utilities" which "flee from him who creates them and diffuse themselves among the members of the community." The Philosophy of Wealth (Boston: Ginn and Company, 1885), p. 213. Later, Henry Sidgwick called attention to useful services which were "incapable of being appropriated by those who produce them or who would otherwise be willing to produce them." The Principles of Political Economy, Book III (London: MacMillan, 1901), p. 412.

Although this chapter is not concerned with social benefits either in general or with particular reference to economic development, it is nevertheless relevant to point out that there are many social benefits of economic development which, by their very nature, remain outside the market or price calculus. Furthermore, the prevention or minimization of social costs has effects which have all the characteristics of social benefits.

To view social costs and social benefits in this fashion explains why standard economic theory has shown relatively little interest in incorporating them into its analysis. Social costs and social benefits are essentially non-or extra-market phenomena. They arise as a result of physical and economic interdependencies of which we have become aware only gradually while economic and industrial development became cumulative and widespread in Europe and North America. Furthermore, and perhaps equally if not more important is the fact that different persons may place different valuations on these extra-market phenomena. Hence, they may easily give rise to controversy when normative judgments as to their relative importance must be formulated. Contemporary positive economic theory has long confined itself to the analysis of phenomena for which market processes provide seemingly unambiguous criteria of observation and measurement. Viewed from another perspective, one might also say that social costs and social benefits represent serious difficulties for the interpretation of positions of equilibrium as social optima and as a basis of "welfare" and investment criteria for the formulation of public policies and development programs.[4] With the

[4]In recent years social costs and social benefits have been sub-sumed under A. Marshall's earlier concept of "externalities" (external economies) which accrue to firms as a result of decisions or the location of other enterprises. However, this identification of social costs and social benefits with Marshall's "externalities" raises more questions than it hopes to solve. For, if output and supply are not affected by, and hence independent of social costs, and may even be a function of the firm's ability to avoid and shift these costs, and if important social benefits are not reflected in market returns, the standard normative interpretation of

growing knowledge of physical and economic interdependencies and of the magnitude of social losses, economic theory can hardly ignore these extra-market phenomena. Indeed, as the economy becomes more complex, non-market interdependencies are likely to assume greater significance. For this reason social costs are bound to become increasingly important not only in advanced but also in developing countries.

Social Costs and the Philippine Economy

This chapter is concerned with the social costs arising in the course of economic development. Our empirical evidence will be drawn primarily from the Philippines. However, the discussion will be kept at a sufficiently general level so as to make it relevant to other Asian and South East Asian countries as well. That is to say, while our illustrations may be from a particular country or group of countries at a particular stage of economic development, such evidence is introduced only to lend empirical support to the thesis that the process of economic development may give rise to a variety of social costs of considerable magnitude which may be of such a nature as to retard and even arrest the development process unless appropriate steps are taken for their prevention or minimization.

Economic development in the Philippines offers a particularly clear and simple case for the demonstration of our thesis. The Philippine economy has long been exposed to the dominating impact of a major economic growth center with many of the accompanying "spread effects" and most of the "backwash effects."[5] Unlike other low-income countries

equilibrium price loses much of its persuasive cogency. In short, the existence of "diseconomies" external to and "economies" inappropriable by the firm raises serious questions with regard to the status and relevance of static equilibrium analysis.

[5]"Spread effects" in this context are expansionary or stimulating influences which advanced economies or growth centers may have on less developed economies and which actually promote the development of the latter. "Backwash effects" refer to the impact of advanced economies which tend to increase the inequalities between the two types of

which have recently won their political (and economic) independence, the Philippine attempts to reach higher levels of output have not been "planned"[6] but are strongly influenced by a prevailing image of American business enterprise. The economy follows a pattern of development in response to market forces and, at least implicitly, accepts many if not most of the normative implications of classical and neo-classical positive economics in which social costs (and we may add social benefits) figure, if at all, only as "externalities." An important corollary of this pattern of economic development has been the continued dependence upon American markets and sources of supply which is still reflected -- although to a decreasing extent -- in the international accounts showing the distribution of exports and imports. The de facto devaluation and decontrol of the Peso (1962) seem to have strengthened this pattern of economic development. In fact, under the combined impact of spread and backwash effects, it is plausible to argue that the pre-independence tendencies of a dualistic economic growth pattern reassert themselves. Such patterns are reflected in the co-existence of a relatively profitable export sector with emphasis on such traditional exports as abaca, lumber and sugar and a commercial and industrial sector catering not so much to a mass market

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economies. These two conflicting effects which may give rise to a precarious and highly unstable equilibrium are part of the explanatory framework of under-development advanced by Gunnar Myrdal, op. cit. pp. 27-38. See also A. A. Castro, The Philippines - A Study in Economic Dependence, Harvard Dissertation, 1953.

[6]Broad generalizations such as these need to be qualified. There have been numerous attempts of national economic planning. The failure to implement and the subsequent abandonment of practically all these plans and the final dismantlement of the system of controls lend support to our conclusions. R. S. Milne (ed.), Planning for Progress (Manila and Quezon City: U.P. Institute of Public Administration and Institute of Economic Development and Research, 1960); and Jose Soberano, Economic Planning in the Philippines: Ecology, Politics, and Administration (Manila: U. P. Institute of Public Administration, 1961).

which has been rather slow in emerging but to the satisfaction of an effective demand for less or non-essential luxury goods and services -- a demand which is constantly stimulated by a high responsiveness to standards and levels of living in the more developed countries of the West.[7]

In the meantime morbidity and mortality have been reduced without any decline of the birth rate. On the contrary, current estimates of the rate of population growth in the Philippines vary from an observed rate of 3.0% to current estimates of a future rate of 4.09% which would support the conclusion that population in the Philippines is increasing at an accelerated rate (as compared with earlier estimates.)[8] The result has been an increase in population not accompanied by a sufficiently high increase in yields[9] and output of food, or, for that matter,

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[7]For a recent analysis of this "reversion" see Benito Legarda, "Philippine Economic Paradoxes," Address before the 12th Annual Conference of the Philippine Statistical Association, July 3, 1964, The Manila Times, July 9, 1964. See also Benito Legarda, "Back to the Sugar Republic," Far Eastern Economic Review, Vol. XLV, No. 4 (October 1964), pp. 171 ff.

[8]Estimates of population growth rates for the Philippines vary from an observed rate of 3% (based upon 1948-1960 census data) to projected rates of 3.6% for 1960 to 1965, 3.8% for 1965-1970, 3.9% for 1970-1975 and 4.09% for 1975-1980 (based upon projected fertility and mortality rates, taking account of age-sex differentials over time and improvements in expectations of life). While the death rate in the Philippines is estimated to decline to less than half of its initial estimate between 1960-1980, recent studies and surveys have indicated no pronounced urban-rural or other differentials in fertility which are the forerunners of fertility decline. K. V. Ramachandran, R. A. Almendralo and M. Sivamurthy, "Population Projections for the Philippines, 1960-1980," The Philippine Statistician, V. XII, No. 4 (December 1963), pp. 163 and 160.

[9]"One of the more puzzling features of rice production in the Philippines is the apparent stability in yield per hectare. In spite of the introduction of the new varieties, heavier applications of

of employment opportunities in urban industries. Hence, despite a pattern of income and wealth distribution that could be considered as favorable to saving, investment, and capital formation, the available potential sources of savings have remained unavailable for investment either under private auspices (e.g., for improvements in agriculture or the establishment of manufacturing industries) or by way of taxation for public investments in much needed social capital. This outcome, together with the emphasis on consumption and a high preference for wealth in real estate, is in striking contrast with the earlier successful pattern of development in Europe. While the economies of England and the Continent during the 19th century also tended to produce inequalities of income and wealth, the patterns of conspicuous consumption characteristic of latter-day affluent societies and their imitation had not yet taken hold. "The new rich of the 19th century were not brought up to large expenditures and preferred the power which investment gave them to the pleasures of immediate consumption. In fact it was precisely the inequality of the distribution of wealth which made possible those vast accumulations of fixed wealth and of capital improvements which distinguish that age from all other. Herein lay, in fact, the main justification of the capitalist system. If the rich had spent their new wealth on their own enjoyment, the world would long ago have

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fertilizer, and changes in agricultural methods, national average yields have remained in the neighborhood of 27 or 28 cavans (about 1.2 tons) per hectare since the mid-1920's." While this stability of a national average may be due to an expansion of rice cultivation into upland or unirrigated areas with lower yields and thus conceal higher yields obtained in irrigated areas, it retains its significance as a rough index of some of the difficulties faced by Philippine agriculture in increasing total output on the basis of existing irrigation facilities during the last 40 years. (Quotation from Ernesto C. Venegas, "Rice Production, Area, and Yield in the Philippines." Paper presented at the International Rice Research Institute Seminar, July 11, 1964).

found such a regime intolerable."[10]

It is possible to look upon this case of dissipated potential savings and frustrated investments -- which is in no way confined to the Philippine economy -- as a missed opportunity as far as economic development is concerned and in this specific sense as a kind of social opportunity cost. We cannot concern ourselves in this chapter with these social costs nor with those social losses which result from the long standing neglect of public investment in social capital and the traditional quantitative and qualitative inadequacy of public administration in many underdeveloped economies.[11] This neglect is not confined to such most elementary functions of government as the maintenance of security of persons and property and a tolerable administration of justice, but affects every phase of productive expenditures in social capital such as irrigation facilities, farm to market roads, weather forecasting, highways, ports, electric power and adequate supplies of drinking water and similar "infrastructure" facilities.[12] Social costs can also be shown to arise either because government controls have not been enacted, or if enacted, are not enforced (e.g., due to the absence of an adequate administrative machinery or due to the fact that those responsible for social costs are willing and able to corrupt the administrative personnel).

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[10] J. M. Keynes, The Economic Consequences of the Peace (New York: Harcourt Brace, 1920), p. 18.

[11] K. William Kapp, "Economic Development, National Planning and Public Administration," in Hindu Culture, Economic Development and Economic Planning in India (Bombay: Asia Publishing House, 1963), pp. 67-95.

[12] "Our relative neglect of the needs of the agricultural sector in terms of infrastructure facilities to enable it to function more efficiently lies at the root of our present food problems. Had we constructed more irrigation facilities to provide water for at least 500,000 more hectares of rice farms, we can say without fear of contradiction that our present rice problem would hardly haunt us now." From a speech by A. V. Fabella, Director-General, Program Implementation Agency, Manila Bulletin (October 12, 1964).

Other social costs may be said to arise as a result of inadequate or inadequately conceived government controls and partial development plans. Such social costs also play an important role in those developing countries which follow a pattern of development under public auspices by expanding the public sector of their economies. This "system-mix," i.e., this co-existence of a private and a public sector with its combination of market and public controls may make it necessary to redefine social costs in a more general sense as damages and harmful effects of economic decision-making (private and public) rather than as a result of entrepreneurial action alone. Such a broadening of the original concept of social costs would call for a critical analysis of the effects of faulty economic development planning.

Economic Development, Structural Change and Social Costs

We shall start our analysis of the social costs of economic development with a brief survey of certain social losses inherent in structural change. Our thesis in this respect is simple: all economic development is structural change and structural change tends to give rise to losses which are shifted to and borne by third persons or society at large. This thesis rests on the following consideration: economic development in the sense of increasing real incomes involves three kinds of structural changes:

1) increasing real incomes are spent not proportionately but disporportionately on different goods and services (different income elasticities);

2) productive factors (inputs) can be increased not at constant but at disproportionate cost (different supply elasticities);

3) different sectors of the economy are able to introduce and assimilate innovations only at varying rates (with the result that some industries lag far behind in the utilization of innovations).[13]

[13]See F. Redl, "Wirtschaftsstruktur und

Such structural changes inherent in economic development entail a transfer of resources including labor embodying special training, skills or knowledge. These transfers are associated with costs which do not necessarily enter into entrepreneurial outlays and, hence, into the decision-making process. The neglect of these costs is frequently the reason for resistance to economic change which may limit economic development. These social costs of transfer can arise also under conditions of planned economic development if the plan does not include provisions for social investments designed to absorb the costs of structural change by providing various public services and/or the direct subsidization of the transfer of resources.

It is one of the characteristics of the market economy to permit owners of capital assets and laborers with special skills or knowledge to absorb the financial windfalls or "unearned" increments which may accrue to them as a result of economic change. This fact is taken for granted in economic practice and accepted by economic theory.[14] Less realized is the fact that the market mechanism also forces laborers with specialized skills and established in particular localities, as well as owners of specialized resources, to bear the losses caused by the decline or shift of particular industries. "In the process not a few. . .people are trapped by

Wirtschaftliches Wachstum," Zeitschrift für Nationalökonomie, Vol. 23, Nos. 1-2 (1963), pp. 195-196. In addition there are other structural changes which tend to be connected with economic development: increased rates of population growth (due to the unequal rate at which underdeveloped countries are able to assimilate methods of "death control" and "birth control") give rise to changes in the age composition of the population; changes in the economic significance of different kinds of natural wealth (resources) as well as changes in the traditional value-orientations and institutions which influence economic behavior and decision-making.

[14]Price theory has even coined the term "quasi-rent" for these windfalls arising in the course of structural change which enhance the commercial fortunes of particular industries or particular skills.

the low salvage value of their particular skills in other occupations,"[15] or by the obsolescence of their capital assets. It is safe to say that the older the laborer and the more specialized his skill or the owner's asset, the more difficult it is to avoid these social losses. The only way in which developing countries can minimize these social costs is by absorbing them on public account by investments in retraining, i.e., in the acquisition of new skills or education in general and transfer subsidies.[16] In this way, opposition to economic change would be reduced and the structural adjustment called for by economic development made easier, as well as accelerated.

It may be argued, and in fact it has been argued, that the shift of these social costs of economic development to third persons or future generations is a prerequisite for accelerated economic growth and that any attempt to "internalize" them into entrepreneurial outlays either by social legislation or by taxation required for remedial action would have the effect of slowing down the rate of growth. Prima facie, this argument seems to be irrefutable. In fact it may be formulated in even more general terms with reference to all social costs. However, closer examination reveals that the argument possesses only a superficial plausibility as we shall endeavor to show in the concluding part of this chapter.

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[15] T. W. Schultz, "A Policy to Redistribute Losses from Economic Progress," Journal of Farm Economics, Vol. 43 (August 1961), p. 555. Replying to the argument that these losses cannot be foreseen and, hence, are unavoidable, Schultz makes the point that "particular classes of people as workers or even some owners of non-human resources are absorbing such losses not because no one knew these losses would occur but because some people are caught in a process from which they find it exceedingly hard to extricate themselves." Ibid., p. 557. See also K. William Kapp, The Social Costs of Private Enterprise (Cambridge: Harvard University Press, 1950), pp. 156, 162-170.

[16] Even resistances rooted in cultural or socio-psychological factors which we cannot investigate here may be overcome in this manner.

Resource Utilization and Social Costs

We turn now to specific cases of social costs which play an important role in developing countries. For many decades to come, the economies of Asia, Africa and South America are likely to derive the bulk of their national output from agriculture and other extractive industries based upon renewable or non-renewable resources such as land, forests, fisheries, and minerals. Hence, economic development is likely to call for an extension of the margins of utilization[17] quite apart from the growing need for increased output due to a rapid increase of population. In many advanced countries, such extension of the margins of cultivation has given rise to considerable social losses, and there is every reason to anticipate similar experiences in the developing countries.

(1) Institutional survey. Let us start with a brief institutional-historical survey[18] which may serve as a background for the subsequent analysis. Tribal societies or village communities in which land has not yet become a commodity are likely to be conservative in their land-use practices. When land is not a commodity -- i.e., when it is used by individuals or families but cannot be sold or mortgaged -- it is valued for the subsistence it provides to the members of the group. As their legal or religious fictions may have it, the land may belong to the tribe, the ancestors, or simply to all past, present and future members of the family. Each family may have the right to cultivate and pasture some land. Land may even be a medium of investment

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[17] The theory of production as it applies to land use distinguishes two margins: the intensive margin -- the limit beyond which a further intensification of land use is unprofitable due to diminishing physical returns on a given area of land -- and the extensive margin -- which separates good lands from submarginal lands which would be unprofitable to cultivate. Needless to add, these economic margins are not fixed once and for all but change with changing prices and technologies.

[18] For a more detailed discussion see K. William Kapp, Social Costs of Business Enterprise (1978), op. cit., pp. 98-106.

and a "storehouse of value;" in fact, pastures may be needed to support large cattle herds used as instruments of wealth. But the fact remains that land is valued and used not in response to the maximization of a case income but for the subsistence of the individual and the group. For all practical purposes, this must have the effect of a built-in restriction to use the land so as to preserve it intact for future use. Indeed, all kinds of primitive conservation practices may be maintained in the interest of present and future generations.

For the study of the social costs arising in the competitive utilization of renewable resources (and indeed all resources), it is instructive to trace the effects which a commercial penetration by advanced market economies has upon the rate of resource utilization in traditional societies. Admittedly, this type of culture contact is taking place under special conditions which are particularly destructive due to the absence of political and institutional restraints. Nevertheless, a discussion of these destructive effects discloses the factors and forces at work with particular clarity. The establishment of colonial rule and administration radically changes the rate of resource utilization. Even if boundaries are not established, the contact with the colonial power, its economy and the world market for primary commodities is bound to have the most far-reaching effects on the intensity of land use. Land will now become valuable as a source of cash income. Cultivation will become more systematic and continuous. With land as an asset capable of yielding a cash income there will emerge a tendency to establish exclusive ownership rights. Hand in hand with these rights goes the power to transfer land at will and transmit it to individual members of the family. As a result fragmentation and dispersion may set in. Increasing population pressure, low incomes, fluctuating prices, high rates of preference for present profits and consumption as compared to future income, and other obstacles to the practice of soil conservation, will act as inducements to maximize rent income at minimum current cost. The results of this combination of circumstances will be reflected in an over-intensive utilization of farm land in the course of which depletion of soil fertility, overgrazing, and erosion may become common characteristics of land utilization. The familiar vicious circle of poverty,

low income, ignorance, and soil depletion will complete the process and cause low yields -- which are characteristic of agriculture in many underdeveloped countries.

The widespread existence of tenancy and cropsharing in many less developed countries acts as an additional factor which favors the neglect of soil conservation and may lead to highly destructive practices. There are several factors (such as uncertainty, price fluctuation, and inadequate credit facilities) which influence the intensity of resource utilization and the possible emergence of social costs.[19]

(2) The "critical zone" as a key concept. For our purposes, it will be sufficient to limit the discussion to the exploration of a key concept which is basic to the study of social costs. Whether we are concerned with social losses arising out of the utilization of natural resources or with the social costs of air and water pollution, or with the "human" costs of industrial accident or occupational diseases, we are implicitly introducing the notion of a safety limit or "critical zone."[20]

Closely connected with this concept of the critical zone relevant for resource use is the concept of

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[19] In this connection there arise many intriguing questions which cannot be answered here. For instance: How is one to evaluate the losses sustained by future generations due to the depletion or exhaustion of resources? How safe is it to proceed on the assumption that technological progress will always provide us with adequate substitutes for a resource base depleted by present practices? Can theoretical optima of utilization -- assuming they can be formulated in terms of market prices -- be translated into criteria of policy and rules of action?

[20] For example the "human" costs just referred to arise when certain minimum safety standards are not maintained in modern factories. The social costs of air and water pollution occur when waste products discharged by industrial establishments lead to a concentration of pollutants in the atmosphere or waterways which exceeds permissible or tolerable levels.

natural balance which refers to the delicate system of interrelationships between land and its vegetative cover. Essentially this is a physical concept which has an important bearing on what are adequate and safe principles of soil and water or forestry management as the case may be. For anything that destroys this natural balance is likely to interfere with the protective function of the vegetative cover of the land. For example, the ecological balance may be disturbed by the process of bringing virgin land under cultivation, by draining ponds and other wet lands, by plowing under the natural sod, or by removing the forest cover. All of these operations may have harmful effects which often fail to be considered by those interested in increasing the area of tillable land. Indeed, if carried out on a large scale and without protective measures in response to a rapidly growing demand for farm products, the process of bringing virgin soil into use may endanger the very prosperity which it seeks to promote.

Similarly, improper land use and certain lumber operations, like improper selection and "repeated burning and improper degree or timing of grazing may upset this balance to such an extent that the valuable species are replaced entirely by other less valuable ones."[21] In other instances, the removal of the forest cover may cause a greater frequency of floods, the silting of streams and reservoirs, the diminution of ground water stores, the pollution of rivers, the destruction of irrigation schemes, the harmful effects of dust storms, and the disappearance of wildlife. These far-reaching and often irreversible consequences of human activities are all due to the fact tht they disturb the complex and highly sensitive ecological balance which exists between the land and its vegetative cover.

To define the ecological balance is not to suggest that its maintenance must become a norm. Nor is there any need to point out that rapid increases of population make it increasingly difficult to maintain intact the ecological balance. Even apart from the general increase of population, there may

[21] S. V. Ciriacy-Wantrup, Resource Conservation-Economics and Politics (Berkeley: University of California Press, 1952), p. 257.

be other overruling reasons why this balance cannot be maintained -- as for instance, in periods of natural disaster or national emergencies. However, any such disturbance has long-run cumulative consequences which man can anticipate to a large extent and which it is always imprudent to ignore in the interest of maximizing current returns or minimizing current costs.

Whenever the rate of utilization exceeds the critical zone, the resource flow tends to decrease and the resource base may finally lose its capacity to renew itself altogether. In fact, it ceases to exist. In the case of wildlife and fisheries, the destruction of the breeding stock or its natural habitat terminates reproduction and makes the depletion irreversible. "Soil depletion may become economically irreversible if a protective plant cover is destroyed by cultivation, improper degree or timing of grazing, and repeated burning in areas where topography, climate or soil renders precarious any existing balance between erosive forces (water, wind) and the stabilizing force of plant cover."[22] Certain types of gully erosion effectively terminate the possibility of utilizing the fertility of the soil for plant growth. In forestry, a rate of cutting and certain unselective lumber practices soon cause the ecological balance to be upset and may give rise to an economical irreversible degeneration of species or the complete disappearance of the forest and its protective functions.

Expressed differently, it may be said that there is a minimum standard of resource use beyond which any intensification in the rate of utilization will cause an economically irreversible depletion which is associated with considerable social losses. Obviously, the type and magnitude of these losses will vary depending upon the kind of resource under consideration. Admittedly there are elements of uncertainty which affect both the outcome and the magnitude of the losses. For example, adaptation to the loss of a particular resource and changes in taste are possible. Furthermore, there is no absolute certainty whether the process of depletion cannot be reversed -- except in the case of extinction of an

[22] Ibid., p. 256.

animal species. Nevertheless, the social losses may be said to be substantial in terms of their potential social consequences and in relation to the cost of avoiding them. Thus invariably the consequences of an economically irreversible destruction of renewable resources narrow alternatives of activities open to a social group. An irreversible depletion limits and channels development toward specialization rather than diversification. It sets the stage for a process toward arrested economic growth and leads ultimately to a dead end. From the perspective of the group, enforced specialization and arrested growth must be regarded as a serious limitation of the path of development. For this reason, it is true that any irreversible depletion of any resource constitutes a substantial social loss.

Compared with these potential social costs likely to be caused by an economically irreversible depletion, the actual costs involved in avoiding these adverse social consequences are relatively small. This conclusion is justified if we consider that what is needed, in many instances, is the adoption of more selective techniques and practices of resource use which are in harmony with the life and growth cycle of such resources as wildlife, fisheries, and forestry. In all these instances, the rate of use may have to be reduced not to zero but only to a safe distance from the critical zone.

Again, it must be pointed out that the "critical zone," beyond which the depletion becomes practially irreversible, is a definable benchmark and not a norm which must inevitably determine the rate of utilization at any given time. There may be overruling reasons why some resources and their "habitats" may have to be sacrificed to the expansion of settlement and civilization. Furthermore, the maintenance of a safe minimum standard defined in physical terms (i.e., in terms of sustained yields) is still subject to the economic requirements of minimizing the total costs involved. Thus, if there are alternative conservation practices which would preserve a safe level of utilization, that practice which involves the lowest total (private and social) costs is called for. On the whole, the safe minimum standard for the utilization of renewable resources is a practical, definable social optimum which can serve as an operational benchmark for the formulation and evaluation of policies and practices.

The type and extent of the harmful consequences of soil erosion depend upon such natural factors as the composition of the soil, the amount and distribution of rainfall, and the topography of the land. Thus, the sandier the soil, the more intensive the precipitation, the steeper the slope of the land, the more pronounced will be the effects of erosion. These natural factors are, however, given and not subject to human control. In other words, in order to avoid soil erosion, methods of cultivation have to be adapted to the conditions of the natural environment. If the farmer fails to do so and if rapid erosion sets in as a result of a combination of natural factors and price-induced farm practices, it is obviously the latter which must be considered the cause of the devastation of the land and not the high rainfall or the steepness of the slope.

It may be argued that the costs of soil depletion and soil erosion are borne by private owners and as such constitute private rather than social costs. Any cultivator who engages in practices which deplete the fertility of his soil or give rise to erosion lives, so to speak, on the substance of his capital and undermines the foundation of his future output. It may be said that he will do so only out of ignorance of the consequences of his action, an ignorance which could be overcome by better education, for example, through improved agricultural extension services.

Of course, it is correct that to some extent the costs of soil depletion and erosion are borne by private owners in the form of a depreciation of their capital which may lead to higher costs and ultimately higher prices for consumers which in the present context would not constitute a case of social cost except as an avoidable opportunity cost. In addition, however, there are the social effects of soil destructive practices which are reflected in the reduction of soil fertility of land owned by persons often at a considerable distance from the place where the process of depletion and erosion was set in motion. Erosion does not stop at the border of a person's property. Soil and gully erosion may affect an entire watershed. Downstream silting of reservoirs and rivers is another case in point. These social costs may be substantial in monsoon regions marked by torrential downpours concentrated during a few months of the year. In

semi-arid regions, wind may carry soil particles loosened by cultivation over considerable distances and deposit them on cultivated land with the result of reducing or actually destroying its fertility.[23] We may add that soil depletion and soil erosion will be promoted even, and especially, under conditions of commercial agriculture either when increasing farm prices make it profitable to extend the area under cultivation and seem to offset or obscure declining yields and rising costs or, alternatively when depressed farm prices prevent costly conservation practices. In any event where short-term or insecure tenancy prevails, as in many parts of the underdeveloped world, neither education nor improved extension services but only land reform and modern agriculture in accordance with scientific requirements provide an effective solution for the problems raised by the social costs of soil erosion and depletion.

(3) Soil depletion and erosion. In the Philippines various methods of land use, such as repeated plantings of soil exhausting crops without or with little regard to fertilization of the land, short-term tenancy arrangements, as well as population pressures and inadequate credit facilities, have contributed to serious soil depletion and erosion in some regions. Tenants who have no assurance that they will occupy the same land next year have no incentive to improve or even to maintain it. Moreover, under conditions of acute population pressure farmers may actually extend the area of cultivation to steep mountain slopes susceptible to erosion. The Soil Survey of Cebu Province reports "serious" and "excessive" erosion to have affected 205,000

[23]The most dramatic case of such social costs caused by soil destructive practices is the emergence of the American Dust Bowl which extended from Northern Kansas to Texas and from Colorado to parts of Oklahoma. More recent reports indicate that wind erosion and soil destruction over long distances are still going on, particularly after prolonged periods of drought. See Donald Janson, "The Dust Bowl in Grip of 2-Year Drought," The New York Times (March 4, 1965).

hectares or 63% of the area investigated.[24] It can hardly be doubted that man-made soil depletion and erosion are major contributing factors to the low and stagnant level of average rice yields in the Philippines.[25] Nor are the social losses of soil depletion and erosion confined to lowered yields. Accelerated run-off may increase the frequency and severity of floods; droughts may become more severe in their effects, soil and other sediments may be deposited in rivers, and premature silting may become a serious and costly problem in reservoirs needed for storage of water for irrigation, or the production of electricity.[26]

A special source of serious social costs is the system of shifting or kaingin agriculture as it is called in the Philippines. This system of agriculture makes use of burnt-over clearings which are cultivated and then abandoned and left fallow for considerable periods of time. As long as population density remains low this system of shifting agriculture does not necessarily give rise to serious damages. Indeed, due to the fact that most tropical and forest soils are poorer and more fragile than those of temperate zones and, hence, can be easily destroyed,[27] this land-extensive method of cultivation by rotation of fields rather than of crops with

[24]R. E. Huke, Shadows on the Land (Manila: The Bookmark Inc., 1963), p. 64. "Serious" erosion refers to conditions where 75-100% of all top soil is removed, whereas "excessive" erosion means that all top soil and some subsoil have been lost.

[25]Average yields of upland rice in areas in Batangas, Cavite and Iloilo which have been farmed intensively for many years and have suffered fertility depletion and erosion range from 5.0 to 8.9 cavans per hectare whereas yields on similar soils in Lanao which have not yet suffered depletion and erosion are 23.0 cavans per hectare. See D. Z. Rosell and J. P. Mamisao, "The Agricultural Soils in the Philippines," Journal of the Soil Science Society of the Philippines, Vol. IV, No. 1 (First Quarter, 1952), p. 17-18.

[26]See below, Section (4).

[27]Pierre Gourou, The Tropical World, Its Setting and Economic Conditions and Its Future Status (London and New York: Longmans Green, 1961), p. 13;

long fallow periods permitting the recovery of the soil may actually be a rational adjustment of man to his environment which can even be successful as a method of opening new lands and developing new crops.[28] However, the system becomes highly destructive and self-defeating in countries with high population density when the proportion of land cleared and cultivated exceeds the limits of safety and the fallow periods tend to become too short to restore the fertility of the soil. When this form of agriculture is practiced in high elevation or steep slopes, the top soil may be rapidly washed away and the soil stabilizing capacity of the watershed is greatly reduced or lost altogether.

In the Philippines, the kaingin method of cultivation in forest areas is increasing and, no doubt, contributes to the emergence of the social costs of erosion and deforestation. With rising population pressures, the kaingineros have no alternative but to use larger areas of steep forest slopes for cultivation as long as the slow tempo of industrialization does not provide adequate employment opportunities in towns and cities or as long as alternative opportunities for cultivation in the plains are not opened up by new irrigation, drainage and settlement schemes or remain unavailable due to the slow pace or failure of land reform.

(4) Deforestation. Excessive or indiscriminate logging operations are another source of serious social costs. Population pressure, export opportunities and a pressing need for foreign exchange may cause the utilization of renewable timber resources to be carried beyond the limit of safety which can be defined by studying the physical and economic interdependencies and the ecological balance to which we have referred to above.

Douglas H. K. Lee, Climate and Economic Development in the Tropics (New York: Harper and Brothers, 1957), p. 33 ff.

[28] As in Indonesia where rubber and coffee were first developed by small-holder cultivators using the kaingin (swidden) system. Karl J. Pelzer, "The Agricultural Foundation," in Indonesia, Ruth T. McVey (ed.), (New Haven: Yale University Press), pp. 123-124.

In Indonesia the reduction of the forest cover is said to have reached or surpassed the limits of safety, particularly in the heavily populated islands of Java and Madura. "Java has been without arable forest land since before World War II, and inroads made since then in its forest reserves -- which should cover 30 instead of the present 22.7 percent of the area -- have caused erosion and flood problems which can be checked only by the reforestation of the most exposed land.[29] In the Philippines, it has been estimated, on the basis of admittedly incomplete and tentative land classification surveys, that a 58:42 ratio is needed to maintain the necessary balance of soil cover. In other words, of the total land area, approximately 17.2 million hectares must be set aside for agricultural uses and about 12.5 million hectares must be reserved as timberland for permanent forest land use and the protection of soil and water resources. Thus far, only 7.5 million hectares, or 24.4% of the total land area, have been classified and delimited as available for forest purposes. Actually, only a total of 5.3 million hectares seem to have been licensed partly for selective logging and partly for general cutting.[30] However, this must not be interpreted to mean that the actual use of timberlands in the Philippines has not given rise to considerable social losses. With post-war Japan, Taiwan and Korea providing the major markets, exports of logs have steadily increased since 1950 and have become the second leading foreign exchange earner displacing sugar from this position. Often, logging operations are carried out under short-term licenses which may have to be renewed from year to year. Under these circumstances, some lumbermen and large-scale logging operators have found it profitable to cut trees indiscriminately (often in violation of the terms of their licenses) in an effort to recoup their investments in the short-run instead of practicing selective cutting with a view to sustaining yields in the long-run.

Indiscriminate cutting of trees does not only

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[29] Ibid., p. 121.

[30] Annual Report of the Director of Forestry of the Philippines, 1961-62. (Manila: Bureau of Forestry, 1962) [Mimeographed], pp. 8-10.

destroy the resource and capital base of the industry but, by undermining the ecological balance, destroys the protective functions of forests in a given watershed area. It reduces the capacity of the soil to store moisture, sets the stage for accelerated run-off, contributes to erosion, enhances the severity of floods (and droughts) and leads to the sedimentation of downstream areas and the premature silting as well as the reduction of the effective life span of reservoirs.[31] A case in point is the rapid silting of the Ambuklao reservoir and hydroelectric project. According to studies on soil erosion conducted under the auspices of the Food and Agriculture Organization, approximately 5 million cubic meters of top soil are annually lost in the watershed area serving the project. According to these studies, the life span of the project might be reduced to only half of its estimated period of existence, and the volume of water available will be considerably reduced unless steps are taken to prevent further erosion in the area. The cumulative effects and social lossses would be felt by all industries depending upon electricity generated by the project, not to mention the loss of electricity for non-industrial uses.[32] In India the effective life span of water reservoirs created for irrigation and power projects at considerable cost are affected by premature silting and sedimentation. It has been estimated that "nearly 40% of the catchment areas of the five major river valley projects -- Bhakra Nangal, D. V. C. (Damodar Valley Project) Hirakud, Chambal and Machkund -- is in need of soil conservation measures."[33] Finally, deforestation in the Philippines reduces the opportunities for supplementary incomes from minor and major forest products such as palm products (especially rattan), nipa leaves, resins, oils, soap substitute, and medicinal plants.[34]

[31] K. William Kapp, "River Valley Projects; Problems of Evaluation and Social Costs," Hindu Culture, Economic Development and Economic Planning in India, op. cit., p. 141-142.

[32] The Philippine Herald Magazine (July 18, 1964).

[33] The Economic Weekly, Bombay (September 26, 1964), p. 1549.

[34] For a discussion of the significance of these forest products see Huke, op. cit., pp. 80-85.

(5) Water logging and salinization. We cannot conclude this discussion of social losses arising in agriculture and forestry without mentioning a series of particularly dramatic cases of social costs which threaten economic development in some parts of Asia: water-logging, soil salinity, and an increased incidence of malaria. These social costs are directly connected with the provision of additional water for irrigation purposes and improper soil management practices which fail to take into account existing physical and technical interdependencies. Unlike artesian irrigation which draws upon available subsoil water, canal irrigation brings additional water to the area and, hence, may raise the ground water level. Depending upon a variety of factors,[35] the additional water may lead to a rise of the subsoil water level and may bring to the surface soluble salts which will adversely affect soil fertility. Even before complete water logging and salinization set in and before the land may have to be abandoned, social costs in the form of avoidable higher costs of production and lower yields will make themselves felt. Preparation of the ground for cultivation becomes more cumbersome and, hence, more costly, plant roots find it difficult to penetrate the soil, and germination is hindered, until finally, the whole composition and structure of the soil change, thereby gradually reduces or destroys soil fertility.

The problem of water logging and salinity is an acute problem in some parts of Northern India and Pakistan where it is often aggravated by a system of water charges under which water is sold at a flat rate per acre -- with the result that it tends to be wasted by the cultivator, especially when sufficient and dependable supplies of water are not certain.

In West Pakistan responsible authorities place the annual percentage of canal irrigated areas

[35] Such as the character and composition of the soil, the level of the ground water table prior to the introduction of canal irrigation, the presence of subterranian obstructions to proper drainage, the frequency and intensity of rainfall, and the rates of evaporation, absorption and seepage in transit before the water reaches the field.

becoming seriously affected by salinity at 3.8%. Of the total canal irrigated areas, 1.3 million acres have gone out of production and 1.7 million acres were (1958) in an advanced stage of deterioration.[36] In India (Punjab), out of a total cultivated area of 200 lakhs (one lakh = 100,000), 30 lakhs acres are acutely afflicted by water logging, the water table being within 5 feet of the surface.[37] In other areas surface accumulation of water and careless water management have given rise to a greater incidence of malaria and have even forced the abandonment of irrigation development projects.[38]

While this is not the place to spell out in detail the broader theoretical and practical implications of these interrelationships for the planning of irrigation projects and the formulation of economic policies in general, we may at least point out in passing that economic planning of major development projects requires an interdisciplinary research effort calling for professional competence which transcends that of the economist. This is, of course, true of most high-level decision-making and more or less generally recognized. What we wish to stress in this connection is the fact that economic planning of major development projects is not simply an exercise in allocating means to given ends but both ends and means need to be ascertained by an assessment of the physical conditions with a view to identifying what is technically possible and necessary, institutionally workable and economically worthwhile. In short, decision-making of this kind includes a choice of goals and means rather than an adaptation of "given" means to "given" ends.[39]

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[36]West Pakistan Water and Power Development Authority, Salinity Control and Reclamation Projects (January 1959, mimeographed), p. 94.

[37]Narindar Singh, "Some Aspects of Canal Irrigation in Punjab," The Economic Weekly, Bombay (February 17, 1962), p. 315.

[38]K. William Kapp, "River Valley Projects: Problems of Evaluation and Social Costs," Hindu Culture, Economic Development and Economic Planning in India, op. cit., pp. 138-141.

[39]K. William Kapp, "Economic Development in a New Perspective: Existential Minima and Substantive Rationality," KYKLOS, Vol. XVIII (1965, Facs. 1), pp. 49-77.

Urban Concentration: The Social Costs of Water and Air Pollution

Economic development and the concomittant process of industrialization are likely to give rise to a process of urban concentration which may have far-reaching negative effects which are not necessarily, and certainly not fully, reflected in entrepreneurial outlays and hence, constitute social costs. In fact, even without industrialization of any major significance, existing urban centers in less developed countries seem to attract the bulk of the "surplus population" who leave the countryside in search of better employment and living conditions. In the absence of regional and metropolitan development plans, this exodus from the rural areas moves not to small towns and cities but to a few sprawling metropolitan centers, thereby aggravating already existing conditions of congestion. According to current demographic calculations, Calcutta may have between 36 and 66 million inhabitants in the year 2000. The corresponding figures for Delhi vary between 18 and 33 million and Bombay may have between 12 and 22 million inhabitants.[40] Metropolitan Manila has grown from 1,410,785 to 2,075,770 in the relatively short period from 1948 to 1960.[41]

It is possible to analyze and interpret the ensuing concentration and urban agglomeration in the light of a theory of location which views the decisions of entrepreneurs and other individuals, such as laborers and consumers, as responses to either current or future (anticipated) economies of cost and income differentials. Such a theory tends to demonstrate that the concentration or production in a few urban and metropolitan centers makes possible "the production of any given output at lower costs than elsewhere and thus releases resources for other

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[40]Kingsley Davis, "Urbanization in India: Past and Future," in Roy Turner, (ed), India's Urban Future (Berkley: University of California Press, 1962), p. 25.

[41]See Census of the Philippines: 1960, Population and Housing, Vol. I (Manila: Bureau of the Census and Statistics, 1962). Metropolitan Manila includes Manila proper, Pasay City, Quezon City, Caloocan, Makati, Mandaluyong, Paranaque and San Juan.

production and use."[42]

However, to discuss problems of location solely in terms of a search for various cost differentials and pecuniary benefits has the effect of oversimplifying reality by omitting a wide variety of social costs caused by the ensuring process of concentration. As a result, what appears to be a rational choice of location aiming at production of a given output at minimum cost and allowing the release of resources for other uses may actually lead to a costly process of "overconcentration" which, by creating the need for remedial action, may have the long-run effect of freezing rather than releasing resources from alternative uses. Many economically advanced countries are burdened today with substantial social costs caused by the uninhibited search for cost differentials by private entrepreneurs. Among the more important social costs engendered by urban concentration are water and air pollution, traffic congestion with the resulting serious inconveniences and losses of time spent in traveling to and from places of work, shortages of water for individual needs, fire protection, and industrial purposes, increased public expenditures for social capital (e.g. for transportation, sanitation, police and fire protection, and ultimately slum clearance and urban renewal) not to mention the more intangible but not less real demoralization and dehumanization of life in congested areas.

It is, of course, true that insofar as investments in social capital are made and remedial steps are actually undertaken, some of these social costs will be reflected in higher taxes paid by entrepreneurs and other taxpayers. That is to say, these social costs are to some extent internalized in entrepreneurs' outlays, although usually with considerable delays. While entrepreneurs may be said to consider current tax rates in urban areas in their choices of location, it would hardly be warranted to conclude that future tax rates made necessary by remedial public policies are taken into

[42]Walter Isard, Location and Space Economy (New York: John Wiley and Sons, 1956), p. 174. See also Ibid., pp. 24-54 for a summary and critique of some general theories of location.

account in current entrepreneurial decisions. For this reason, it appears safe to assert that the social costs of urban concentration tend to falsify the competitive calculus as an index of the social efficiency in the allocation of resources. A more decentralized pattern of location may offer better opportunities for economizing resources and, hence, for their availability for other uses.

In this context, it is relevant to mention that increasing and uncontrolled urban concentration does not only lead to a more intensive use of existing social capital but renders such equipment progressively inadequate as far as its capacity is concerned. If public outlays required to offset such obsolescence and to expand the capacity of social capital and essential urban services in proportion to anticipated growth rates or urbanization were taken into account, it would probably be found that actual economies and cost differentials which induce industrial concentration are either non-existent or considerably lower than anticipated. If, however, public services and facilities are not expanded, the concentration of economic activities in existing urban centers gives rise to true social costs in the sense of harmful effects borne by third persons or society as a whole. Essentially, this is an empirical problem which would seem to call for extensive interdisciplinary research on the basis of which it may be possible to establish operational investment criteria relevant for urban and regional development planning.

Within the context of this chapter, it is neither possible nor necessary to analyze the various cumulative processes set in motion by the concentration of industries and population in a few urban centers. Instead, we shall deal briefly with the problem of water and air pollution in the light of experiences made in economically advanced countries. Water and air pollution is the result of the concentration of industrial activities in and around a few urban centers and the discharge of untreated waste products into waterways or the atmosphere. As in the case of deforestation, it is possible to identify physical maximum levels of concentration of pollutants either in the atmosphere or in waterways. If safety limits are exceeded, the discharge of industrial waste products can become the source of considerable social losses. The harmful effects,

which will be felt by the entire population living in the affected area, may be reflected in an increased susceptibility to disease (often of epidemic proportions) and increased mortality. Not only respiratory diseases, including lung cancer, but a variety of other diseases, have been statistically correlated with the pollution of the atmosphere. Other losses take the form of a reduction of property values and the destruction of capital assets (e.g., fisheries). Vegetation and crop yields in surrounding areas can be shown to have been measurably affected by air pollution.[43] Perhaps the most significant social losses are those resulting from the fact that, in some areas of industrial concentration in the economically advanced countries, clean air and clean water are becoming scarce resources. If this process continues unchecked, the shortage of water for human consumption and industrial uses and of clean air would actually become a limiting factor in the choice of location of industries and residential areas.

The conditions which have given rise to water and air pollution in the developed countries are rapidly and indeed cumulatively emerging in some parts of the underdeveloped world. While countervailing group action and political decision-making aiming at minimizing these costs remain weak or non-existent, it has been found that, in the Philippines, mining, beverage and textile establishments as well as sugar centrals (refineries) and saw mills dispose of untreated poisonous waste materials by discharging them into waterways with various cumulative harmful effects on human health, live stock, and fisheries, often at considerable distances further downstream.[44]

[43]Detailed statistical estimates of these losses in monetary and physical terms are available for the United States, England and several European countries. See K. William Kapp, Social Costs of Business Enterprise, op. cit. (1963), Ch. 4, esp. pp. 51-66.

[44]The Philippine Fisheries Commission and the Institute of Hygiene of the University of the Philippines in collaboration with the Department of Health conducted a survey on problems related to water pollution in the Phillipines. See Leon Manahan

Air pollution in Manila is likewise creating harmful effects with 8,000 industrial establishments emitting chemical substances and 90,000 public and private vehicles adding to the contamination of the atmosphere.[45] In Calcutta, another area of considerable concentration and congestion, recent estimates place the average monthly fall of soot at 25 tons per square mile.[46]

Industrial Accidents and Occupational Diseases

It is sometimes believed that the newly developing countries are in a relatively favorable position to avoid at least some of the "human" costs of industrialization which were among the first to attract attention in the early literature of social criticism and dissent of the 19th century. Today, the causal relationships between various industrial occupations and industrial accidents and occupational diseases are relatively well understood, and their prevention has become the object of protective labor and factory legislation in most developing countries in line with international labor conventions adopted under the auspices of the International Labor Office. However, despite national legislation and international conventions, the impairment of the human factor of production is still a serious problem. Indeed, awareness of causal relationships is at best only the first step toward the prevention of these social costs. What is equally important is a political environment which makes it possible to translate such awareness into adequate legislation. Moreover, the enforcement of statutes and ordinances, especially in the underdeveloped world, usually lags far behind the willingness to sign conventions and to enforce the legislation. Even the developed countries have not succeeded in fully eliminating these social costs. Not

"A Scourge of Industrialization: Water Pollution," Philippines Free Press (June 7, 1964). Unfortunately the findings of this survey have not been made public and are still considered confidential and not available for circulation.

[45]See E. R. Kiunisala, "A Hell of Smoke and Stench - That's What Greater Manila is," Philippines Free Press (March 21, 1964).

[46]The Economic Weekly (Bombay), January 2, 1960.

only has it been shown that protective legislation has often remained inadequate and incomplete as far as coverage of cases is concerned, but rising price levels have had the effect of making existing compensation provisions increasingly inadequate. No wonder, therefore, that the struggle for adequate factory legislation and workmen's compensation acts has remained on the agenda of social reform.[47]

In this connection it is important to emphasize that the same conditions which rendered possible, and indeed invited, the shifting of costs during the early stages of economic development in Western Europe and America, are precisely those now prevailing in the less developed economies of Asia and Africa. In this respect, we need only refer to the rapidly increasing population which makes it possible to replace "worn-out" laborers by new workers from the increasing "reservoir" of unemployed persons. The existence of extended family and kinship patterns in many less developed countries would seem to support the view that, to a considerable extent, the human costs of production are shifted to and borne by the injured worker and his larger family rather than by the entrepreneur and the consumer.[48]

Summary and Conclusions

Which conclusions can be drawn from the foregoing analysis of social costs in economic development? Generally speaking, we can say that the process of economic development tends to give rise to a variety of essentially heterogeneous harmful effects and losses which are shifted to and borne by third persons or society at large. Most of these social costs tend to emerge as a result of complex physical and economic interdependencies which are likely to increase as economic development takes hold and employs technologies which are based on modern

[47] K. William Kapp, Social Costs of Business Enterprise, op. cit., Ch. 9.

[48] In traditional societies the extended family carries the burden of sick, old and unemployed members without sufficient income. While this means that the individual is not left without support it represents in effect a shift of the cost of subsistence to other persons.

science. Due to these complex interdependencies, the causal relationships which lead to social costs are frequently self-reenforcing rather than self-correcting. That is to say the emergence of social costs may become cumulative unless deliberate public action is taken to stop the cumulative process. The relevant causal and functional relationships are considerably more complex than those studied by classical equilibrium analysis which were seen as self-corrective and tending toward a position of "normalcy" or stable equilibrium.

The heterogeneity of the harmful effects and the lack of any value denominator make it unlikely that a single index will be found to express the magnitude of social costs. Indeed, no single index is likely to be sufficiently comprehensive. Only a system of complementary indices expressing various harmful effects in physical terms (e.g., extent of erosion, increased frequency of floods, increased morbidity) can ultimately provide a comprehensive picture of social costs. Such a system of multiple complementary indices in physical terms together with objectively defined safety limits will be called for if the developing countries wish to adopt policies with a view to minimizing the emergence of social costs of development -- costs which not only are bound to affect negatively the quality of life in general but may actually set limits to the growth process. It would be an illusion to believe that social costs will be borne only by future generations. Destructive farm and forest practices which aim at minimizing current cost may raise the cost of next year's output not only of other producers but even on those farms whose owners were responsible for the emergence of the social cost in the first place. Similarly, air and water pollution affects not only the health and cost of production of future generations but also present cost of production, even of those entrepreneurs who have contributed to the emergence of these social costs. In fact, from the perspective of the economy as a whole, social costs are never "unpaid." Furthermore, in many cases it is probably true that an early prevention of social costs is considerably less costly for society than the costs of repairing the losses and damages once they have occurred. Hence, while the internalization of social costs may make certain productive activities less profitable and, hence, affect the rate of growth in the short run, the

neglect of social costs and their cumulative and corrosive effects may retard and arrest the process of economic development altogether.

Thus, we are brought back to the question raised earlier as to whether social costs are the inevitable and unavoidable price of economic change and whether the endeavor to eliminate or at least "internalize" and redistribute them will have the effect of putting an end to all economic development.[49] More recently, it has been suggested that "the old capitalist trick of shutting out of the economic calculus a variety of social costs" has actually accelerated the process of economic development and that the attempt to internalize some of these costs into entrepreneurial outlays and thereby "temper the ruthlessness and destructiveness of capitalist development"[50] may have the effect of slowing down the rate of economic growth.

This suggestion rests upon the unwarranted belief that social costs are isolated phenomena of secondary significance or minor exceptions -- a belief which overlooks the fundamental and cumulative character of social costs which may affect not only the productive basis of the economy but indeed the stability of society. Thus, if logging companies or, for that matter, farmers, in their efforts to minimize the costs of current production, should find it profitable to increase output, the resulting deforestation, erosion, and soil depletion may go beyond tolerable safety limits; if ill-planned canal irrigation and the misuse of water by farmers lead to water logging, soil salinity and an increased incidence of malaria; if the expansion and concentrartion of industrial production in the growing metropolitan areas of Asia are permitted to give rise to slums and widespread air and water pollution; if the introduction of new techniques proceeds without any regard to the obsolescence of older skills and the increasing rate of unemployment -- in short, if nothing (or not enough) is done to

[49] D. M. Wright, The Economics of Disturbance (New York: The Macmillan Company, 1947), pp. 91-92.

[50] Albert O. Hirschman, The Strategy of Economic Development (New Haven: Yale University Press, 1958), pp. 57-61.

minimize these social costs of development, they are bound to rise to a point where the whole development process may be slowed down, if not brought to a halt, by increasing disparities and the inevitable political polarization which a disintegration of traditional societies may entail.[51]

Indeed, it cannot be overemphasized that economic growth and development, far from providing for an automatic adaptation of society, may lead instead to increasing conflicts and resentment and thus to socio-political tension and disruption. Hence, the strategy of economic development cannot be based solely upon the elaboration of economic investment criteria or an increase of foreign aid or investment. Actually, what may be called for, above all, is "the simultaneous if not prior solution of the problem of social integration,"[52] and socio-cultural reform. Such integration and reform are particularly important in traditional societies and the newly independent countries of Southeast Asia, many of which are still handicapped by the lack of a common language; the absence of common loyalties beyond the family, the tribe, the village or the region; the prevalence of particularistic over universalistic value orientations; and inadequate political, legal, administrative and social frameworks, as well as attitudes and religious traditions which stress other worthwhile purposes of society and human endeavor than the increase of economic wealth and for which improvements of living standards and economic growth are neither self-evident (and, hence, self-

[51] Mancur Olson, Jr., "Rapid Economic Growth as a Destabilizing Force," The Journal of Economic History, Vol. XXIII, No. 4 (December, 1963), pp. 529-552. Hirschman is aware of the fact that economic development is anything but a innocent process which can be easily grafted upon traditional societies. Indeed, he specifically includes among the social costs of economic development such highly destabilizing consequences as the disruption of traditional ways of living, the obsolescence of old skills and old trades, the emergence of city slums, and rising rates of crime and suicide. op. cit., p. 56.

[52] John Friedman, "Integration of the Social System," Diogenes (Spring, 1961), p. 79.

justifying objectives) nor a sufficient enticement for action and the acceptance of a period of austerity.[53]

APPENDIX: On the Measurement and Diagrammatic Representation of Social Costs and Social Benefits

The present paper has not made use of any quantitative and diagrammatic representation of social costs. Perhaps the reason for this "omission" should be made explicit.

In the first place, we feel that the search for quantitative precision in the analysis and measurement of social costs (and social benefits), while useful up to a certain point, could easily be carried to the point of zero returns and may actually distort the problem under investigation. For purposes of practical policy and in order to provide indicators of the approximate magnitude of specific social costs, it is of course necessary and, as we have shown, possible, to define and enforce so-called tolerable safety limits. Nevertheless, even then, it needs to be realized that a certain residue of imprecision and indeterminacy may continue to surround the measurement of social costs (and incidentally of social benefits). This is due to the fact that our knowledge of social costs at any given time is not only incomplete but their evaluation differs between different persons and groups. For this reason it would be unrealistic to expect the same degree of precision in the definition of social costs which we find in purely formal or mathematical concepts or in many concepts of the physical sciences which are actually derived from, and defined in terms of measurements in numerical terms.

Secondly, we believe that the cumulative character of the causal processes which give rise to

[53]For a penetrating analysis of the thesis that economic development may fail as long as the modernizing (Western educated) elite fails to establish closer and more effective lines of communication with the traditional and religious sector, see Soedjamoko, "Cultural Motivation to Progress and the Three Great World Religions in South East Asia," (U. P. Manila Conference, 1963) [mimeographed].

social costs and the fact that social costs are closely interrelated with entrepreneurial outlays and social benefits (including the so-called external economies) support the conclusion that there seems to be no satisfactory technique (i.e., no simple functional relationships or equation) which makes it possible to express or represent these relationships formally. Nor would it be logically satisfactory, in view of the complex interdependencies, to treat the social costs and entrepreneurial outlays by simple addition or subtraction, or, in formal diagrams, by two related curves of which one represents the entrepreneurial cost and the other the social cost. In fact, traditional techniques of representation seem to be of little help if it comes to the analysis of the economic and physical interdependencies which are characteristic of modern industrial processes.

For this reason it would also be problematical to attempt diagrammatical representations of social costs and social benefits in an effort to develop some notion or awareness of a so-called optimum degree of development at which "social benefits" are just sufficient to offset the social costs of development. While it is doubtless important to realize that social costs cannot be completely eliminated and must be viewed in relation to the social benefits of economic development, it is important to keep in mind that we are dealing with essentially heterogeneous magnitudes and qualities for which there can be no common denominator. Hence, if we nevertheless proceed to represent them in a single system of coordinates, we create the false impression of a commensurability which simply does not exist. Surely, measurement and quantification, while often contributing to clearer notions and concepts in social analysis, are themselves subject to diminishing returns and ought not to be pursued for their own sake, regardless of whether they assume the character of fictitious or empty formulae without empirical content and practical relevances. Therefore, any diagrammatical representation of social costs and social benefits seems to be highly problematical if not indeed logically inadmissible.

In short, we feel that the study of the social costs of economic development calls for a causal-descriptive analysis of the economic and physical interdependencies which are likely to be set in

motion by the development process. Only in this way can we hope to arrive at operational criteria for the formulation of policies designed to prevent or minimize socially destructive development patterns or to improve "incrementally" destructive conditions once they have arisen.

CHAPTER 2

Environmental disruption: General issues and methodological problems *

1. Introduction

Since the task of presenting the opening statement to this international symposium has been assigned to me, I should like to preface my paper by one or two introductory observations. I consider it as particularly appropriate that this first international symposium on the disruption and possible destruction of man's environment takes place in a country that had to endure the horrors of Hiroshima and Nagasaki. Moreover, Japan today has one of the most rapid rates of industrialization and of economic development with all its disruptive consequences on the environment. This is another reason which makes the choice of Tokyo as the geographical site for this international discussion of a world-wide problem highly appropriate.

The impairment of man's environment has a long history; some of the phenomena even antedate the Industrial Revolution; they can be observed in varying forms and intensities in pre-industrial societies and less developed economies. However, while deforestation, soil erosion and even air and water pollution are anything but new phenomena, their role and significance as threats to human well-being and in fact to human survival tend to become cumulative with the progress of modern industrial techniques and their indiscriminate application under conditions of increasing rates of population growth and settlement density. In fact, the rapid advance of science and technology in such fields as energy production from atomic and thermo-nuclear sources,

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the unresolved problem of the disposal of radio-active waste material, the indiscriminate use of pesticides and " hard " detergents, new means of transportation at super-sonic speeds with their detrimental effects of noise, the ever increasing use of automobiles, the steady growth of agglomerations with their congested and unsanitary living conditions, new techniques of communication and of storing data and centralizing knowledge of all sorts together with their potential use for purposes of controlling and manipulating human behavior and human choices — all this introduces new hazards into man's natural and socio-political environment which are bound to undermine his physical and mental health [1] and ultimately to threaten human civilization and survival. I do not regard it as my task to analyze these actual and potential consequences, which, indeed, has been done by more competent scholars working both in the natural and social sciences. However, we need to remind ourselves that the impairment of our environment has reached not only a new quantitative dimension but a new quality as a result of the combined and cumulative effects of the complex interaction of a multitude of factors. While pre-industrial societies have been threatened by man-made deforestation, erosion and natural catastrophes of various sorts, and while air and water pollution could perhaps still be regarded as limited dangers a few decades ago, the causes and effects of the disruption of man's environment have multiplied to such an extent that it is necessary to view them as immediate threats and typical phenomena which transform the world upon which human life and survival depend.

The disruption of man's natural and social environment has been discussed and to some extent systematically investigated for more than two decades. However, the growing realization of the magnitude of the dangers involved has given the problem of environmental disruption a new urgency which makes it one of the most challenging issues which mankind has ever faced and calls for practical action which does not permit further postponement. The social sciences must develop more adequate perspectives and concepts for the analysis of the causal chain which leads to environmental disruption and thus prepare the ground for more effective methods of control.

The analysis and control of the impairment of the environment in modern society is not the special province of any particular scientific discipline or group of disciplines. No single discipline and indeed neither the social nor the natural sciences of and by themselves are able to come to grips with the problem of environmental disruption. For, this disruption is the outcome of

1. "The problem of the psychological pressure of crowding [...] the development of stress syndromes in some mammals leads to death, increases frustrations and neurotic behaviour [...] it is bound to engender violence if it goes on too long [...] crowding means you are going to have an increasing amount of regimentation, which can very readily go over to authoritarianism if you are not careful." From Sir Julian Huxley, "On population", *The Center Diary*, July 4, 1946.

a complex process of interaction of social and physical factors which cannot be adequately analyzed in terms of the concepts, theories and perspectives of any of the conventional disciplines. The disruption of man's environment by his own activities and decisions is a particularly complex process which transcends the scope and the points of view of any of today's highly compartmentalized fields of study. For this and other reasons which, I hope, will become more persuasive in the course of the subsequent analysis, I feel that many of the terms and concepts developed by particular disciplines (as, *e.g.*, externalities, diseconomies, nuisances, ecological imbalance, biospheric disruption, etc.), useful as they may have been and perhaps still are for particular theoretical purposes, are no longer adequate. In fact, the increasing disruption of man's natural and social environment raises the most far-reaching problems not only with respect to the proper methodological and theoretical procedures but also, and particularly with regard to the proper modes of control and policy-making. The solution of these theoretical and practical problems calls for the closest possible collaboration of social and natural scientists, including technologists. With this end in view I would indeed endorse Professor Tsuru's suggestion to use the term "environmental disruption" as a broad and general concept designed to cover all those phenomena which either singly or together affect the character and quality of the natural and the social environment of man. The use of the term environmental disruption should serve as a recognition of the fact that we are concerned with matters that touch the core of human existence and which in their complexity transcend the scope and competence of any particular discipline.

2. Circular causation

This brings me back to the fundamental issue of the causal process which gives rise to the disruption of the physical and social environment. Only if we view the process of causation correctly can we hope to make headway with the urgent task of controlling this disruption or at least limiting its most destructive effects. Nothing would be more misleading than to oversimplify this process of causation and view it in a superficial and uncritical way.

Of course, it is true that the increase of population alone is bound to give rise to an impairment of man's environment. It is also correct that some disruption may be caused by natural catastrophes without man's intervention. And nobody can deny that evidence of environmental disruption antedated modern industrial societies. Air pollution was reported in London as early as the 13th century and deforestation of steep slopes and valleys with its increased incidence of destructive snow and stone avalanches — not to mention erosion — has been present in Switzerland long before the Industrial Revolution and before this country developed a predominantly industrial structure during the 19th and 20th centuries. Similarly, destructive effects of defores-

tation have been characteristic features of other pre-industrial economies including many of today's less developed Asian countries, as for instance the Philippines, Indonesia and India [2].

However, these earlier examples should not divert our attention from the important fact that in modern societies disruptive effects are set in motion by the often indiscriminate use of industrial techniques under specific conditions of institutionalized legal relations and patterns of action and investment. Hence to concentrate only on the physical chain of causation or to view the problem in isolation from the institutional framework in which it takes place can convey only an incomplete and therefore a false picture. In short, the causal chain is at the same time a physical and a social process [3]. Speaking as an economist, I have long held the view and continue to believe that the institutionalized system of decision-making in a market economy has a built-in tendency of disregarding those negative effects (*e.g.*, air and water pollution) which are "external" to the decision-making unit. Even if an individual firm intended to and would be in a financial position, as many oligopolists obviously are, to avoid the negative effects of their applied technology, it could do so only by raising its costs; that is by deliberately reducing its profit margin and its profit earning capacity. Thus, a system of decision-making, operating in accordance with the principle of investment for profit, cannot be expected to proceed in any other way but to try to reduce its costs whenever possible by shifting them to the shoulders of others or to society at large. Two points may be raised in opposition to this view. In the first place it may be argued that these affected persons or society will defend themselves by legal action if they consider the damages of sufficient importance. If they do not defend themselves, this must be proof of the fact that the damages are not important enough to warrant such action. This argument overlooks that *a*) the damage may be gradual in building up until it becomes cumulative in character and comes to light only after considerable delays, and *b*) it may be difficult to prove damages and impossible to impute them to the action or lack of action of any particular economic unit.

In the second place, it may be argued — in opposition to my view that the institutional system of decision-making in a market economy has a built-in tendency of disregarding all negative effects — that the decisions of municipalities and public authorities in general are also responsible for the disruption

2. See K. W. Kapp, "Social costs in economic development", in: G. P. Sicat *et al.* (eds.), *Economics and development: An introduction*, Quezon City, 1965 (Reprint n° 49, Institut für Sozialwissenschaften, Universität Basel, Switzerland), and C. Uhlig, *Das Problem der "social costs" in der Entwicklungspolitik*, Stuttgart, 1966.

3. Professor Tsuru has made the point that "superimposed upon the physical chain of causation are the socio-economic and legal relations which could make a great deal of difference to the impact of physical factors upon human welfare". *Cf.* "Environmental pollution control in Japan", paper presented to the International Symposium on Environmental Disruption in the Modern World, p. 1.

of the environment. This is doubtless correct. One may even be inclined to go a step further and argue that socialist planning agencies will act in a similar way. Perhaps this is so, although it is not self-evident why.

But let us review these cases a little more closely. In the first place there is no doubt that municipalities also contribute to the disruption of the environment. However, apart from the problem of the relative importance of public sources of environmental disruption (in comparison to private sources) [4], does this refute the thesis advanced earlier? If municipalities and public or planning authorities set the stage for an impairment of the environment, for instance when they attract industries in order to increase their tax income regardless of possible negative effects they sacrifice the quality of the environment for revenues by choice, that is their action is identical to that of a private firm operating under the "constraints" of the principles of rentability. Both try to maintain an artificial, purely formal short-run financial solvency by ignoring the social costs of development. Some of the current attempts to render public decision-making more "rational" in terms of market costs and returns may carry the danger that the disregard of some or all of the negative effects of decisions may become even more general and typical. Instead of reducing the incidence of social costs connected with environmental disruption, such attempts are likely to increase them.

Rather than pursuing this perhaps controversial line of reasoning, let me suggest a more general framework of analysis in order to deal with the explanation of the process of causation which underlies the disruption of man's environment. Human action, including public decision-making, takes place within, and has repercussions on our natural-physical environment which has its own ecological structure and is subject to specific laws [5]. If these structures and regularities are left out of account, either due to ignorance or deliberately, the outcome of any decision may differ from one's intended objectives or, even if the original goal is attained, there may be additional effects of a negative character. Viewed in this way, the disruption of the environment can be interpreted as the outcome of human action which, while apparently rational within a given institutionalized framework of socio-economic and legal relations, nevertheless gives rise to a particularly destructive (social) irrationality because its repercussions on the physical, biological, psychological and social environment are ignored or neglected.

The result is an inefficient use of economic means and resources in the sense that socially more important values and objectives are sacrificed and remain unsatisfied in favor of less important ones. More specifically, formerly

4. "According to some estimates in some fields, and with respect to some kinds of discharges, industrial wastes exceed by a multiple the discharge by all municipalities, quite apart from the fact that industrial plants discharge vastly different amounts of waste." A. V. Kneese, "Research goals and progress towards them", in: H. Jarret (ed.), *Environmental quality in a growing economy*, Baltimore, Md., 1966, p. 79.

5. The same applies *pari passu* to the disruption of the social environment.

"free" goods like clean air and water have become scarce. Moreover, by shifting the costs of environmental disruption to third persons or to society, we add to the distortion of an already imperfect market and price structure and of the distribution process. Some economic units are able to acquire benefits by disrupting our environment. It is not that they get something for nothing, which is problematical enough from the point of view ofany hoped for and frequently alleged correlation between income and output, but they get something by causing damages to the others.

We may go one step further: by viewing human action as taking place within, and with repercussions on a physical and social environment with specific structures and regularities, it becomes clear that the various spheres of man's environment which are affected by his action are interdependent. Moreover, the interaction of the socio-economic with the physical and biological spheres (or systems of relationships) is much more complex and much less explored than the operation of any of the various systems which the conventional academic disciplines have isolated for separate study in the light of their particular objectives. If we look in this way upon the causal chain which gives rise to disruption it must be evident that its causal analysis cannot be carried on successfully in terms of one or the other of the compartmentalized social, physical and biological disciplines. Neither social nor natural scientists nor engineers and public health experts, trained in their limited disciplines and familiar only with their narrow concepts and theories today are able to focus attention on the whole relevant pattern of interaction which must be the "unit of investigation" — if we are to make headway with the causal analysis of the impairment of our environment. It is true, we still lack such a theory and/or science which is capable of elucidating the mode and outcome of the complex interaction of several systems. Hence, our knowledge of the causes and extent of environmental disruption is incomplete and we continue to feed this imperfect knowledge into data-processing computers. In other words, we must act on the basis of imperfect knowledge as we have in the past and may have to, even though to a lesser extent, in the future.

However, there is one important aspect we do know about the causal chain which gives rise to the disruption of man's natural and social environment: in many (if not in most) instances it is a process of circular causation which has a tendency of becoming cumulative unless some deliberate action is taken to arrest or redirect it. The effects for instance of air and water pollution are typically the result of the interaction of several factors. Thus, the effects of any single discharge of pollutants varies with its frequency and concentration as well as the capacity of the environment to absorb the pollutants without harmful effects.

"Up to a certain level of concentration, disposal of wastes, disfigurement of the landscape, and congestions are, at worst, local irritations. Air, water and earth room can absorb a lot without great damage. Beyond that point, real trouble ensues; differences of degree of frequency and concentration

create differences in kind." [6] In short, there is a threshold beyond which further discharges of waste cause not constant but cumulative changes and disproportionate damages. The disruption of man's natural and social environment is cumulative in still another way. Not only will different kinds of pollutants from different sources combine in chemical reactions but a whole series of intervening environmental variables such as weather, wind, topography and even design of construction of dwellings in large cities may combine to bring about varying degrees of deterioration of the quality of the environment. Such cumulative tendencies apply not only to air but also to water pollution. What is frequently overlooked is the fact that the quality of our environment as indeed that of society is always an aggregate: that is to say, the actual effects in terms of damage to human health and vitality, and actually experienced discomfort caused by any particular type of environmental disruption is always a function of the combined effects of all sources of disruption which may include, in addition to air and water pollution, other factors such as excessive noise, urban concentration, long hours spent in travel to and from work in metropolitan areas under chaotic traffic conditions and inadequate, congested transport facilities with high accident and death rates, inadequate time for leisure and recreation and the progressive absorption of free space and open landscapes [7]. Future hazards to man are such more or less dimly visualized developments as sonic booms, radio-active contamination, damage to the genetic structure and mutations, to name only a few [8].

3. Increasing disruption of the environment and increasing social costs

Before dealing with some of the more specific issues raised by the control and maintenance of the quality of man's environment, I would like to advance the thesis that we are faced with a tendency of an increasing impairment of the environment and hence of increasing social costs resulting thereform. The thesis is advanced tentatively and substantiated here in a deductive-systematic manner but I am sure that it can be and will be substantiated also in terms of empirico-quantitative data as soon as we put our mind to developing the proper statistics and quantitative indicators. With population rising at prevailing rates, with output (as measured in terms of GNP) rising

6. Jarret (ed.), *op. cit.*, pp. ix-x.

7. A more complete picture would have to include such perhaps less tangible but no less important factors as the effects of increasingly sedentary working conditions in an expanding service-sector of the economy, changes in the rhythm of work and rest, increasing specialization and monotony of work in some, and requirements of hectic performances in other professions, which in their combined effects are manifest in specific occupational morbidity and mortality rates and new characteristic civilization diseases. (*Cf.* M. Hochrein, J. Schleicher, *Herz-Kreislauferkrankungen*, 1959.)

8. *Cf.* H. J. Barnett, "Pressure of growth upon environment", in: Jarret (ed.), *op. cit.*, p. 16.

at higher rates than rates of population growth, with time (as measured in travel time) and space shrinking, not only congestion but input and hence residual waste products and the need for their disposal tend to increase disproportionately. Under these circumstances, the resulting disruption of the environment is likely to increase disproportionately also unless inputs could be converted fully into outputs and consumption of final outputs took the form of a final "destruction" of such outputs or, alternatively, if the capacity of the environment to assimilate residual waste products could be shown to be unlimited or could be increased without running into increasing real costs. None of these conditions is fulfilled or can be expected to hold as has been shown recently [9].

The capacity of the environment to assimilate residual waste products is limited and can be expanded only at increasing costs; inputs cannot be converted fully into outputs and the so-called consumption of final products, far from being a process in which such outputs are fully used up or "destroyed", leaves undesirable waste products to be discharged and disposed of in one way or in another. After a certain threshold has been reached, such discharge tends to lead to a growing impairment of the environment with resulting negative consequences on human health and life which can be counteracted and controlled only at increasing costs. In the light of these considerations it must be clear that increasing population, rapid progress of science and an indiscriminate application of new technology, increasing outputs and hence inputs, while increasing "productivity" (in a narrow sense), nevertheless are giving rise to increasing social costs understood either in physical terms (*i.e.*, in terms of the negative social effects represented by the impairment of the environment, human health and life) or in terms of the real outlays measured in terms of labor required to prevent or remedy damages caused by the disposal of residual waste products. Until quite recently, modern industrial economies have not held their producers accountable for the widespread damages caused by increasing outputs (and inputs) and their practice of disposing of residual waste products more or less indiscriminately with the resulting impairment of the quality of the environment.

Today we are witnessing a growing awareness of the character of the damages caused and of the losses sustained. As long as this awareness was absent or could be played down by general references to the advantages of growth and development and also to the obvious difficulties surrounding all exact measurement and evaluation of losses, it was possible to take a "calculated risk" [10] with regard to these losses or to disregard them by shifting them to

9. R. U. Ayres and A. V. Kneese, "Production, consumption, and externalities", *American economic review* 59 (3), June 1969, pp. 282-284.

10. The term "calculated risk" is, of course, a popular cliché which appeals to our age of calculation and measurement; actually nobody "calculated" anything and there was at first no empirical experience in terms of which probabilities could be measured. *Cf.* L. A. Chambers, "Risk versus cost in environmental health", in: H. Wolozin (ed.), *The economics*

the economically and politically weaker sections of society. Such a willingness to take "calculated risks" with man's environment and hence with human health and life was and is, of course, in open violation to all those systems of ethics which do not condone the sacrifice of human health and life either to increased output or to some abstract notion of the common good [11]. Today with the growing awareness of the threat and the magnitude of the actual and potential damages, the deterioration of man's environment is a public and hence a political issue. Thus, it becomes evident that economic practice and economic theory have systematically underestimated the costs of production, that the unpaid or social costs unaccounted for in traditional entrepreneurial outlays have been staggering and that the real costs (measured in terms of labor required to remedy or prevent the deterioration of the environment) are assuming increasing proportions of total costs and outputs [12].

But whether the principle of increasing environmental disruption and increasing social costs is accepted or not one conclusion can hardly be denied: under the impact of human action and decision-making and under the influence of a rapidly advancing technology and science, our environment is being transformed to an ever increasing extent. To be sure, man has always changed and adapted his environment in accordance to his own requirements. In this sense the present disruption represents an acceleration of a trend which has been present in the past. However, what must not be overlooked is the fact that we are confronted with a change of quantity into quality. Today's transformation of the environment is no longer an expression of an increasing mastery over the world we live in but is instead a sign of a loss of such mastery. We have reached the point where a steadily growing quantity of disruption turns into a serious impairment of the quality of the environment. It is this impairment with its manifest threats to human health and human life which has created an entirely novel situation. Its novelty is precisely the fact that the more the environment becomes the product of our action the less can we escape with impunity the responsibility of controlling and maintaining it. This brings us first to the problems of measurement and evaluation.

of air pollution, New York, 1966, pp. 51-60. On the illusions underlying the cliché of a "calculated risk" and probability calculations in contemporary social and military sciences, including capital and investment theory and business administration, see A. Rappoport, *Strategy and conscience*, New York, 1964, p. 22 *sq.*

11. Chambers, *op. cit.*, p. 52.

12. I cannot deal here with the implications of the foregoing analysis for future rates of growth except to emphasize that our traditional measures of output and growth in terms of GNP are likely to become progressively inadequate and unreliable as indicators of growth and development if increasing amounts and proportions of outlays are spent on nothing else but work designed to protect and keep intact the substance of our environment.

4. Issues of measurement and evaluation

In view of the extent of the deterioration of man's environment nothing seems to be more important than to develop reliable indicators designed to assess, measure and evaluate, to the fullest possible extent, the degree and consequences of this deterioration in its various manifestations. This issue is directly related to the problem of environmental control. In the first place, the assessment of the negative consequences of environmental disruption is an important desideratum of and, indeed, the first step toward an evaluation of the benefits obtainable from the control, protection and improvement of the quality of the environment. The two tasks: assessment of negative consequences and estimates of benefits, are closely interrelated. In the second place, it has long been argued that measures of control are economically justified only if their total benefits exceed or equal their costs. For this reason too, problems of assessment and measurement are obviously important.

And yet, problems of measuring costs and benefits belong to the thorniest and most controversial issues. Nor is this surprising. Both the costs of environmental disruption and the benefits of environmental control and improvement are predominantly non-market in character. Many of the costs and benefits cannot be quantified and still less be adequately measured in terms of prices. Some may be measurable in this way, or ways and means may be found to arrive at some indirect form of quantification in monetary terms. For example, when air and water pollution affect property values, any improvement of the quality of air and water may be reflected in higher land or real estate values. But even here problems arise. Suppose we were able to devise a technique to establish and impute the causal contribution which a particular source of water or air pollution has made to the loss of value of a particular site, this would still not be a reliable and unambiguous measure of social costs nor of benefits of control. Just as the decreased land and property value caused by air and water pollution affects third persons who may have had nothing to do with the productive process responsible for the pollution, the increased property value resulting from air and water pollution control are in many instances "unearned" increments. To identify such unearned increments with the social benefits of environmental control is highly questionable, even on theoretical grounds, which most social scientists, and especially economists, would have to reject as problematical even though, or more precisely because, such identification may be found acceptable by the real estate lobby [13].

Any suggestion to decide the justification of control measures in terms of a willingness to pay for them, or by assuming a capacity to compensate

13. It is possible to justify such identification of social benefits with unearned increments on the basis of some arbitrary and highly unrealistic assumptions as to market structure; on the whole subject see M. Mason Gaffney, "Welfare economics and the environment", in: Jarret (ed.), *op. cit.*, p. 91 *sq.* and 99.

those who have to bear the costs of control out of increments of property values or other monetary values accruing to others fails to take sufficient account of three factors: *a*) actual markets are far from perfect — in fact they are "oligopolistic" in character —, *b*) the consequences of environmental disruption are highly heterogeneous and cannot be compared quantitatively with one another, and *c*) the benefits obtainable from environmental control are equally heterogeneous and can neither be compared quantitatively with one another nor with the outlays for control. To quantify them nevertheless by means of some arbitrary monetary standard is at best problematical and at worst contradictory to logic if not in violation of our ethics. For what is the monetary value of human health and human life? What is the value of the quality of urban life or the beauty of a landscape that is being sacrificed in the process of urban expansion? The fact of the matter is that both, disruption and improvement of our environment, involve us in decisions which have the most heterogeneous long-term effects and which, moreover, are decisions made by one generation with consequences to be borne by the next. To place a monetary value on and apply a discount rate (which?) to future utilities or disutilities in order to express their present capitalized value may give us a precise monetary calculation, but it does not get us out of the dilemma of a choice and the fact that we take a risk with human health and survival. For this reason, I am inclined to consider the attempt of measuring social costs and social benefits simply in terms of monetary or market values as doomed to failure. Social costs and social benefits have to be considered as extra-market phenomena; they are borne by and accrue to society as a whole; they are heterogeneous and cannot be compared quantitatively among themselves and with each other, not even in principle.

More specifically, the social benefits sought by environmental control are social or public goods and must be dealt with as such. That is to say, they are above all goods or services which diffuse themselves throughout society; no one can nor should be excluded from their enjoyment; they are "non-rival" that is, their use or enjoyment by one does not necessarily reduce their supply. For this reason we will have to look for other methods of assessment than those available or suggested in terms of market values. We will have to face political decisions based on evaluations arrived at outside the market under conditions of possible disagreements and lack of unanimous consent. Such decisions are similar to those which were made in the past and continue to be made with regard to labor legislation (including workmen's compensation for accidents and occupational diseases), to social security legislation and legislation regulating standards of food and drugs, provisions of educational facilities, etc. No cost-benefit analysis helps us in these instances and no market values and indeed no compensatory principle and no Pareto optimum can help us now in deciding whether and which controls are to be adopted. As in all decisions of this kind, we will have to act even if some industries may be worse off or fail to give their consent initially as was the case with regard

to the aforementioned cases of legislation. In fact, the more we admit that *all* benefits (secondary, indirect, intangible, etc.) of control measures ultimately have to be included in benefit-cost calculations the more problematical becomes any evaluation in terms of one single monetary standard. In short, I fail to see that cost-benefit analyses as they stand today have a solution of the problem of evaluating either the social costs of the disruption, or the social benefits of the improvement of our environment by control measures [14].

And yet, my position should not be interpreted as a counsel in favor of arbitrary action; nor should economists who hold similar views be accused of preaching a gospel of license. In order to act rationally, we must know and assess the consequences of our action or non-action. To this effect we will have to draw the necessary inferences from what I have called the complex and cumulative character of the causal chain and to make an inventory of the actual and potential damages and losses caused by investment decision and government action or non-action. To this effect, we need a cooperative multi-disciplinary research effort on a national and perhaps an international basis [15]. In fact, in modern industrial societies it has always been important and is steadily becoming more urgent to anticipate the actual and potential effects of damages *before* investment decisions are taken. What are needed are inventories of the fullest possible range of the consequences which new technologies and inputs are likely to have on man and his environment. There can be no rational action and decision-making any more without systematic prior scientific analysis and prognosis. Many (though perhaps not all) of the unanticipated negative consequences and social costs which confront us today could have been anticipated by prior research and adequate outlays for scientific analysis. Today when we can build upon the accumulated experiences and lessons of the past, the pay-off of such prior research and prognosis is likely to be considerable.

14. Musgrave and others have made the point that the situation is more "manageable" when we deal with multipurpose water development projects, for in this case we are confronted not with a final social benefit but with an intermediate (social or public) good which contributes to final goods with market values, R. A. Musgrave, "Cost benefit analysis and the theory of public finance", *Journal of economic literature* 3 (3), September 1969, p. 800. While this is true up to a certain point I doubt whether the case is in fact much easier and more manageable. Because even in this case it is not evident that the current market values (*e.g.*, of crops or electricity) are such as to provide (especially in less developed countries) a sufficiently reliable and meaningful indicator of the relative importance of the goods and services which can be produced with the aid of such intermediate social goods or projects — quite apart from such thorny problems as to the choice of the capital inputs (*e.g.*, seed varieties) and hence yield data to be used not to speak of the selection of the interest rate to be applied as the relevant discount rate in order to arrive at current values of benefits.

15. It may well be that this research effort calls for an institutionalization in the form of national and international research institutes whose primary task it would be to develop methods of study and collect relevant data related to the deterioration of man's environment by various types of investment decisions under specific conditions.

Analysis and prognosis, by assessing the consequences of decision-making, will provide us with an inventory of the nature of the damages and social costs of private and public investments; it will at the same time yield the necessary data and facts in the light of which it will be possible to evaluate and revise our aims and objectives and thereby to improve our policy-making. However, far from denying that measurement is important and that science is measurement (and all that), I want to emphasize that what is even more important than precision in measurement is the selection of the goals, *i.e.*, the distinction of what is essential and what is less essential; this indeed will call for more than data and facts concerning the possible consequences of alternative courses of action. It calls above all for some general standards in terms of which it may be possible to agree on and select the social goals we seek. Once agreed and stipulated, it would then be necessary to compare the real costs of attaining such stipulated ends by different courses of action or methods of control.

5. Environmental control

The data and relationship established by analysis and their possible future consequences are directly relevant for the elaboration of the policies and methods of control which we are looking for. Implicit in this suggestion is the thesis that such data and relationships point to norms of action and facilitate the formulation of explicit value premises. By telling us what we have to expect; by showing us the dangers and threats which the disruption of the environment implies for human health and survival, analysis and prognosis define the choices before us and are thus part of the process of arriving at intelligent and reasoned decisions. In short, they are indispensable parts of the logic of formulating aims, policy objectives and methods of control.

The standards in terms of which it may be possible to stipulate specific social goals remain, of course, subject to *bona fide* differences of opinion. For this reason it is essential to work out objective standards in the form of appropriate limits of maximum tolerable or acceptable levels of concentrations of contaminants, *e.g.*, in such fields as air and water pollution or minimum requirements for the maintenance of human health and survival. The object of such safety limits is to determine the extent to which any type of disruption becomes a threat to the environment and to man. We cannot concern ourselves here with the specific techniques of elaborating such limits [16]. This is the task of natural scientists, technologists, public health experts and social

16. In the light of our analysis of the cumulative nature of the causal chain it goes without saying that such limits or safety standards cannot be identical for all localities and all countries. Thus, the multiplicity of the sources of air and water pollution, of the intervening environmental variables, of the conditions of climate, topography and the nature of the cumulative process would call for a variety of standards.

psychologists. What concerns us is the role and significance of safety limits in connection with the problem of controlling the disruption of the environment. Such limits fulfill several functions in addition to providing standards for measuring (in physical terms) the state of the disruption of the environment at a given time and place, thus serving also as indicators of dangers. They define what may be called the fundamental existential minimum requirements of individual life (or social needs). As such they may be regarded as the individual and social welfare minima directly relevant for the formulation of social goals or objectives. That is to say, while such safety limits do not represent automatically social goals — indeed they have not been social goals in all those countries which have tolerated the present disruption of the environment — and while the selection of policy objectives will continue to call for choices, such choices will have to be taken as a function of the social or existential minimum needs on the one hand and the community's productive potentialities on the other [17]. Furthermore, such social minima would be relevant for the selection of what is important in the light of objectives derived from individual human requirements and would bring us closer to a substantive concept of economic rationality measured in terms of actual satisfaction of human needs in contrast to a purely formal concept of rationality which underlies our contemporary abstract models.

It must be admitted, however, that social minima do not define an ideal or perfect state or, for that matter, an "optimal" use of resources. In fact, they provide only a modest and imperfect answer to the problem — but they would offer at least operational criteria or indicators for policy-making in terms of increments of improvements. Such operational indicators would be a considerable advance over optima formulated in terms of market outlays and returns which take inadequate account of social costs and benefits, and which despite their obvious questionable character have again and again been advocated as criteria of action [18]. Once safety limits, as for instance maximum permissible levels of concentration of pollutants, have been stipulated by the political process of decision-making, they can then be translated into a broad production function (or physical investment pattern), in the form of an input-output model designed to identify the inputs and techniques as well as the outputs called for by our existential minimum needs [19].

17. C. Bettelheim, *Studies in the theory of planning*, Bombay, 1959, p. 14. It goes without saying that social minima and existential minimum needs must not be considered as static but are subject to change depending upon the state of our knowledge, our technology and the level of productivity.

18. For a recent denunciation of this "vice of vulgar economics", *cf.* J. Robinson, *Essays in the theory of economic growth*, London, 1962, p. 27.

19. I realize that I am using the concept of an input-output relationship in a broader fashion than it was originally developed but I think that this extension of the concept can be justified, see W. Leontief, "The problem of quality and quantity in economics", in: *Essays in economic theories and theorizing*, London, 1966.

The emphasis must be placed on a direct *ex-ante* approach to control in contrast to current attempts at remedial action by such indirect measures as tax-exemptions, subsidies and the levying of charges according to the flow of pollutants. *Ex-post* remedial measures designed to check the impairment may have the advantage of leaving the choice of input and techniques to the individual economic unit. This method, which has been relied upon in the past, is becoming hazardous and in many instances irrational and potentially suicidal. Penalties, tax exemptions, subsidies or charges in accordance with the volume of contaminants discharged have very different incentive (or disincentive) effects on different firms depending upon their market power and their income and income tax position [20]. A penalty of $ 100 for each violation is ineffective and invites pollution if several hundred thousand dollars worth of costs (if not millions) can be avoided by the discharge of untreated waste materials. Similarly, small subsidies may offer little incentives for the installation of the required equipment. In view of the fact that expenditures for such equipment can anyway be treated as costs and hence are tax deductible, the resulting incentive effect has apparently not worked in the past. Massive subsidies and hence public expenditures may have to be called for in order to be effective and the outcome would be additional taxes levied on Peter to pay Paul [21]. In short, tax reductions and incentives alone will not be effective, quite apart from the fact that they tend to distort further an already imperfectly working price system.

The magnitude of the threat and the values at stake seem to me to call for a line of attack which must be directed towards the design and technique of production. What needs to be changed and controlled are the "input mix", the technical process and the location and concentration of the process of production. This is perhaps best illustrated by a concrete example: if we want to avoid the destruction of plants by insects and pests, we can use insecticides and pesticides. We have done so in the past only to discover that the insects and disease carriers develop immunity and that the increasing amounts of chemicals or their residues pollute our environment and tend to become serious health hazards to man. Instead of developing more and "better" pesticides which, moreover, tend to attack not only pests but insects in general, plant geneticists and plant breeders are experimenting today with breeding plants with greater resistance to attacks by insects and pests. This type of control, by changing the nature of capital inputs, may be more economical and more effective in the long run than the use of chemicals, while at the same time avoiding the dangers of the pollution of the environment [22].

20. On this point see Gaffney, *op. cit.*, p. 91.

21. Time and space do not permit a consideration of the question as to the proper allocation of costs of remedying past damage and preventing future disruption.

22. *Cf.* S. S. Chase, "Anti-famine strategy, genetic engineering for foods", *Bulletin of the atomic scientists* 25 (8), October 1969, p. 4.

Similarly, the control of air pollution by automobiles seems to me to be more economical and more certain by the design of new and more effective engines and/or by substitutes for gasoline than by indirect controls or better law enforcement.

Another illustration of the possibilities of controlling pollution by a new input mix and design is the installation of a central heating unit for a new residential district in the Northwest of Frankfurt (Germany), following earlier experiments in Lausanne (Switzerland). This heating unit uses as inputs the garbage collected in the residential district, which is burned at high temperatures (900° C). This not only prevents odorous compounds of the garbage from entering the atmosphere but tends to avoid the impairment of the atmosphere of the residential area thanks to the installation of one single smoke stack of special height (110 m), equipped with an electric filter. Moreover, the site for the smoke stack was selected after careful study of climatic conditions with respect to prevailing wind direction and velocity. The case of the Northwest City of Frankfurt is mentioned here as an illustration of a simultaneous disposal of waste material and its utilization as input for a central heat generating unit designed and located in accordance with the relevant technical and meteorological considerations [23]. While even this approach does not solve all problems of air pollution [24], it does show that the choice of a rational input mix necessarily calls for a deliberate choice of location.

In fact, this brings me to the final observations I wish to make in this context. Since the disruption of the environment is clearly a function of the location and relative congestion of an area it is imperative to consider these factors in all future decisions concerning industrial and residential sites. In other words, a rational determination of land use requires that we extend the unit of investigation and the area of environmental control in accordance with the actual physical interdependencies in an area as determined by its waterways, its topography, its climatic and meteorological conditions as well as its density of settlement. This broader perspective in location theory will become more and more urgent with the growing exposure to the dangers of pollution from radioactive waste materials and possible accidents from radioactive sources such as atomic reactors. Instead of purely local zoning regulations, a rational location policy requires planning based upon a complete inventory of physical conditions and existing population densities on a regional, national and perhaps even international basis. In short, choices of site and location problems in general, whether residential, commercial or industrial can no longer be made

23. H. Kampffmeyer *et al.*, *Die Nordweststadt in Frankfurt-am-Main*, Frankfurt-am-Main, 1968, and personal communications.

24. It does not because it is not feasible to reduce completely or destroy all effluents of a noxious character (*e.g.*, sulphur dioxyde, SO_2). Furthermore "the leeside of one city may be the windward side of another city", *cf.* J. R. Taylor *et al.*, "Control of air pollution by site selection and zoning", in: World Health Organization (ed.), *Air pollution*, Geneva, 1961, p. 294 (Monograph series, 46).

solely with reference to traditional market factors and costs such as outlays for transportation, materials and labor. Here too, costs and benefits will have to be evaluated in the light of inventories of hazards established by multidisciplinary research efforts. Whether the practical implications of such studies will be a dispersal or a concentration of industries and residential areas and which methods of control will be called for is today an open question.

6. Conclusions

We are thus led to the conclusion that while science and technology and their application under given institutional arrangements have led to a serious deterioration of man's environment, the mastery and control of the resulting hazards to human health and life can be achieved if at all only by making science and technology accountable to society. At the same time, social policy and decision-making must themselves be shaped by scientific research. So far we have applied science and technology without paying attention to their human and social consequences. If we want to reverse this process and bring it under social and political control, we will have to pay greater attention to the imperatives of human life and survival in making use of science and technology.

Unless we succeed in this endeavor even at the price of substantial changes in our institutional arrangements, the disruption of man's environment is likely to assume increasing dimensions. In fact, this disruption is becoming the dominant problem of the outgoing 20th century — equal if not surpassing in importance the recurrent threats to human health and survival in the Middle Ages by diseases of epidemic proportions, the exposure of the individual to arbitrary and despotic rule and exploitation, and the human and material losses caused by mass unemployment which preoccupied economists during the last decades.

From the perspective of modern biology and anthropology man has been described as an endangered being whose survival and development into a functioning member of his culture constitutes an achievement against many odds. In the light of the cumulative effects of an uncontrolled use of modern technologies on the quality of man's natural and social environment, man in addition endangers himself because his action and his uncontrolled productive activities threaten his health and actually his survival as a species. Ultimately the disruption of man's environment by his own action and the human and social costs created thereby call for more than remedial action here and there; they call for *ex-ante* measures of control. The destructive transformation of the world we live in will neither be stopped nor reversed as long as responsibility for the maintenance of the quality of the environment in the interest of present and future generations does not find an unequivocal expression in

our system of morals and ultimately in ethical and political imperatives which guide individual and social action. It seems to me that such a system of social and ethical responsibilities for the maintenance of man's environment also confronts the social sciences and is one of the challenges which we have jto face.

The modern problems of the disruption of man's environment and of the social costs and consequences of such impairment, and the search for ways and means of controlling and improving the quality of man's environment, constitute not only a challenge to our intellectual and practical ingenuity but could open opportunities for joining those early social critics and dissenters, who were concerned with these issues. And, if I may add one concluding remark: perhaps it is this urgent task of preventing a further disruption of man's natural and social environment and of improving the quality of the conditions of human life which could bridge the gap between the disaffected parts of the younger generation and those among the older ones whose critical udgments have not been eroded by a positivistic acceptance of the *status quo*.

CHAPTER 3

ENVIRONMENTAL DISRUPTION AS AN ECONOMIC AND POLITICAL PROBLEM*

The problem of environmental endangerment and disruption was clearly recognized and was treated by several economists of the nineteenth century, especially by such early critics of the market economy as Sismondi, Engels, Marx, and Veblen. Social critics (like Fourier, Ruskin, Owen) and agronomists, chemists and Foresters also concerned themselves with the problem. Landry and Effertz in France and Bauer in Austria were among the first to recognize the problems of social costs. However, most of these economists were outsiders.

The representatives of traditional economic theory either ignored environmental impairment or treated it in a way which did not do justice to the significance of the problem. This applies both to micro and macroeconomics. This neglect can be traced back to two classical concepts that today are being called into basic question as a result of the environmental crisis. They are the treatment of natural resources and raw materials, including air and water as "free gifts of nature" and the doctrine of unintended positive side-effects of human actions. The free goods which include the natural environment as well as aesthetic values, were viewed in those days as inexhaustible and indestructible. Their qualitative deterioration and destruction through production and consumption are not expressed adequately in an economic calculus based on market variables, and were therefore hardly treated in classical or neo-classical theory nor in economic practice.

The thesis of the positive side effects of human actions which derives from the enlightenment is, as

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is well known, one of the basic pillars of economic liberalism. According to this thesis, economic activities that are motivated by the individual interest are guided by an invisible hand for the benefit of the individual taking the action as well as the general good. Basically, this doctrine has always been questionable. Today, it is being challenged in principle as a result of the environmental perils and social costs that result from economic activities. What is being questioned, is not the fact that economic activities have social side effects but only the thesis that these side effects are necessarily of a positive nature. This conviction strengthened the belief that it is possible to realize a societal optimum by means of a free interplay of forces in the course of decisions taking in the private sector of the economy. In the light of the increasing environmental crisis, this conception must today be replaced by the thesis that rational individual economic behavior may lead to negative effects for society.[1]

Environmental Endangerment as an Economic Problem

The environmental crisis not merely endangers equilibrium systems of the natural environment such as water and air but also the social conditions of life. It appears important that we do not limit the concept of the environment which is vague in itself, purely to air and water but define it in such a way that it includes the total conditions of human existence. In this comprehensive sense, environment has a physical as well as social component. In a broader sense of the word, we are dealing with "public goods" and values which can most certainly be in short supply or become that way; their preservation or production can be associated with considerable costs which, however, remain outside the market.

For these reasons, such elements of the environment are endangered by the market economy right from the beginning. The free market treats them as free goods without value. Producers and consumers can damage these natural elements of the environment without hindrance and destroy them without penalty, by discharging waste products of all sorts (liquid

[1]For further discussion, see Chapter 4.

wastes, gases, smoke, organic and inorganic pollutants up to most dangerous poisons) into the air or waters, without consideration of consequences for third persons or society. These natural elements were not in short supply in earlier times, because environmental quality limits have not yet been reached. In this way, economic decisions and actions, in the presence of a rising population and the development of modern technology, produce social consequences which are diametrically opposed to the doctrine of unintended positive side effects. Anyone who nevertheless relies on the invisible hand soon discovers that market decisions can lead to most destructive effects. After these introductory remarks, let us consider some causal and analytic propositions that are often neglected in economic discussions even though they are of significant importance in the formulation of effective measures in environmental policy.

In market systems we are dealing with the consequences of economic actions according to the principle of maximization of net benefits. Public institutions and collectively planned economies likewise contribute to the destruction of the environment if their economic activities are guided by corresponding principles. In addition, the economist has to be concerned with global connections that exist within and between different systems if the analysis is not to be limited to a partial and therefore incorrect way of looking at the problem.

Before we follow these thoughts further, it is important to note several specific economic tendencies of cause and effect. It is known that if an enterprise wishes to survive commercially, it has no choice other than expanding production and in order to remain competitive to bring it to the latest stage in technology. Because of technical progress the enterprise is forced into ever greater new investments. Therefore, the full use of productive capacity achieves ever increasing significance in order to keep costs down. As Galbraith has shown, the significant oligopolistic market structures of today require planning of markets along with their particular planning of production. The imperatives of technology and cost reduction lead to imperatives in the planning of markets in a microeconomic framework on the one hand and total demand on the other. This has not only led to planning of

consumption through advertising of all kinds but also to a one-sided development of technology through suitably directed expenditures for research, which is concerned not only with cost reduction but the development of new products that make the existing ones obsolete. Such obsolescence of existing durable goods is often fostered consciously, whether through a planned reduction in their useful life, or through technically useless changes in design details, that make the existing products seem out of date to the consumer. The objective of maximum utilization of production capacity requires the promotion of sales and mass consumption of new products even when the existing ones are technically still able to fulfill the purposes intended for them.

It appears to be no coincidence that in this way a consumption society has developed which one could in fact rather call a waste society. The waste products that are created at the production stage as well as during consumption are therefore much more voluminous than necessary. Traditional methods of measurement of total production that do not take account of the accruing environmental destruction reinforce the deceptive impression that every expansion of production is to be regarded as real growth and material progress.

Under the influence of Keynes and the creation of credit that rest on global monetary price and inflation theories, planning of total demand for purposes of stabilizing economic cycles has created conditions for a public economic policy that is not directed towards the protection, let alone improvement of environmental quality. On the contrary, even here the necessity for investments, including public ones is directly linked to an expansion of production at any price, in order thus to create the market potentials that increasing production capacity and productivity demand; these could not be realized if increased rates of saving accompanied increasing income. The total demand, which has thus been increased by inflationary means leads by way of the market through private market planning to an increase in market demand or to the financing of public projects. At least so far (i.e. in the last three centuries) these have not been directed towards the satisfaction of basic human needs, including environmental protection, but rather to the

the development of new technologies, for instance space travel and weapons technology of all kinds. It is this forced application of research and technology that has led to a relative stabilization of economic cycles. These objectives and the principle of individual cost minimization, accompanied by far-reaching neglect of social costs, have brought forth the present environmental crisis. In this connection, it should be mentioned that public bodies, socialist economic systems, and underdeveloped countries are likewise faced with problems of environmental endangerment. It is, however, important that the orientation of production towards growth of gross national product has led to the development of technical knowledge, production technology, and capital investments that is not oriented towards a reduction of environmental damage.

The above causal analysis leads us to formulate a thesis of disproportionately increasing environmental endangerment and of rising social costs provided that effective protective measures for the environment are not applied. This tendency towards disproportionately increasing environmental dangers is the result of a set of related factors: population increase, increase of production and with it the volume of waste products, development of technologies dangerous for the environment and of products without prior clarification of their harmful effects, increase in pollutants and poisons and their disposal in the atmosphere and waterways, concentration of production and population without a socially sensible choice of location by considering the pollution limits of capacity of self-regeneration of the environment. These factors must necessarily lead to progressively rising demands on and endangerment of the environment which must in turn lead to a progressive deterioration in the quality of human conditions of life or progressively rising expenditures for necessary measures of prevention and abatement. Before threshold values are reached, i.e., the limits of self-regeneration of waterways and the air, little or no expenditures are required for prevention or abatement. If the threshold limits are reached, however, further introductions of pollutants lead not to proportionate but disproportionately rising costs.[2]

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[2]See pages 60-62. See also minutes of the First

Environmental Endangerment as a Problem in Political Economy.

Let us now turn directly to several problems and concrete tasks in political economy which derive from environmental endangerment. It would certainly be wrong to expect too much from simple solutions. There are no simple solutions for multidimensional problems of appreciable complexity. Beyond that it seems unrealistic to bring about a complete elimination of environmental endangerment or even a return to the natural and social environmental conditions of preindustrial periods. Rather, it is essential to prevent the process of increasing environmental endangerment from escaping human control. That necessitates first of all to establish environmental conditions that conform to the basic needs of human existence.

For this purpose it seems necessary to look into why economic political objectives for the formulation of sensible environmental policy are still lacking today and why the traditional points of departure are hardly sufficient as long-term models of solutions. For example, I consider it questionable to regard environmental endangerments of the most diverse kind as so-called externalities, in order to make them the basis of economic and political considerations within the framework of welfare economics. In this way, there is danger of accepting a whole set of theoretical but not quantifiable ways of thinking and writing and to use them for the formulation of criteria for economic and political measures which might conform to the market but which cannot do justice to the problem. It would take us too far to consider in detail the suggestions that

Public Information Conference of the Interior Committee of the West German Bundestag (Hearing on "Water Resources," Part 1, No. 36, pp. 21-23.) R. England and Barry Bluestone take the view that there are only two ways of compensating for this tendency towards a disproportionate rise in environmental endangerment and social costs: a reduction in the volume of harmful substance per unit of production ora limit to physical growth. See "Ecology and Class Conflict" Rev. of Radical Political Economics, V. 3, No. 4, 1971, p. 40.

go back to Pigou, for raising taxes or fees on the volume of harmful discharges, in order to limit production with negative environmental effects or from subsidies for investments with positive "externality effects" (for example, to encourage the introduction of filters and purification plants). Apart from the question of the level of taxation or subsidies, which are hardly solvable in theory and are in effect open, there arise two further problems that call for our attention. The first concerns the distributive effects of such measures, of taxes as well as subsidies. A tax, for example, on harmful emissions which is passed through to the consumers as a result of a rise in the prices of consumer goods is socially undesirable because it falls mainly on lower income levels which are already most affected by physical and social impairment of the environment. A similar case is that of subsidies for the installation of salters and purification plants. In that case, the enterprise which was the cause of pollution gets support from general tax funds in order to prevent or reduce environmental damage.

There are further reservations concerning the attempts, supported by welfare economics, for a monetary valuation of costs and revenues of measures of environmental protection and their related suggestions for optimizations or trade-off and cost-benefit calculations. How, for instance, should we look upon attempts to determine the value of human life or health by means of calculations of lost income? Can we measure the value of the advantages of improved park and recreation facilities by the expenditures for overnight stays, fishing gear or motorboats? Does it makes sense to measure the recreational value of a marina and the recreation hours spent in it by the hypothetical hourly earnings of its users, whereby a marina for top management would have a very much better benefit-cost ratio than one of equal size for middle-level employees or a kindergarten or park program for poorer population groups in a large city?[3] These examples show very clearly the questionable nature of monetary valuation of human needs that lie outside the market sector and cannot therefore be put in terms of market values.

[3]Dieter Weiss, Infrastrukturplanung (Infrastructure Planning), Berlin, 1971, p. 49.

For the market sector, i.e., the private entrepreneur, the objective of his actions is clear. His objective is the maximization of net profit. This net profit can be quantified precisely because it is in monetary units. In an environmental policy which is directed towards effective environmental protection, however, objectives are neither homogenous nor simply structured. They are open for discussion; they must be formulated and require a social evaluation outside of the market.

I am therefore not convinced that the habits of thought and concepts of traditional welfare economics offer a suitable point of departure for a solution to the environmental crisis and a basis for the formulation of successful environmental policy. It is without doubt important to be clear about the costs of measures for environmental protection; it cannot, however, be assumed that the manifold dangers of the environmental crisis can be reduced by making decisions on environmental policy on the basis of a formal principle of rationality that has hitherto served as the foundation of the private economic sector.

When the market neglects the natural and social environment of humanity, i.e., when the market mechanism makes production and distribution decisions without consideration of environmental quality, as the result of a built-in prejudice, environmental values will continue to be sacrificed as long as it is not possible to make environmental values expressly subject to social and political valuation. It is therefore necessary to declare environmental protection and the improvement of the quality of the environment as public goals -- goals which derive from the necessity of satisfying the basic needs of human existence and which must therefore be socially evaluated. Such a valuation does not need justification in terms of market values. When objectives of environmental protection are being formulated, it is necessary to start with environmental concepts that are precisely defined and with a setting of priorities among these goals. Such a procedure would confront the national economy with entirely new tasks -- tasks that extend to the setting forth and investigation of precisely formulated goals and a process of distinguishing among social needs by orders of importance. With few exceptions such as,

for example, Menger[4], national economists have so far refused to undertake an evaluation of needs, mainly because it was thought that in this way the freedom of consumers, e.g., their alleged sovereignty is called into question. However, environmental endangerment that makes humanity a victim of processes over which it has no control as individuals or consumers, forces the national economy to take a position on the problem of the relative importance of needs, i.e. the quality of the environment. For this, new empirical and quantitative points of departure are necessary. The first step consists of the regular collection of data and information on the current level of environmental endangerment in the form of environmental indicators.

The next step would be the setting of tolerance limits, i.e. maximum acceptable concentrations of pollutants in air and water. This would already involve minimum needs in the light of available information and experience. We are dealing, therefore, with physical norms that already rest on a social valuation, i.e., they require political sanction by social decision makers. Such norms need be neither fixed forever nor the same for the entire world. They just have to be suitable for the available means and developments of productive resources. In the light of such tolerance limits, it would then be necessary to develop the goals of a long-term environmental policy, the components of which will only be outlined here without attempting an exhaustive presentation.

In the short run, it is necessary to prohibit immediately the use of the most dangerous pollutants that are not biodegradable. In the long run a new orientation is required in the first instance in the formulation of objectives of economic development which would have to work towards the improvement of the environmental situation in the light of the minimum requirements. The economic and political ways of doing this are direct controls over the input mix and above all, a new orientation

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[4]Carl Menger, Grundsätze der Volkswirtschaftslehre (Principles of Economics) 2d ed., Leipzig 1923, esp. Ch. 1.

of research on the development of technologies that put no stress or less of it on the environment and which systematically give reference to recycling or biodegradable waste materials.

A further set of measures would have to be directed towards the choice of location. Instead of the prevalent geographic concentration of production and its related environmental endangerment, it will be necessary in the future to direct the choice of locations towards a greater decentralization outside of the areas that are densely settled today and with consideration of the natural potential for self-regeneration of air and water.

Effective environmental planning is nothing less than the systematic investigation and evaluation before the introduction of new production processes of advantages and disadvantages for the entire economy, i.e., or the total environment. In this connection it will not be enough to limit one self to positive and negative effects that can be expressed in monetary terms; rather, the non-monetary and diverse consequences must also enter the calculations. For this reason alone, the goals of environmental planning and environmental policy are multidimensional. This does not by any means suggest that environmental goals and measures for their attainment must be removed from all economic calculations. However, it is quite clear that they cannot be subordinated either to the principle of market calculations and especially those of the private sector.

Environmental goals have a public character and require the direct social valuation of their long-term significance for society, longer than is the case in private and some public projects. Such an evaluation has to start with the requirements of human existence and this in turn requires that the basic needs of human life must be determined objectively and the various needs put in order of their importance. This does not in any event exclude a survey of voter sentiment. On the contrary; however, the survey has to be direct and should not go by way of the market, i.e. through effective demand which can be influenced by advertising.

The specific goal formulations of environmental policy and planning are also neither permanent nor

are they always set in advance. They can only be derived from exact knowledge of the situation and the interactions between the various ecological and institutional systems. The formulation of environmental objectives thus puts one under the necessity of identifying these interactions and the dangers that they present for the living conditions of humanity. The economist, and particulary the environmental economist, will not be able to avoid investigating these system interactions and will in this way have to transcend appreciably the traditional framework of the field, which thus far has largely limited itself to exchange relationships expressed in monetary terms.

This necessary interdisciplinary concern with the interdependence of various systems results not only in a general understanding of the relations between economy, humanity, and the environment but the possibility of research on what is necessary and thus the identification of present and future environmental needs and specific tasks. Neither the general formulation of objectives nor the criteria of an effective environmental policy are presented by the market; rather, they must be developed. The choice, as well as the objectives and means and the economic political-structure already presuppose an interdisciplinary system analysis as the basis of effective environmental planning. In this connection, there is the well known maxim that it is more important to decide on the "right" objectives and economic political structures, than to achieve the optimal solution of the allocation of resources. The choice of wrong resources only means that one has not found the optimal solution of the problem, whereas the choice of "wrong" objectives means that one has tackled the wrong problem.[5]

This, however, only means that the traditional separation of means and ends and the assumption that ends and means are given, or can be regarded as such in the planning process, can no longer be maintained. The formulation and choice of objectives and the determinations of methods for their realiza-

[5]E. S. Quade and W. I. Boucher (eds.), Systems Analysis and Policy Planning, New York, 1968, p. 39; see also Dieter Weiss, op. cit.

tion are only derived from the planning process itself. In this way, the traditional separation between planning and policy is also eliminated. In short, environmental planning is politics.[6]

This connection between environmental planning and politics is further reinforced by the following consideration: The environmental crisis and environmental planning again place in the forefront of discussion not individual but rather social needs that have to do with conditions of human life, such as health, pure water, clean air, reduction of noise, possibilities of recreation and aesthetically satisfying environmental conditions. These basic human needs, the satisfaction of which the market often neglects, place society under the necessity on the one hand for new tasks in information gathering and transmission and, on the other hand, the formation of political opinion. Their accomplishment involves complex problems in organization. The problems cannot be solved by a search for guilty parties nor by appeals to good will. One necessity is maximum publicity on the interactions and consequences of environmental impairment. These causal connections and consequences have to be firmly anchored in the consciousness of the mass of the population. To do this will require the incorporation of environmental problems in the entire system of education from elementary school to universities.

Not until regional groupings of citizens, unions in certain industry sectors, political parties and international organizations concern themselves with environmental endangerment and participate in the formation of political opinion and decisions will there be the preconditions for politics and planning that will be appropriate to the environmental crisis. I think that this process is already underway in various countries, although the present

[6]Cf. G. Myrdal, Asian Drama, New York, 1968, pp. 1884, 1902. For the broader structure of the problem see Brigitte Janik, "Probleme der Planung und Planungsrationalität in Entwicklungsländern," (Problems of Planning and its Rationality in Developing Countries), Zeitschrift des Forschungsinstituts der Friedrich-Ebert-Stiftung, Vierteljahresberichte, Hannover, 1972.

discussion is in part popularization or even a downgrading or a diversion from the real causes.[7] For economic thought, as well as for environmental planning, there will be new tasks which must find their expression in a new orientation of economic theory and revision of preexisting planning concepts, insofar as it proves possible to direct and approach environmental endangerment and protection according to the directions indicated above.

It might then turn out that, from the viewpoint of cognitive theory no less than economic policy, the environmental movement of today has within it the potential for a fundamental change in the market economy. In that it places once more in center stage the material and social endangerment of humanity and forces us to make basic human needs the point of departure of our formulations, it forces us into a political determination of our welfare criteria for the setting of objectives, and the priorities of economic planning and for the shaping of the future. In that way, the environmental crisis would contribute to a humanization of economic theory and reality -- a humanization which could at the same time be the precursor of a political economy in a more basic sense than envisaged by the classicists.

[7]Gerhard Kade, "Ökonomische und gesellschaftspolitische Aspekte des Umweltschutzes," (Economic and Socio-Political Aspects of Environmental Protection), Gewerkschaftliche Monatshefte, Heft 5, 1971, pp. 3-15.

CHAPTER 4

ENVIRONMENTAL DANGERS, NATIONAL ECONOMY AND FORESTRY[1]

You have chosen an economist and allowed him to discuss a subject which until recently was at most at the margin of traditional economics although today it is within it. Presumably, you expect insights of some relevance to forest and economics from a discussion of present problems of environmental endangerment from the perspective of economics. I hope that you will not consider it false benevolence on my part if I start with the conviction that in the course of its long history, forestry has made appreciable contributions to economic knowledge and has done so precisely with respect to environmental endangerment; today, forestry is engaged in expanding its joint efforts with economics.

Economics and Forestry

The relationships between forestry and economics have changed substantially in the course of time. In the nineteenth century, they were no longer as close as was still the case in the seventeenth and eighteenth centuries. Mercantilism and the so-called cameralists in the German-speaking countries concerned themselves with a broad spectrum of problems in political economy. Forests and their utilization, whether in public domains or private hands, were part of them. I need only remind you of some of the great names of mercantilism, like Colbert in France.

In Colbert's time, the price of wood which was used, inter alia, in ship building and for war purposes, had risen considerably and Colbert made efforts to fight the excessive exploitation of the available forest and wood reserves which was already making itself felt. His forest legislation, and especially his ordinance of 1669, are well known.

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[1]Keynote address at the Centennial of the Baden-Württembergische Forstliche Versuchs und Forschungsanstalt, University of Freiburg i. Br., June 6, 1971. Forstarchiv, V. 41 (8/9), 1971. Reprinted by permission. Translated by J. E. Ullmann

This legislation can certainly no longer be regarded as the last word in the area of forest economy, but at the time, it was something of a high point in the attempt to create a more rational forest economy; it was later reversed, especially during and after the French Revolution.[2] Among the German cameralists we also find a thoroughly positive evaluation of forests, even though mainly as sources of public income. The cameralists stress the economic side of public forest lands. Gottfried von Moser's Principles of Forest Economy (1757), a theoretical work, and Johann Beckmann's Principles of German Agriculture (1769) which treats forestry as applied natural science are of interest here.

The Physiocrats who were interested in agriculture and forestry in the comprehensive sense of land economy, not only developed a circulation scheme of the traditional economy (tableau economique), but also a forest economy based upon experience. Before his fall as finance minister before the French Revolution their supporter, Turgot, drafted a law which somewhat mechanically but evidently for good reasons proposed the reforestation of about 20% of privately owned land in France. In the course of further economic and industrial development, the problems of forest utilization as part of economics faded into the background.[3]

This development was perhaps inevitable or at least could be traced to the fact that in modern

[2]E. G. Huffel: Economie Forestière, Paris 1920, pp. 289-96.

[3]With interesting exceptions of which we here mention only the theoretician J. H. von Thunen and Friedrich List; both were outsiders. On an empirical basis, von Thunen worked out a model of location theory with simultaneous development and application of marginal analysis. In this way, he, at any rate, placed forests into the second circle of his model of concentric circles in the course of which he evidently began to imagine at least some of the social functions of forests which are today called social benefits. Friedrich List made an explicit distinction between the private economy and the national economy and developed a theory of productive resources in contrast to and as explicit critique of classic liberal economics.

society wood lost greatly in significance as raw material, building material and energy source, in favor of other physical products, especially coal, steel and cement. I need hardly stress here, however, that wood and paper and, therefore, forests and the forest economy still play a significant part even in industrial societies.[4]

At any rate, wood and forest economics lost the place in economic investigations which they still had in the eighteenth century. Classical economics and its successors did not direct their interest to the forest nor to other natural production factors that received considerable attention in the seventeenth and eighteenth centuries. In economic practice and theory, a forest, if recognized at all in theory, was at most a private source of capital and income, which could and evidently should be utilized, managed and exploited, according to the calculus of the private or market economy. Under the influence of these points of view and in the interest of those who wanted to use the land for other purposes than forestry, forests began to be regarded as a hindrance to economic development and this led to demands that national forests be liquidated or turned over to private property.

It is hardly an exaggeration to say that in almost no country the effects of the application of private economic calculations on forests had as disastrous consequences as in America where (with some exceptions) a continent was largely developed according to the principles of laissez-faire. For a long time, forests were largely regarded as obstacles to development, agricultural settlement and communications and treated accordingly. Forests were kept down with the same zeal, not to say with

[4]One should perhaps note in passing that wood still plays the central role of a source of raw materials in pre-industrial civilizations and in less developed countries that it had in Europe in earlier times. Anyone who has ever worked in the tropics or subtropical areas of Asia knows that whole civilizations and economic systems can be regarded even today as wood or bamboo civilizations, in a similar way as one could speak in earlier times of wood civilizations in the Mediterranean countries and in Europe.

the same lack of care, with which under King Fredric William I of Prussia, i.e, at the time of the cameralists, the forest on the Frische Nehrung was cut down: "as a result of which a desert was created for a distance of 100 km. The Frische Haff silted up, the waterway between Elbing, the sea, and Königsberg ceased to be navigable and, as a consequence, a whole village was buried."[5] As earlier on in the eastern provinces of Prussia with their low population densities, forests were cut down in America throughout the nineteenth and until the twentieth century, without consideration of the quality of forests, the character of the soil, and the predictable erosion effects and dangers of floods and silting up of rivers. Under the incentive of rising wheat prices during World War I, land was used which was unsuitable for agriculture because the forest or grass cover offered the only protection against wind erosion. The result was the dust bowl and the dramatic migration of the impoverished population to California during the great Depression of the 1920's and 1930's. The forest in America and its fur-bearing animal population belonged to those resources which were regarded as inexhaustible and, therefore, together with air and water, were considered prototypes of so-called free goods and as such became the first victims of the principles of the American system of business enterprise.

Veblen has eloquently described the results:

> "In those countries where this pursuit of private gain at the cost of the country's resources has been allowed freely to run its enthusiastic career, as, e.g., in America, the consequences have been a wasteful exhaustion of certain natural resources (e.g. the destruction of forests by the lumber interests) together with a hurried appropriation of the tillable land, followed up with a slovenly cultivation and impoverishment of the soil, resulting in low yields and high aggregate cost per unit of goods delivered; so also the speculative holding of natural resources out of present use with a view to a prospective unearned gain (as in American land speculation, rural and urban, and the monopolization of transportation franchises, waterpower, or mineral deposits); and, as will commonly, though it may be less patently, happen in the like case, the gravest mischief has been a pervasive deterioration of industrial enterprise into a collusive chicanery and a speculative traffic in unearned gains.[6]

Elsewhere, Veblen had said:

> "This American plan began at the beginning, and has continued. It is not peculiarly American, except in the sense that it has been worked out more consistently and more extensively here than elsewhere, and that it has been worked into the texture of American life and culture more faithfully. In the last analysis, the difference in this respect between the American and the other civilized nations will probably resolve itself into a difference of opportunity, and there is no wide difference at that. This American plan or policy is very simply a settled practice of converting all public wealth to private gain on a plan of legalized seizure.
>
> First among these natural resources to fall under the plan were the fur-bearing animals. The fur-trade, of course, was not a matter of the first magnitude, and it is now a scarce-remembered episode of pioneering enterprise; nor does it now count in any appreciable degree among the useful means of livelihood, in great part because business enterprise has run through that range of natural resources with exemplary thoroughness and expedition and has left the place of it bare."[7]

It is therefore no coincidence that American experts in forestry and agriculture were among the first who drew attention to the excessive exploitation of these economic sectors. They belonged to

[5] R. B. Hilf: Waldwerk und Waidwerk in Geschichte und Gegenwart (Forest and Heath in History and at Present), Potsdam, 1938, p. 200.

[6] From Veblen's "Outline of a Policy for the Control of the Economic Penetration of Backward Countries and of Foreign Investment." Reprinted (by J. Dorfman) in Political Science Quarterly, Vol. 47, 1932, p. 197.

[7] Thorstein Veblen, "Absentee Ownership and Business Enterprise in Recent Times." 1923, p. 168.

the founders and members of the so-called conservation movement which has played a certain political and scientific role in America since the beginning of the twentieth century. With respect to the national economy, it was primarily those social scientists who were among the institutional critics.[8]

In this way, i.e. in connection with the common concern for the scientific investigation of the causes and effects of excessive exploitation in agriculture and forestry and the need to overcome them, new relationships between forestry and a part of the economic sciences have been developed during the last decade. These were relationships which, as we have already mentioned, existed during the age of mercantilism and the cameralists and which during the liberal period of classical and neo-classical economics only existed at the margin and among critics of conventional economics. In an age of general environmental damage and the environmental crisis, they will without doubt be extended further which could be fruitful for both disciplines.

However, before I deal with this point in greater detail, I would like to indicate briefly the reasons that led to a parting of the ways between forestry and economics which are at the same time the cause for the systematic neglect of the environment on the part of economics in general.

The Environment and Economic Liberalism

Wood, and therefore forests and forest economics lost their interest within economics as problem and objective of research, as mercantilism and cameralism were replaced by the market system and in connection with the general industrialization on the basis of new sources of energy and raw materials. This is also true in the same way for other and in fact for all natural resources for which the market can offer an inadequate expression of value, if any. Natural resources inclusive of forests, were regarded as so-called free gifts of nature and treated as if they were inexhaustible and indestructible. This doctrine of free goods played a

[8] Ise, J., The United States Forest Policy, 1920. C van Hise and J. Havemeyer, Conservation of Our Natural Resources, 1930.

sizable part in classical and neo-classical economics which today is being very definitely called into question. As noted in Chapter III, negative effects for individuals and society, i.e. social costs, are neglected, a neglect which is being institutionalized and furthered by the market-oriented principle of cost minimization or profit maximization.

It is well known that the philosophical foundation of the imposing theoretical edifice of classical political economy is derived from the enlightenment, especially from the Scottish philosophy of the enlightenment. These foundations find their most portentous expression in the doctrine of unintentional positive side effects of human behavior -- unintentional but advantageous and optimal for individuals and society. Basically, all of economic liberalism rests on this theory of positive side effects of human behavior. In contrast to scholasticism and mercantilism, the concept became established that man, or at least economic man, brings about results by following his material interests which not only serve his own interests but at the same time those of society and especially of consumers. This is the well and widely known doctrine of Adam Smith of the "invisible hand"[9] which is well worth citing in its original form.

> "Every individual is continually exerting himself to find out the most advantageous employment for whatever capital he can command. It is his own advantage indeed, and not that of the society which he has in view. But the study of his own advantage naturally or rather necessarily leads him to prefer that employment which is most advantageous to society ...
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> Every individual necessary labours to render the annual revenue of the society as great as he can. He generally, indeed, neither intends to promote the public interest, nor knows how much he is promoting it ... by directing that industry

[9] Adam Smith, An Inquiry into the Nature and Causes of The Wealth of Nations (Ed. by W. Cannan), Dunwoody, GA, 1976 (1904 Ed.), Book IV, pp. 421, 423.

in such a manner as its produce may be of greatest value, he intends only his own gain, and he is in this, as in many other cases, led by an invisible hand to promote an end which was no part of his intention.

These well-known passages express the theory of positive social effects of economic behavior which has formed the philosophical and logical foundation and the methodological basis of classical economics until the present time. This form of economic thinking, and this conception of economic behavior, which Smith put forth entirely within the framework of Scottish moral philosophy and therefore in a qualified manner, has basically always been somewhat problematic. It has now become questionable in principle due to the phenomena of environmental damage and social costs. What is being questioned is not the fact that individual economic activities are associated with social side effects but that these side effects are necessarily and predominantly of a positive nature.

Hegel called the classical thesis of positive social effects of human behavior a "trick of reason." It owes its superficial persuasiveness to a series of circumstances. First, it served classical political economy as the justification for its premise that the economy is subject to automatic built-in systems of self-regulation. We would say today that it is a programmed system, i.e. with the imminent objective of reaching a social optimum. The classical economists, as well as their successors, occupied themselves with the formulation of laws of the developing market economy, and this economy required an explanation as well as a justification. In other words, the classicists endeavored to find proof of the superiority of the unfolding market economy to the feudal and mercantilist systems of price and production controls.

With the aid of the thesis of positive social side effects, it was in fact possible to show by means of a suitable delineation of research objectives in the economy and suitable assumptions and maxims with respect to "economic" behavior, that markets, prices, and profits, carry out certain functions of self-regulation. Problems of allocation, investment, production, in short, of the choice and application of constrained resources for

the reaching of objectives therefore needed no other controls; they solved themselves, as it were, quasi-automatically. The entrepreneurs acted as representatives of the consumers -- at least those consumers who had buying power, and therefore provided the market with effective demand -- and, therefore, under a system of mutual competition, managed to bring about what in the time of scholasticism and mercantilism had been more or less vainly attempted by means of price and production controls of the most varied kind. Entrepreneurs were inclined to maximize their net profits, i.e. to reduce their costs as much as possible and to use the price of their goods as indicators of demand and their value or the relative scarcity of resources as a basis for their calculations and their decisions. Therefore, they simultaneously served their own interests and the desires of their consumers, and, in this sense, society.

A second reason which made the thesis of the invisible hand persuasive rests on the fact that classicists rationalize the principle of the control of prices through demand and supply by extending it to all goods and services, including work, land and money. In other words, labor, land, and money were regarded as goods.

However, labor as well as land, including certain natural resources, and money are goods of a very special kind, and the same is true of their prices, i.e. the wages, rents, and interest. Here there was and still is today a whole set of basic questions with which we cannot deal in this connection. Let me say only that the principle of control of prices of goods through demand and supply only makes sense with what can be produced and offered for sale at will, that is, goods which one can acquire and which can then be sold for a certain price. This is only true to a limited extent of land and labor. Land cannot be produced at will or in the short run. With increased demand or scarcity, prices of land and rents can lead very quickly to monopoly prices or monopoly rents which can have most negative social effects. This of course was known to the classicists and it finds its expression in their theory of rent, albeit incompletely.

In the factor of labor, the workers and their performance cannot be separated from humanity. They

are linked to it and when wages fall below a certain level or when it only begins to fall, the worker usually reacts in a "market-conforming" way, as one would call it today. He loses his vitality and productivity, his morbidity and mortality increase which today is still the case in many of the less developed countries, or workers unite and resist and use the political and democratic apparatus for the defense of and increase in their standard of living. If this is then rejected as lacking market conformity, a supposedly neutral system of concepts is wrongly used for normative purposes, even though it has become evident that labor is finally no commodity, the quantity of which can be reduced or increased at will and in the short run, and which can be bought and offered for sale in the same way as other goods. For this reason, most of the social reformers of the nineteenth century have very properly started their critique of the market economy at this point.

There is a second circumstance which at one time made the thesis of positive social effects of economic action convincing but calls it into question today. It derives from the fact that there has always been things which one either cannot produce or which, if one could produce them, could not be acquired and offered for sale in a reasonable way. Among these are important elements of the environment, i.e., the external conditions and preconditions of human life.

Market Relationships and Environmental Relationships

We include in the present concept of the environment clean air, clean waterways, lakes, rivers, and oceans, as well as a number of raw materials that cannot be reproduced in the short term, like forests, and their social functions, as well as the aesthetic quality of the countryside or the urban scene. These are goods which the classicists simply treated as gifts of nature, as so-called free goods. These goods have no market value. One did not need to produce them. They stood outside the market system. Here, the market mechanism did not function, i.e. it already failed at the time of the classicists. London had environmental problems, especially air pollution, well before the industrial revolution. These free goods which at first were not in short supply and have no market value were

always endangered. One could inflict damage upon them without hindrance and destroy them in certain cases without penalty in that liquid wastes and other waste products could be dumped into rivers, lakes, or oceans without consideration of the consequences for third persons or society. In other words, there are negative effects that were not considered by the classical thesis of positive social effects of economic activity and are in fact directly opposed to it; nor are these insignificant or untypical side effects but rather typical manifestations of appreciable significance with increasing dangers. In this connection, not only the classical thesis of positive effects fails but at the same time the whole market system; in effect, the market system actually invites negative social effects of production and consumption on the environment.[10]

The thesis of positive social effects and the theoretical system of explanations of the market economy must fail to an increasing extent for two specific reasons: First, environmental damage increases in significance because for the last 200 years or so, first slowly and in the last 30 or 50 years ever faster and more radically, the relationship of humanity and environment has developed in

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[9]And with the failure of the market system, the classical system of explanations or conventional theory of the market economy also fails. It is, therefore, not surprising that today there are again efforts to save classical and neo-classical systems of explanation or to fit them to environmental problems. On the theoretical side, there are attempts at steady expansion of the concept of external effects which had been developed for completely different purposes and on the practical political side, the neo-Malthusian population theory as well as the statement that ultimately it is all "the fault" of modern technology. There is even the view that the consumer is responsible for the increasing environmental crisis because of his infinite desire to consume, as if the consumer, given modern methods of consumer persuasion, still had the central and decisive position with respect to the production system with which the thesis of consumer sovereignty had endowed him.

such a way that humanity itself has been able to create the environment in which it lives. While for millenia, humanity was more or less passively at the mercy of nature and regarded it as an overwhelming power. Today it is humanity today which influences the environment to an ever increasing extent. With the application of complex and dangerous technologies, in accordance with the principle of cost minimization, these influences take on ever more serious consequences.

Secondly, there is a fundamental difference between market relationships, i.e., relationships between the economic units of production and households and the relationships between production and environment and environment and humanity, which lie outside the market. Market relationships are processes of exchange which in their form and content usually represent a more or less voluntary contractual relationship; they are reciprocal relationships in which an evaluation of advantages and disadvantages still plays a certain part. In contrast to these reciprocal exchange relationships, the theoretical definition and explanation of which has stood from the very beginning in the center of scientific interest in economics, the relationships outside the market between production and environment on the one hand and environment and humanity on the other can in no way be compared to contractual market relationships. They are neither voluntary nor reciprocal. In general, there is no assessment at all of effects or advantages or disadvantages. What happens, happens, as it were, behind the backs of those who are adversely affected. The individual has no overview of the course of events; he cannot therefore get a clear picture. In the great majority of cases, he is helpless and the passive victim of a irrational process. Environmental relationships are not market relationships. They can, therefore, hardly be comprehended with the traditional conceptual apparatus of pure economic benefit and exchange theory.

One thing can be said, however: The emission of waste products and toxic substances by producers or in the course of consumption of products takes place according to the principle of direct cost saving. Negative effects on third persons or society are not as a rule considered, or they are accepted even when one knows about them. The avoidance of these costs,

e.g. through the development and substitution of new environmentally protective technologies presupposes investments that do not appear profitable, when regarded from the viewpoint of the private economy. Sometimes these evaluations are an empirical question which could only be answered case by case and only under consideration of long-term social advantages and disadvantages. These reasons also explain the general neglect of research in the area of developing environmentally protective technologies.

The difference between market relationships and those between production and environment and environment and society becomes especially clear if one considers that the emission of harmful waste products into the environment sets into motion physical chemical and biological processes that can easily become cumulative. The discharged substances react upon each other. They form chemical compounds with each other or other substances that they find in the air, in water, or in the soil. In this way, processes can be activated and concentrations of the most various kinds can be created which can be absorbed up to a certain point. However, if through further emissions certain thresholds are exceeded, they can easily lead to disproportional negative effects with catastrophic implications for the quality of the environment (water, air, flora, fauna) and thus for health and life of humanity.

Because of these differences between environmental and market relationships, I take the view that if one wishes to formulate objectives for environmental control and environmental protection, one must start with substantive goals in the form of environmental standards or minimal safety limits, that is, objectives that are precisely defined as to content. This presents a further contrast to the procedure in economic theory in which substantive definitions of objectives are not usually discussed, not even in the well-known principle of the maximizing of some "benefit."

The Social Functions of Forests

During the last decade a common concern for the scientific exploration of the causes and effects of excessive exploitation in agriculture and forestry and measures for counteracting it have once more begun to create closer and more productive relationships between the science of forestry and at least a

part of economics. These relationships had united our disciplines in previous centuries but were loosened during the classical and neo-classical period and only maintained by critics of conventional economic theory.

Forests, of course, were still being utilized in the private and public sector, and forest managers and scientists were still busy investigating problems and principles relating to the economic use of forests. To be sure, inevitably and, as often happens, after some delays, they were influenced by economic theories; rationalization and maximum net yields from the available forest resources were strongly espoused. If I read aright its history and literature on this subject, European forest science of the nineteenth century could not keep these influences away. However, at the same time it absorbed the basic impacts of chemistry, for instance, those of Thaer and Liebig, as well as botany. For the forest manager and scientist this cooperation with the natural sciences is in an event a matter of course, much more so than, for example, for the social scientist and economist. It was exactly the natural sciences relevant to forestry that made considerable progress during the nineteenth century and thus prevented the full subordination of forest science to the cost and profit calculations of the private economy.

In that forestry and forest science made the discoveries of chemistry, botany, and hydrology their own, they not only, to an increasing extent, became natural sciences themselves but managed relatively early to recognize forests as economic factors of a special kind. They found interactions between forests and societal interests of which neither mercantilists nor cameralists had any awareness nor could they have had. Forest experts and scientists who thus made the concepts of natural science their own were and, its seems to me, predestined to inform the public that forests are a renewable source of raw materials whose utilization implies long periods of maturation and whose yield can be increased through various and alternative technical methods that have to be discovered.

Many forest experts therefore recognized at a very early time that commercial cutting methods that often rested on relatively short-term calculations of costs and profits, led to appreciable

social losses and capital losses. These losses represent an unnecessary waste of social values and common substance which can in many cases take on a catastrophic character. An analysis of the situation has led to a number of research results of great interest for the discussion of the environmental crisis and environmental protection.[11]

It is evidently and increasingly clear to modern forest science that forests fulfill important social functions that go much beyond those of wood production which had been traditionally pursued in the private and public utilization of forests. At least in the theory of forest science, forests are recognized as economic factors and capital goods with definable multiple functions within society. In the acute phase of today's environmental crisis it is modern industrial society that cannot do without these functions without setting into motion in a number of areas cumulative and irreversible social impairments with which economically weaker parts of the population are then burdened.

Forests are therefore not only the economic basis of wood and paper production but provide at the same time significant contributions to the assurance and improvements of water resources, purification, and

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[11] M. Prodan: "Wirtschaftstheorie und Zielsetzung in der Forstwirtschaft" (Economic Theory and Goal Setting in the Forest Economy) Forstarchiv, V. 41, No. 23, 10, Dec, 1969, pp. 477-481;

_____, "Wirtschaftstheoretische Begründung der Waldwert Schätzung" (The Justification of Forest Valuation by Economic Theory) Der Forst- und Holzwirt," V. 24., No. 23, 10. Dec. 1969, pp. 477-481;

_____, "Zur Bewertung der Socialfunktionen des Waldes" (On the Valuation of Social Functions of Forests) Holzzentralblatt, 1969, No. 35, pp. 536-538, and No. 57, pp. 847-848;

H. Pabst: Zur Bewertung der Sozialfunktion des Waldes in Stadtnähe (On the Valuation of Social Functions of Forests Near Cities) Allgemeine Forst- und Jagdzeitung, V. 140, No. 7, 1969, pp. 158-163;

_____, "Die Walderholung als wirtschaftliches Problem: ("Forest Recreation as an Economic Problem," ibid., No. 5, 1969, pp. 111-120.

increase in groundwater levels, the protection of soil against erosion, the improvement of the atmosphere and climate, the reduction of noise, the maintenance of scenic values, and protection of plants and animals, and can even serve the atmosphere in cleansing itself of gaseous pollutants. Beyond that, forests can play an important and ever more urgent role as the recreational area for a population which spends the greater part of its work and life in the environmentally degraded industrial cities and in traffic chaos.

This enumeration of what forests can do for us shows clearly that they are an economic and space factor that quite evidently serves the maintenance of an ecologically safeguarded social and natural environment and are necessary for the creation of an optimal living space for humanity. This is so even though today, it may still be difficult to define this social and substantive optimum from case to case. The formulation of a theory of the national economy or of economic political decisions, thus implies the derivation of pragmatic sets of objectives that arise from the necessity of solving the problems, which furthermore can be evaluated and permit conclusions as to the social values of the forest.[12]

Such formulations of objectives already contain the elements and in fact the first steps to a practical solution of control measures, i.e. of methods for reaching the long- and short-term social goals, including the necessary legal reforms and legal bases for such measures . . . The multiple use of forests and the appropriate pragmatic goals form part of such specific objectives of economic, regional and location policy as the separation of air polluting industrial areas from especially sensitive areas like hospitals, residential and recreational areas, or protective forests and plantings as well as greenbelts in settled areas. Other measures of this sort are changes in the composition of

[12]M. Prodan, op. cit. (1970), p. 193 and Der Forest- und Holzwirt, pp. cit. 1969, p. 480; cf. also W. Mantel: Die "Bewertung der Wohlfahrtswirkungen," (The Valuation of Welfare Effects), A.F.Z., 1965, pp. 506-507.

forests in areas damaged by air pollution as well as reforestation for purposes of maintenance and formation of protective forests for atmospheric improvements and for the protection of water and groundwater resources. One part of this is the promotion and development of new technologies through research programs for air quality and environment protection in general as well as the systematic protection and provision of forest recreation areas. With respect to privately owned forests, one could visualize legal requirements for the owners in utilization of their forest resources according to regionally set norms, which would at the same time serve long-term forest management as well as regional land use planning. If necessary, suitable incentives like government subsidies could be provided and used to support prohibitions against cutting, damage to forests, and especially clear cutting, as well as requirements for reforestation.

It would lead us too far and would be unnecessary in this connection to try and complete this listing. The economist notices particularly that the setting of objectives and environmental tasks, as well as the appropriate legal measures, are derived and conceptualized from a diagnosis of problems. What we have is a formulation of measures for environmental protection for the entire economy which come out of expert knowledge of the problems and their effective solution. This is in contrast to the norms and views of market conforming measures or those "external to the system."

To those who at this point are inclined to use the current and popular cliche of technocratic solutions that supposedly will be our undoing, I would suggest a look at the work which has been done in forest science. One discovers in these writings about the theoretical economic basis of the valuation of forests and its social functions, including recreation, that this part of forest science not only concerns itself with highly current interdisciplinary investigations but can already offer a number of interesting attempts at valuation. The estimates of certain social functions of forests have yielded values up to double that of wood production and in some cases, as for example, in recreation, four times as much.

If it is possible to justify these calculations, it should not be difficult and in fact quite proper

to estimate the total value of forests by means of capitalized values of wood yield plus those of the social functions. This has already been done. Today, depending on assumptions and interest rates, the total value of the forests of the Federal Republic of Germany is estimated at DM 70 billion of which approximately DM 53 billion are just for the welfare and social functions of forests. One could counter these and similar calculations by asking whether such attempts at expressing these benefits monetarily are not an impermissible and arbitrary measure of basic human needs according to market criteria. This is apart from the fact that they are necessarily expressed in market prices distorted by imperfect markets, unequal distribution as well as social costs and environmental damage. At any rate, as attempts at quantification they are not uninteresting.[13]

I have tried to show that there were close relationships between forestry and economics at the time of the mercantilists and cameralists. Under the influence of excessive exploitation, and in the age of environmental crisis, as well as ever more urgent environmental protection, these relationships should become even closer and more productive than this has ever been the case in the past. These relationships should be consciously expanded, for the joint exploration of scientific and practical progress toward an improvement in the quality of the social and natural environment. Human health and survival are dependent upon it in increasing measure, and all of us, especially in science, are responsible for it, or should be.

[13] "Exact investigations in the area of wood production (i.e. direct market costs and profits) are in no way scientifically more correct (and I would add exact) than the often very complicated estimates of various effects and functions of the forest; they are only simpler," M. Prodan, Der Forst- und Holzwirt op. cit., 1969, No. 23, p. 480.

CHAPTER 5

'Recycling' in Contemporary China*

Summary. – The paper presents an overview of current recycling policies in contemporary China within the broader context of China's efforts to protect and improve her social and physical environment. Starting with an interpretation of China's traditional agriculture as a 'recycling' and energy-producing economy, different efforts to improve the use of organic waste materials in agriculture are shown to have had positive results which, however, could be further improved by modern methods of recycling developed in the USA and other industrialized countries. The recovery of materials and their re-use or, as it is called in the Chinese literature, 'turning the harmful into the beneficial' may be regarded as one of the guiding principles of China's anti-pollution policies not only in agriculture but also in industry where both labour intensive methods and modern equipment are in operation. Control of inputs and location are shown to play an additional role in China's environmental policies. The paper concludes with a presentation of the Chinese interpretation of the causes of environmental disruption in the light of Chinese sources available in translation.

1. INTRODUCTION

As compared with prerevolutionary conditions, contemporary China offers a number of striking contrasts. It is no longer a country of abject misery with periodic famines and epidemics, with recurrent natural catastrophes resulting either from drought or the flooding of its major river systems and without medical care in rural areas. Chinese policies seem to have been successful in protecting and even improving the natural and social environment and in maintaining a connection between economic development and the satisfaction of essential human needs. This is no small achievement, particularly if we compare China's performance with conditions in other less developed countries, including those which at the UN Conference on Human Environment (Stockholm, 1972) voiced their concern about suggestions that greater attention be paid to the disruption of their environment. Some countries were outspoken in their refusal to sacrifice rapid industrial growth to environmental protection, apparently in the belief that their natural environment was still able to absorb considerable amounts of pollutants. In fact, these countries insisted on giving priority to rapid industrialization without paying major if any attention to the ecological consequences and health hazards of development policies.

China seems to have chosen a different road. The Chinese leadership is aware of the fact that the development of productive forces in many industrial countries has gone hand in hand with the emergence of social costs and cumulatively destructive forces. For this reason, they seem to be determined not to repeat the 'mistakes' which the industrial countries have committed in the past and which would sooner or later call for costly clean-up operations of land, air and water resources. As a result, China offers the picture of a country which attempts to pursue simultaneously a policy of economic development and environmental protection and improvement.

I am not suggesting that China is an environmental paradise or that it has solved its environmental problems. Nor am I arguing that she has avoided all social costs of economic development. However, the Chinese leadership is not only conscious of the environmental hazards of expanding production indiscriminately but has

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taken positive steps to cope with the possibly harmful effects of economic growth; moreover, they seem to have developed specific strategies and, above all, succeeded in mobilizing grass-root participation on a scale which goes far beyond anything existing in other developing and developed countries. Of course, China is only at the beginning of its industrialization, and what the future holds is still uncertain. However, and this seems to me the crux of the matter, Communist China has taken positive steps to cope with the environmental disruption not only during the last three years but almost from the very beginning of its systematic efforts to plan its agricultural and industrial future. For this and other reasons, which cannot be discussed here in greater detail, I am prepared to argue that China's environmental prospects are better than those of most developing and even of industrialized countries some of which are just beginning to realize the short-sightedness of their past neglect of social costs and are forced today—partly by public opinion and partly out of economic necessity—to start, however reluctantly, costly 'clean-up' operations of their physical and social environment.[1]

II. TRADITIONAL AGRICULTURE AS A 'RECYCLING' AND AN ENERGY PRODUCING ECONOMY

Traditional agriculture in China has always been a 'recycling' economy in the wider sense of the term. Poverty has forced China's population to frugality out of necessity, and the 're-use' of waste and sewage materials is not an altogether new phenomenon. As a predominantly agricultural economy the country has always practised the principle of the 'comprehensive' re-use of materials and human waste which has made it possible to provide the necessary food for the oldest and greatest agglomeration of people within a unified and relatively stable civilization which history has ever known. The role of this systematic recovery of organic waste in China's agriculture has a long history; it was well known to Western observers during the nineteenth century as can be seen from the following quotation of Victor Hugo's *Les Misérables:* 'No Chinese peasant goes to the city without carrying back, at the ends of his bamboo, two buckets of what we call filth.' Human excrements were not free goods in China and apparently no prejudice, as in other countries, stands in the way of the systematic re-use of human excreta. Even today it is estimated that 'about 80% of all fertilizer used is organic—either animal or human wastes, mulches or green manure crops.[2] Figure 1 provides a highly simplified visual presentation of this process of re-utilizing organic waste materials.[3]

In view of the current critical energy problem in the West, I may point out that Chinese wet-rice agriculture is a highly efficient producer of energy—indeed, much more efficient per unit of (human) energy put into the system in the form of calories (of food consumed by the farmer) than our Western systems of *'farming with petroleum'*. In fact, one calorie (of food) yields about 40 cal. in rice which, incidentally, accounts for the relatively small amount of land needed by the average Chinese farmer living in fertile regions and practising wet-rice agriculture.[4] In contrast modern agriculture far from being an energy producing sector has become a major consumer of energy using today more petroleum than any other single industry. 'There have been estimates that Chinese wet-rice agriculture could produce 53.5 BTU (British Thermal Unit) of energy for each BTU of human energy expended in farming it. For each unit of energy the *Chinese* wet-rice farmer expends, *we* get about one-fifth in return. On the basis of these two ratios, Chinese wet-rice agriculture is far more efficient than our own system'[5]—that is if measured in terms of output per unit of energy instead of output per hour of farm labour or in terms of (market) value of output per dollar input.

1. For a fuller treatment of the thesis that China's environmental prospects are better than those of the industrial world and most developing countries, see the author's *Environmental Policies and Development Planning in Contemporary China and Other Essays* (Paris, La Haye: Mouton, 1974). I wish to add that this publication provides also a general background for the problems discussed in the present paper; the treatment of the general issues raised in Sections IV and VI follows closely the discussion of the earlier study.

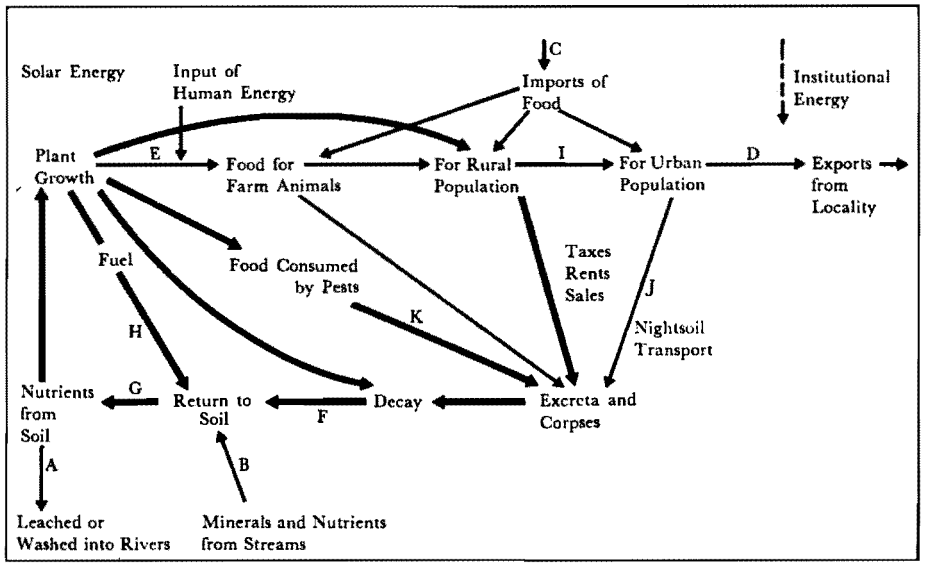
2. 'Energetic Chinese', *Ecologist,* Vol. 8, No. 3 (1973) p. 290.

3. From J. B. R. Whitney, 'Ecology and environment control', *Academy of Political Science,* Proceeding 31 (March 1973) p. 97.

4. In fact, according to official calculations (Wu Hsueh-yieu, Chinese Department of Agriculture) a family of four living on good bottom land can support themselves on ½ acre of cultivated land; cited by Robert Rodale, publisher of *Organic-Gardening and Farming and Environmental Action Bulletin,* quoted in 'Energetic Chinese', op. cit., p. 289.

5. Michael J. Perelman, 'Farming with petroleum', *Environment,* Vol. 14, No. 8 (1972) p. 12.

Figure 1. *The flow of plant nutrients in a traditional Chinese farming ecosystem (highly simplified)*



III. CHINA'S EFFORTS TO IMPROVE THE USE OF WASTE MATERIALS IN AGRICULTURE

Of course, Chinese policy makers are well aware of the fact that the use of untreated human excreta in agriculture has serious limitations. Human (and animal) excrements may lead to the contamination of surface and underground water and the spreading of serious parasitic diseases (e.g., shistosomiasis in tropical climates);[6] moreover, excreta are inadequate to meet the rising requirements for fertilizer in Chinese agriculture. Since 1958 China has shown a highly critical attitude toward the traditional use of human excrements as manure, and of sewage water for the irrigation of rice fields. Scientific research in the epidemiological departments in 18 major cities and municipalities has been carried out since the Scientific Planning Committee of the State Council ordered such studies to be undertaken in 1958.[7] The results of these studies indicated that *'under certain responsible conditions'* the self-purification of sewage water could be greatly increased and oxygen consumption, floating matter and bacterial content in sewage water could be greatly reduced after five days; the breeding of mosquito larvae was also reduced. It should be noted that this type of research which led to the drawing up of 'Health Regulations in the Utilization of Sewage Water for Irrigation'[8] goes back to the late fifties, i.e., to a time when other less developed countries were hardly concerned with the pollution of water and its purification for irrigation purposes.

Today, Peking possesses more than a dozen

6. According to doctors at Peking's Anti-Imperialist Hospital shistosomiasis is China's most serious health problem; this disease is taking the place of malaria as the most important parasitic disease in many countries with tropical climates. Salley Reston, 'Report from Red China', *The New York Times,* eds. (Avon, N.Y., 1972, p. 311) and 'Shistosomiasis and leishmaniasis', *Life Science Research Report,* Vol. 3, No. 2 (1971), Stanford Research Institute, Menlo Park, Calif., quoted by Frank P. Sebastian, 'Waste treatment in China: ancient traditions and high technology', *Ambio,* Vol. 1, No. 6 (1972) p. 210.

7. Wang Te-P'u, *et al.,* 'China's major scientific and technical achievements in community hygiene in the past decade', *People's Health,* Vol. 1, No. 10 (1959) JPRS 2745, p. 25.

8. ibid., p. 26.

sewage treatment and disposal plants in which high pressure pumps deliver waste water at a rate of 3 tons per second to a 6 metre deep sedimentation basin where dirt and residue carried in the water settle to the bottom. After sterilization the water is channelled to farmlands for irrigation. These processing plants are said to carry out constant analysis with a view to identifying poisonous matter exceeding specific safety limits. If such matter *is* found and the source identified, the plant is ordered to stop draining its waste water and/or to take appropriate preventive action. Waste water containing acid from the Peking Petro-Chemical Works undergoes a bio-chemical process which makes it possible to use it for irrigation and for raising fish and ducks.[9] The same source also states that Peking has 48 garbage disposal yards using a high fermentation (compostation) process which kills bacteria and makes it possible to use rubbish as fertilizer. Other cities (Changchu and Shanghai) initiated canal projects and a pipeline scheme of up to 30 km length using 90 per cent of the sewage water and pumping 300,000 tons of sewage daily to irrigate paddy fields and farmlands.

As far as shistosomiasis is concerned China has taken measures to eliminate the snail vectors and to sterilize human excrement by compostation before its being processed into pellets prior to its use as fertilizer. China has also organized systematic surveys of larval parasites in water and particularly with a view to preventing and treating shistosomiasis in man and cattle.[10] These preventive measures are part of China's systematic effort to improve water supply and community hygiene and the quality of the social and physical environment in rural areas.

I am not suggesting that the improvement of the ancient custom of 'recycling' human and animal wastes by the application of modern techniques will be adequate for meeting China's long-run requirements. Her increasing food requirements will call for considerable supplementation of organic waste products by chemical fertilizers both from internal sources and imports. China's estimated needs for chemical fertilizers (35 million tons in 1971) still far exceeds its domestic production (14 million tons in 1971).[11]

IV. 'TURNING THE HARMFUL INTO THE BENEFICIAL' AS A GUIDING PRINCIPLE OF CHINA'S ANTI-POLLUTION POLICIES

Chinese experts would have no difficulties in accepting the view that man can neither create nor destroy matter or energy, i.e., the first law of thermodynamics or the principle of the conservation of energy. Indeed, the Chinese come close to accepting what has come to be known as the material balance approach and the related view that man's economic activities neither produce nor consume matter energy. While most economists would admit that there is a qualitative difference between what goes into the economic process and what comes out of it, some unorthodox economists today 'would say that what goes into the economic process represents valuable resources and what is thrown out of it is valueless waste',[12] the Chinese seem to take the position that there is no valueless waste.

> In making one product, resources are partially transformed into this product and the rest becomes 'waste'. . . . From the metaphysical point of view, waste cannot be got rid of. On the contrary, the materialist dialectical view holds that what is waste and what is not waste are relative terms. There is nothing in the world that is absolute waste. 'Waste' under one condition may be valueless; under different ones waste material left from one product can become a good material for another product.[13]

This way of looking upon waste is one of the guiding principles for China's policy of the multipurpose use of resources; it supports and explains current campaigns in favour of recovering and re-using waste materials or, as it is called in the Chinese literature, 'Turning the harmful into the beneficial'.

9. John Sigurdson, 'Recycling that pays', *Läkartidningen*, Vol. 69, No. 23 (1972) pp. 2837 ff.

10. For a detailed description of some of the control techniques applied to snail control in combination with agricultural production see, Lois Wong Chi's review of *Fun Zhi Shistosomiasis Shou Chai* (Prevention and Control of Shistosomiasis, Handbook) compiled by the Revolutionary Committee of Shanghai, Shistosomiasis Research Institute, second edn. (Shanghai: People's Press, 1971) in *Science*, Vol. 179, pp. 1118–9.

11. Estimates by Chou En-Lai; see Frank P. Sebastian, 'Waste treatment in China: ancient traditions and high technology', *Ambio*, Vol. 1, No. 6 (1972) p. 212.

12. Nickolas Georgescu-Roegen, *The Entropy Law and the Economic Problem*, Dept. of Economics, University of Alabama, 1970, p. 3.

13. 'Multipurpose use: important policy for industrial production' (by the Writing Group of the Tientsin Revolutionary Committee), *Peking Review*, No. 6 (1971) p. 7.

Of course, this comprehensive use of materials may be interpreted as a carry-over of the old and persistent attitude of frugality borne out of the necessity of making the maximum use of scarce resources under conditions of poverty.[14] However, the present insistence on the recovery and re-use of waste materials goes far beyond anything China has undertaken in the past. In fact, the recovery and re-use of the 'three wastes' (i.e., waste liquid, waste gas and waste slag) is being advocated as a method of transforming waste into wealth and as an important means of diversifying and increasing output. More than this: The principle of the comprehensive use of waste is in fact regarded as a necessity of socialist development; while it serves, above all, the protection of the social and physical environment and thus of human health rather than the recovery of materials which have economic value, it is also a means of changing the traditional division of labour and the specialization of work. In short, it is simultaneously an anti-pollution measure, a method of increasing production, an approach to diversifying and re-locating industry and an improvement of urban and rural sanitation. It is multipurpose in this comprehensive sense.

V. RECYCLING IN INDUSTRY

As far as the recovery and re-use of waste materials in industry is concerned China uses both labour-intensive and highly modern capital-intensive techniques. Labour-intensive methods play an important role in connection with remedial measures after pollution has occurred, such as large-scale dredging operations and the cleaning up of polluted streams, rivers and lakes affected by the discharge of untreated industrial waste materials and the collection of human and animal waste not used for fertilizing fields. In some instances, substantial quantities of waste materials have been recovered and are being re-used such as oil, chemicals, slag waste, etc. Such waste materials are said to have yielded thousands of tons of fertilizer.

In little more than a year Shanghai has recovered gases and slag, several hundred tons of dye-stuff, 8,000 tons of oils and thousands of tons of chemicals. In addition, some 10,000 tons of metal were recovered. Waste slag made 200,000 tons of cement. Paper, electroplating and leather industry wastes yielded hundreds of thousands of tons of fertilizers and the processed waste water now irrigates 6,650 acres of farmlands.[15]

In recent years, China seems to have concentrated its major efforts on the *prevention* of water and air pollution. Much attention has been given to the construction of urban sewage systems and treatment facilities for the proper disposal of human waste in the more densely populated areas.[16]

With respect to air pollution the Chinese approach calls for the installation of recovery and purification facilities in big and middle-sized factories[17] and the elaboration, imposition and enforcement of rules on emission, the location of new and the relocation of old factories 'on the opposite side of the city from which the wind usually blows'.

As an illustration of the use of a *modern* recycling technology we may cite the case of the Peking Petro-Chemical Works which are reported to operate a waste water treatment plant (similar to advanced systems in Europe and the US) which is said to remove almost all contaminants except nitrogen from waste water.[18] Reports from Kirin (North-western China) also support the thesis that China employs modern technology in her recycling practices. Thus, a plant (in Kirin) processes waste oil and lubricants on a large-scale basis as an economic process after it has originally been established on an *ad hoc* basis to overcome industrial bottlenecks through the collection

14. As early as 1958 (i.e., during the 'Great Leap' period) and probably earlier, Mao called for a struggle against 'waste' at all levels. 'Every co-operative, every shop, every office, every school and every military unit must seriously conduct its own anti-wastefulness campaign and will continue to do so once every year.' Jerome Ch'en (ed.), *Mao Papers* (Oxford, 1970) p. 61.

15. Charles Snyder, 'Tomorrow's challenge', *Far Eastern Review*, (31 October 1970) p. 43.

16. Leo A. Orleans and Richard P. Suttmeier, 'The Mao ethic and environmental quality', *Science*, Vol. 170, p. 1174.

17. Wang Te-P'u *et al.*, op. cit., p. 21.

18. Sebastian, op. cit., p. 113. See also ibid., pp. 113–4 for further details of the use of modern recycling technology. This interest in utilizing modern technology in recycling is also confirmed by reports from Japan where the Nippon Steel Corporation received a request from China for technical guidance for equipment for the recovery of exhaust gases from converters enabling the recovery of carbon monoxide gas generated in the process of steel making and its re-use as fuel at steel mills. 'Peking requests NSC technology', *The Japan Economic Journal* (10 July 1973) p. 4.

and refining of waste oil. The Kirin Chemical Fertilizer Plant recovers a wide range of products among which are mercury, benzene, hexanol, hydrochloric acid, *et al.*, totaling some 25 different kinds of chemicals.[19] Slag from iron plants is being used as ingredient for making cement.[20] Iron plants are reported to design and build ovens in order to collect and make use of coal tar. Wheat and rice straw (formerly used for thatching of houses and huts) are being used as raw materials for paper mills.[21]

The recovery and re-use of materials may take place either in the factory in which the waste originates or in specialized industries or in separate small-scale plants or even in home industries. In this way the traditional division of labour and the lines of demarcation between industries are said to be changed.

> A factory is divided into several, one raw material is used in many ways, a piece of machinery is used for many purposes, one worker is capable of many kinds of work apart from his specialization, and a factory can produce many things while engaging mainly in [the production of] one product. All this gets better results from limited manpower, equipment and resources.[22]

From the numerous examples listed in the literature it appears that several patterns of recovering and re-using waste materials are in process of development: (1) A large plant operating its own small plant to process its waste material; (2) a large plant operating several small plants to process its waste materials (into raw material and consumer goods); (3) several large plants (e.g., in Shanghai) operating in co-operation one waste utilization plant using old, discarded, unused or rebuilt equipment turned over to them;[23] (4) neighbourhoods, cities and villages operating small-scale factories either processing scrap materials collected by retired workers, housewives and children or turning them over to other small and large-scale factories; and (5) plants specializing in acquiring waste products and making them available to specialized factories which turn them into useful products.

Of course, the available data on the recovery and re-use of materials are fragmentary and do not permit any definite conclusions as to the relative importance which the recovery of materials and recycling play in contemporary China. There are no over-all data on recycling for China as a whole just as it would be difficult to ascertain, at the present time, the relative importance of recycling in Switzerland or the United States. However, it is significant that the systematic re-use of materials has been accepted as a policy of environmental protection at a very early stage in China's planning for development and industrialization. In view of the emphasis placed upon the thesis that there is 'nothing in the world that is absolute waste' as well as the continuous campaign for the comprehensive use of materials I am inclined to conclude that recycling will remain one of the guiding principles of China's environmental policies. Viewed in this fashion, recycling may be regarded as part of a persistent search for alternative technologies[24] which are ecologically speaking less disruptive than those which have evolved under the influence of the entrepreneurial calculus in terms of market costs and returns.

Economists will inevitably raise the question of how far the recovery and re-use of materials can actually be carried. That is to say, how far is it 'economical' to transform waste materials into useful things; furthermore, are there not some harmful residual materials or indisposable wastes which cannot be recycled without negative effects for the environment or only at exhorbitant costs? All these questions are being raised in the Chinese literature. The Chinese viewpoint may be summarized by the axiom 'that there are no wastes but only things that are left unused; there is nothing that cannot be used'.[25] Difficulties of transforming waste into its opposite are conceded to exist but are seen to be due to the comparatively backward state of techniques and of scientific know-how, lack of research, failure to apply correct methods of thinking and inadequate methods of mobilizing the grass root knowledge of worker-artisans actively engaged in production, and the diffusion of such know-how throughout society. For the Chinese 'there is no limit to people's ability to know and transform the objective world. Thus, there is no limit to utilizing the "three wastes" ... there is no absolute waste which cannot be utilized. Continued scientific experiments have yielded important material from remaining wastes'.[26] Evidently, the Chinese experts have not yet taken into consideration that some industrial residues cannot be recycled (e.g., radioactive materials) and have therefore failed to raise the question of how to dispose of the indisposable.

VI. THE CHINESE INTERPRETATION OF THE CAUSES OF ENVIRONMENTAL DISRUPTION

It will hardly come as a surprise that the Chinese interpretation of the causes of environmental disruption puts considerable stress on the capitalist mode of production as the main cause of the environmental crisis. By 'capitalist mode of production' the Chinese understand not simply the existence of private ownership of the means of production but, above all, the resulting orientation of output and allocation, the choice of techniques and location of industries as well as distribution, all of which determine the relations between man and his social and natural environment in contemporary industrial economies. In short, it is this complex system of institutionalized economic and socio-political relationships and behaviour patterns which the Chinese marxist interpretation regards as the cause of environmental disruption.[27]

This interpretation considers it as axiomatic that man's environment is continuously being transformed through the 'industrious labour' of man and the development of science and technology. However, in contrast to certain Western proposals of slowing down or even arresting economic growth, the Chinese differentiate between conditions in developed and underdeveloped countries. Whereas some highly industrialized countries have seriously polluted their own environment and frequently affected that of other countries even on a worldwide scale, 'the urgent need for the developing countries at present is to develop their national economy, to build a modern industry and a modern agriculture and achieve complete economic independence and, ... to improve their environment step by step'.[28] This view found expression in China's 10 principles presented at the Stockholm Conference on the Declaration of the Human Environment:

> The history of man has proved that the pace of development of production, science and technology always surpasses the rate of population growth. In the course of social progress and with the development of production, science and technology, mankind can create an ever greater amount of wealth to meet the needs of its own subsistence and development and is entirely capable of improving its environment ever more effectively. It is wholly groundless to hold a pessimistic view in respect to the relationship between population growth and environment conversation. Of course, the natural growth of population will bring new problems to the protection of the environment. But such problems can be solved if a government truly takes the interests of its people to heart and adopts such correct principles and measures as rational planning for the distribution of urban and rural population in the course of the development of the national economy, appropriate control of the urban population, greater effort to protect and

19. Sebastian, op. cit., p. 215.

20. Sigurdson, op. cit., p. 2840.

21. ibid., pp. 2840–1.

22. Chi Wei, 'Turning the harmful into the beneficial', *Peking Review* (28 January 1972) p. 7.

23. 'Honan's Chung-chon city operates more than 200 small plants to make full use of its waste liquid, gas, and residue', *Chung-Kuo Hsin-wen* (9 November 1970), JPRS 52527 (3 March 1971).

24. There is considerable evidence to the effect that the systematic development of new ecologically less destructive technologies has an important place in China's environmental programme. Thus, while China's pesticides programmes have relied mainly on chemical methods, the use of biological methods of pest controls are in process of development and actually in operation. Cf. 'Combating insects harmful to rice', *Peking Review*, No. 3 (1971).

25. Hua Ching-yuan, 'In multipurpose utilization of materials, it is necessary to promote what is beneficial and eliminate what is harmful', *Red Flag* (1971), and reprinted in *People's Daily* (7 September 1971) p. B2 (Peking Domestic Service, 1971, translated).

26. Chi Wei, op. cit., p. 7.

27. 'Under the capitalist system, because the capitalists seek enormous profits and because of severe anarchism in production, large quantities of waste, liquid gas and slag are allowed to pollute the air and rivers, drain into farm land, affect the people's health, damage marine resources and harm agricultural production. In the United States, Japan, in many other capitalist countries, industrial wastes have become unsurmountable nuisances in society and unsolvable political problems for the ruling class, causing growing dissatisfaction and objection on the part of the working people.' Hua Ching-yuan, 'In multipurpose utilization of materials it is necessary to promote what is beneficial and eliminate what is harmful', *Red Flag*, and reprinted in *People's Daily* (7 September 1971) p. B1 (Peking Domestic Service, 6 September 1971, translated). At the Stockholm Conference this emphasis on the institutional causes as the main cause was further elaborated by pointing to 'monopoly capitalist groups which seek superprofits under serious anarchy in production' as the real culprits who 'discharge at will and in disregard of the fate of the people harmful substances that pollute and poison the environment'. *Peking Review* (27 June 1972).

28. Statement of China's Spokesman on the Draft Resolution at the Conference in Stockholm. *Peking Review* (27 June 1972).

improve city environment and popularization of family planning.[29]

It may come as a surprise to Western readers that the prevention of social costs may have played a role in the theoretical and political struggle between the 'two lines' advocated by the followers of Mao Tse-tung and those of Liu Shao-chi respectively. Apparently, one of the issues in this struggle centred around the method of economic planning and the formulation of environmental policies. However, this is too broad a subject to be dealt with in this context.[30]

According to the Chinese perspective the task of preventing the impairment of the environment, i.e., the elimination of the 'three wastes' (i.e., waste liquid, waste gas and waste slag) presents itself within the framework of the production plan in the form of the following specific questions: Which is the primary task: to fulfil the production plan or to reduce the dangers resulting from the 'three wastes'? Is the elimination of the three wastes a secondary task which can be neglected? Is the elimination of the three dangers (to people's health, to industrial production and to agriculture) to be considered as a separate problem of secondary importance? In short, what are benefits and costs? How are these to be determined? Apparently, some planners and managers considered it as their primary task to fulfil the production plan while the elimination of the three dangers of environmental pollution was regarded as an extra burden which could be neglected or even ignored. Apparently, some managers and industries allowed the dangers from the three wastes to become serious and were interested only in those preventive activities 'which require little labour, are easy and yield large profits. Any waste product that is of low value is considered unprofitable and not worth recovering'.[31]

This managerial way of calculating costs and benefits from the perspective of the individual production unit is now rejected as the road to continued and increasing environmental disruption and to rising social costs. Some of the 'three wastes' may be difficult to avoid but to consider them only within the context of the micro cost-benefit calculations of individual industrial units is said to be equivalent to ignoring the well-being of present generations and of neglecting that of future generations.[32]

The 'correct' approach to the problem of measuring costs and benefits must be worked out on the basis of practical experiences, scientific research and experimentation, as well as the mobilization and encouragement of the initiative of workers to turn waste and harmful materials into useful things. In effect, this approach rejects the belief that 'waste is waste' and cannot be turned into positive uses. What is called for is to follow Chairman Mao's dictum: 'In observing a problem, a Marxist usually looks at the whole situation instead of only a part of it.'[33] In short, the answer to the question of what are costs and benefits can be found only by discovering ways and means of improving the methods of recovering and re-using the 'wastes' and of limiting, as far as possible, the environmental degradation by taking into account the situation as a whole.

> In some cases, judging from appearances, the loss might be bigger than the profit to an individual factory. However, judged from the over-all situation, the profit [i.e., the over-all benefit to society] might be bigger than the loss .... If we are concerned only with petty profits and ignore the major issues, if we pay attention only to the present and not to the future, if we only take care of our own unit instead of considering the over-all situation, and if we exert efforts only in proportion to the amount of [individual] gains expected, we must have been poisoned by the Liu Shao-chi theory of putting profits in command. Instead of eliminating the dangers from the 'three wastes', we may even lead our enterprise into the path of capitalism.[34]

According to the Chinese point of view the problem of the three wastes and the elimination of the 'three harms' is not only technically but also economically solvable. But it cannot be solved on the basis of a system of monetary calculation in terms of market prices because losses and gains, costs and benefits thus calculated would necessarily be judged from the narrow point of view of the individual factory. The actual issues and the social dangers would

29. ibid.

30. For a recent and sceptical appraisal of the position of Liu Shao-chi, see K. S. Karol, *La deuxième révolution Chinoise* (Paris: Robert Laffont, 1973) pp. 128–36 and ff.

31. Hua Ching-yuan, op. cit., p. B3.

32. 'Socialist production must serve proletarian politics, and the function of all socialist enterprises must be geared to the entire revolutionary situation, to the requirements of people throughout the country and the welfare of future generations.' ibid., p. B2.

33. ibid., p. B4.

34. ibid., p. B4.

be neglected or underestimated. That is to say, for the Chinese planner both the prevention and the elimination of the 'three harms' caused by the 'three wastes' by means of a systematic recovery and re-utilization of waste materials is at the same time 'an important scientific and technical task' and 'a serious political assignment'.[35]

As far as priorities are concerned the Chinese seem to adopt a pragmatic approach according to which it is first necessary

> to grasp the projects which are most harmful and wasteful and to gradually solve the problems of the 'three wastes' in each specific trade and unit .... In developing industry, particularly in developing the agricultural chemical industry, the medium-sized and small cities and towns must attach importance to protecting farmland and water resources, so as not to affect the development of agriculture and fisheries. In places where this has already occurred, immediate action must be taken to solve this problem. To eliminate the 'three wastes', it is necessary, first of all, to keep a firm grip on capital construction .... Measures for eliminating the 'three wastes' must be included in all industrial projects under construction.[36]

Special emphasis must be placed on the need to absorb all available knowledge and successful experiences in the field as well as on the conduct of research.[37]

Despite the optimistic undertone of the literature on the subject the Chinese do not underestimate the difficulties of eliminating the 'three wastes' and 'three harms'.[38] Nor is there a failure to realize the need for an economical use of manpower and the assessment of costs *and* benefits. The Chinese literature actually warns against any extravagance in the use of manpower and calls for a comparison of inputs and outputs with a view to making 'maximum gains with minimum expenditures.[39] However, input and output, costs and benefits of the prevention and elimination of the 'three harms' are not evaluated in terms of monetary or market values but rather in socio-economic terms or social use values. Unfortunately, the concrete details of this assessment are not set forth and it is uncertain to which extent these important theoretical and practical problems have actually found a solution in China at the present time.

VII. CONCLUSION

Chinese experts are convinced that a solution of the environmental problem is possible. However, this conviction is not equivalent to a belief that industrialization, modern techniques, economic development and population growth will not change the natural and social environment of China. In any event, Chinese planners see no need to pursue a policy of 'zero growth', either with regard to material output or to population. In fact, China considers it necessary to pursue a policy of economic development and growth which includes the protection and improvement of her natural and social environment. Her development policies do not aim at maximizing output regardless of environmental or social costs. Chinese development planning is guided by other priorities than a concentration on rapid industrialization and specialization. Ecological criteria and communal needs seem to play a significant role in her planning and decision-making. In other words, her notion and her criteria of economic calculation differ from those which have guided the process of industrialization and economic development in other parts of the world.

35. ibid., p. B5.

36. ibid., p. B5.

37. ibid., p. B5. 'Leading personnel at all levels on the industrial front must maintain a firm grip on the task, strengthen their guidance, work out over-all plans, carry out investigation and study in depth, and map out effective measures.'

38. 'It must be conceded that we might frequently encounter problems in eliminating the "three wastes" because our lack of practical experience or scientific know-how prevents us from discovering the laws for dealing with the problems and arriving at the ideal solution.' ibid., p. B4.

39. ibid., p. B5.

CHAPTER 6

Socio-Economic Effects of Low and High Employment

ABSTRACT: Both low and high employment, as currently measured, have far-reaching serious consequences affecting the health and well-being of large masses of the population and seriously disrupting the environment. The criterion of public policies, including employment, must be the assurance of socio-economic reproduction for the maintenance of human life, health and survival, not maximum output and employment without regard for genuine individual and social needs. Social and environmental indicators and substantive norms, defined in terms of minimum requirements and social objectives, need to be made the guidelines of public action. In this sense, genuine full employment must be made a continuous objective and will remain a fundamental challenge to developed and underdeveloped countries.

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FOR an analysis of the socio-economic effects of low and high employment, an appropriate conceptual framework is needed which conventional economics can hardly provide. Neither gross national product (GNP) nor the concepts of external economies and diseconomies is adequate for such an analysis; they were never designed for this purpose. In contrast, the labor theory of value and the Marxian concept of the industrial reserve army offer important elements for such an analysis. Thus the concept of the industrial reserve army, which is an integral part of the Marxian theory of the process of accumulation, not only invalidated the thesis that production was able to create and maintain aggregate demand but, in addition, demonstrated that the supply of capital and labor were interdependent forces working upon each other.

> Capital works on both sides, at the same time. If its accumulation increases the demand for labor, it [also] increases the supply of labor by the "setting free" of [laborers]; . . . at the same time the presence of the unemployed compels those that are employed to furnish more labor, and therefore makes the supply of labor, to a certain extent, independent of the supply of laborers.[1]

Moreover, the industrial reserve army regulates the general movement of wages and hence that of profits; it keeps the wage rates of the employed down and holds their "pretensions" in check during periods of expansion and overproduction. "Relative surplus population is therefore the pivot upon which the law of demand and supply of labor works."[2] According to Marx, technological change channels capital and labor from one branch of production to another and, by setting free part of the employed, renders them superfluous, undermines their security and threatens "to snatch from [their] hands the means of subsistence."[3] Technical necessities cause fluctuations of work which impose an excessive mobility upon the laborer, thereby destroying his security, so that every economic progress turns into a social calamity.[4] Marx distinguished three forms of unemployment: regular-floating, constant-latent and irregular-stagnant, with the latter consisting of a self-perpetuating marginal group dwelling largely in the sphere of pauperism—"in short the *faux frais* of capitalist production."[5]

Although Marx' analysis showed clearly that periods of low and high employment tend to alternate and that technical revolutions jeopardize the security of the employed, neither the theory of capitalist accumulation nor the concept of the reserve army was concerned with and took account of the disruption of the biosphere, the emergence of negative effects resulting from sales promotion, affluence and inflation. Nor did Marx deal with the specific problems of today's underdeveloped countries, which face rates of population growth far exceeding their capacity to absorb the number of workers seeking employment.[6]

1. Karl Marx, *Capital*, vol. 1 (Chicago: Charles H. Kerr and Co., 1909), p. 702.
2. Marx, *Capital*, p. 701.
3. Marx, *Capital*, p. 533.
4. Marx, *Capital*, p. 533.
5. Marx, *Capital*, pp. 703–711.
6. An International Labor Office estimate places the aggregate number of presently unemployed in the underdeveloped world at 75 million. This is a minimum estimate based upon conventional definitions of unemployment. It conceals rather than reveals the actual state and rate of mass unemployment for specific groups of laborers, such as young and educated workers, landless rural versus urban workers, handicapped and minority groups, and the like. *See,* International Labor Office, *World Employment Program* (Geneva, 1969).
7. That the notion of a fixed cost of labor is inherent in the classical theory of labor value may be seen from Ricardo's definition of the "natural price" of labor, that is, "that price which is necessary to enable the laborers, one with another, to subsist and to perpetuate their race, without either increase or diminution" . . . and this "power to support himself, and the family which may be necessary to keep up the number of laborers, depend(s) . . . on the quantity of food, necessaries and conveniences become essential to him from habit . . . ." David Ricardo, *The Principles of Political Economy and Taxation* (London: J. M. Dent and Sons, 1917 and 1932), p. 52.
8. J. M. Clark, "Some Social Aspects of Overhead Costs," *American Economic Review* 13, no. 1 (March 1923), p. 55.

An appraisal of these broader socio-economic effects of low and high employment requires an elaboration of the labor theory of value and the adoption of a concept of human needs and social costs. This theory asserts not only a relationship between the relative amounts of socially necessary labor and the exchange relation between commodities; it maintains above all that labor has a fixed cost of (re)production which must be met if the conditions of social reproduction are to be assured.[7] These fixed costs of labor must be borne regardless of "whether the laborer works or not: that is, . . . if the maintenance is not forthcoming, the community suffers a loss through deterioration of its working power . . . ."[8] The maintenance costs of labor are, both for the individual laborer and for society, overhead costs in an even more fundamental sense than are the fixed charges on capital account. Neither the worker nor the community can escape these costs except at the price of undermining the conditions of economic and social reproduction.

How are we to deal, however, with the less tangible, nonmarket and nonmonetary effects of low and high employment? Neither the labor theory of value nor the concept of overhead costs of labor takes account of the psychic and psychosomatic consequences of periods of prolonged unemployment, of job insecurity and the enforced mobility of labor, of employment below the worker's capacity, or of overtime and overwork in times of high employment. While some of these effects are perhaps covered by the concept of alienation, conventional economics has no adequate criteria for the much-needed appraisal of the negative and positive intangible, but no less important, effects of low and high employment. Without such criteria, we are without guidance for any evaluation of these effects.

There is only one way in which we can hope to arrive at such criteria: by making use of a concept and a theory of human needs which must be placed in the center of theoretical and policy considerations. That is to say, an appraisal of desirable and undesirable consequences of low and high employment requires a basic commitment by the social sciences to a theory of human motivation based upon a concept of human needs. Only in the light of such a concept and theory of human needs will we be able to make headway in the appraisal of their satisfaction or nonsatisfaction.

Human needs must be understood as physiological and psychological requirements which have their origin in man's biological and socio-psychological make-up. While they are not fixed once and for all and differ from culture to culture, their nonsatisfaction gives rise to a mul-

tiplicity of psycho-social maladjustments and psychic diseases. What is called for is a theory of the structure of human needs based upon an empirical, and hence tested, body of knowledge which enables us to distinguish between different kinds of physical and psychological needs and human aspirations, as well as the pathological consequences of any threat of failure to satisfy these needs.

Such a theory of human needs has been elaborated during the past 50 years by psychologists, social psychologists and cultural anthropologists. The theory of personality and motivation referred to herein is that of A. H. Maslow, who developed a theory of the structure of basic human needs and human motivation and of psychopathology. Maslow offers important insights into the structural organization of different human needs and aspirations organized in a hierarchy of relative priority and latent prepotency; he also shows what happens to the individual in terms of human suffering and pathology when the satisfaction of these needs is threatened by deprivation, inhibitions, conflicts and frustrations.[9]

Socio-Economic Effects of Low Employment

While we are not concerned with the causes of low employment, we must deal briefly with the typical processes set in motion when employment is reduced either by outright dismissal or by reduction of hours. A social system in which the individual worker is not a slave but a free agent responsible for his own and his family's support translates the fixed cost of labor into variable costs. Wage contracts may be based upon individual or collective bargaining and be subject to specific provisions regarding unemployment benefits and old age insurance, the premiums for which will be covered out of workers' income and/or entrepreneurial returns.

But the fact remains that once the "fixed costs of labor have been converted into variable costs, the entrepreneur is able to disregard completely these fixed costs of labor."[10] This fact plays an important role in all entrepreneurial decisions, including those related to the choice of capital goods—labor saving and energy using machinery and the location of industries, for example. Indeed, a major portion of total investments may be used to increase efficiency through capital intensive and labor saving devices.

A persistent decline in sales will induce the entrepreneur to reduce output by dismissing workers in order to reduce his variable costs of labor. It will thus give rise to a wave of unemployment. "This procedure is not only the most convenient for the entrepreneur but, in view of the fixity of most capital outlays, is the only method of reducing costs of production" and of coping with the decline of profits.[11]

9. While Maslow is neither the first nor the only one who has aimed at formulating such a theory, he has succeeded in presenting his conclusions in a systematic manner. *See*, A. H. Maslow, *Motivation and Personality* (New York: Harper & Bros., 1954 and 1971).

10. Clark, "Some Social Aspects," p. 55.

11. Again it must be emphasized that this procedure is *not* unavoidable, or something that must be accepted as being within the nature of things. It is rather the result of the different manner in which labor and capital contracts are drawn up. Although there may be "substantial reason for drawing them in the customary way . . . it would be quite possible to make labor a constant cost by putting it on a salary basis, as the higher officials are now, and to make capital a variable cost by leasing it for a payment depending upon the use that is made of it." Clark, "Some Social Aspects," p. 56.

12. A guaranteed annual wage would do away with this peculiarity of business enterprise and make the position of workers more secure. By making the cost of labor a fixed charge for the individual firm, an annual wage would not only eliminate an important source of social costs, but it would at the same time create an incentive to use available resources more fully since the cost of labor would have to be paid anyway.

Under these conditions the burden of the overhead costs of labor falls upon the individual worker and his family. Entrepreneurial outlays are thus bound to fall short of the actual costs of unemployment which, except for temporary unemployment benefits, have to be borne by the worker in the form of a reduced level of living or by the community in the form of greater relief and welfare expenditures. Needless to say, this is not the result of any miscalculation by the entrepreneur but is inherent in the present wage system.[12]

Similar social costs of low employment arise if large corporations decide to transfer operations from one part of the country to another or to a foreign country. The impact of such decisions may be a major decrease in employment opportunities in particular regions or countries for which the possible increase of employment by such transfers elsewhere constitutes no compensation. In addition, low employment in particular regions will have the effect of increasing the reserve army and sooner or later will exert a depressive influence on the wage level of those employed. Of course, declines in wage rates may not become evident immediately; there may be lags and rigidities due to the fact that wages are fixed by long term collective agreements; they may be indexed according to standard of living costs which may, at least for a certain time, continue to rise by inflationary pressures generated in the preceding period of forced growth and expansion. The decline in wages of the employed may thus be delayed despite the increase of the reserve army.

The effects of low employment are reflected in a loss of labor income, both personal and family. In addition, a substantial percentage of the dismissed workers will see the range of their opportunities and choice curtailed or eliminated, with the result that they are pushed into a state of poverty. A further effect will be a reduction of public revenues (and expenditures for public services and common goods) due to the curtailment of production. Average and marginal costs of production may increase as production below capacity spreads throughout the economy. Safety and working conditions may not be maintained. The process of curtailing production will thus become cumulative. Younger and older workers, women, and members of minority groups including foreign and seasonal workers will be hit particularly hard and will see the chances of useful and rewarding employment reduced. Not only will workers from minority groups be squeezed out of job openings into which they had previously been able to advance, but opportunities to enter new fields may also be effectively closed to them with or without the support of unions. Foreign workers will be sent back to their respective home countries. Unemployment will thus be exported to these countries as well. Existing training and educational facilities set up during the preceding period of expanding production may turn out to be in excess of, or

ill-adjusted to, changed job requirements. There may even arise, as in present-day Europe, a call for a reduction of educational and training facilities on the ground that estimates of future demands for manpower are below the current or future estimated supply. In addition, periods of low employment deprive the economy and the country of needed goods and services which could have been produced.

What is equally if not more significant is the impact of low employment on the individual worker and his family. What does it mean to see one's employment suddenly terminated by the unilateral and impersonal decision of the employer? No matter how rational this decision may be in the light of private cost and return calculations, the dismissal remains a traumatic experience for the laborer affected—traumatic precisely because it is a demonstration of the humiliating fact that the individual has become useless in the productive process, is no longer needed and hence is not wanted.[13]

Unemployment is thus experienced as an attack on the individual's self-esteem, regardless of whether unemployment compensation is paid to secure partially and temporarily his and his family's sustenance. This applies to all workers, as well as to persons who are preparing themselves for useful and productive activity. They, too, will see their opportunities curtailed and their plans and hopes frustrated. Even part-time workers whose earnings are frequently essential for the maintenance of family budgets will feel these psychological effects.

The feeling of frustration and the response thereto differs from person to person. The termination of employment may be experienced as arbitrary and discriminatory and may constitute for the individual a denial and loss of purpose. Such feelings are bound to give rise to psychosomatic effects and diseases of various kinds which are not confined to the period of unemployment; they have a lasting impact on the worker's psychic health and his personality. In fact, they do not disappear even after re-employment and may have a long term negative effect reflected in various psychosomatic symptoms.

A medical study conducted in France in 1973 tested 367 qualified workers—78 percent of whom had been in a state of good health at the time of employment, with only 5 to 7 percent affected by nervous and cardiac troubles—who lost their jobs in 1964 as a result of a collective shutdown. They received unemployment benefits and found re-employment after a certain time. During the period immediately following the dismissal, 89 percent of the men and women developed symptoms of anxiety, depression and insomnia, and 78 percent developed oxygen deficiencies in tissues and loss of weight but no further serious trouble. During a second period, during which the workers had again found employment, more serious troubles were observed such as cardiovascular and respiratory disorders (21 percent) and nervous troubles (57 percent). Only one young unmarried worker was free of disorders. During a third period, some of the disorders increased: cardiovascular disorders increased to 31 percent, and digestive disorders, depressive anxieties and nervous troubles did not disappear despite re-employment. Among those who did not find employment again, there are cases of long term diseases, premature retirement, one suicide attempt and several deaths.[14]

In times of general and persistent low employment, particularly for groups who have no hope for re-employment, the psychosomatic consequences may take the form of a pervasive feeling of fear and general anxiety with all the psychocultural consequences which such a situation entails. In some people, especially the younger generation, these consequences may take the form of a feeling of *ennui*, despair or disgust, if not crime or drug addiction and other antisocial, irrational and self-destructive behavior patterns. The Great Depression of the 1930s may serve as an example of the dangerous effects of frustration and its psychosomatic impact, aggressive forms of which may be directed against outsiders and minority groups and can easily be channeled into acts of brutality and a general xenophobia (anti-communism and the "yellow peril" are examples).

Once this stage is reached, the doors are open to the "escape from freedom" and the acceptance of authoritarianism which, under whatever ideological pretexts, threatens the entire political fabric of society and ultimately world peace. The fact that persistent high levels of unemployment and underemployment prevail in underdeveloped countries can not serve as a refutation of this thesis—their internal social structures leave ample room for aggressive tendencies and violence, and their propensity to refrain from external aggression is only kept in check by their military weakness and dependence.

Socio-Economic Effects of High Employment

Market economies have long been subject to great instabilities, with periods of depression and unemployment giving way to expansion and high employment. The period of expansion with high though not genuine full employment may be set in motion by a variety of factors and events. Wicksel and Veblen were perhaps the first to describe this process of circular causation created by so-called forced savings and rising prices and issuing into a cumulative process of "inflation of all monetary values."

This inflation must be attributed to the manner in which production is financed: namely, by the creation of credit instruments and new liquidities by the banking system. Since the Great Depression and the adoption of the new economics of Keynes, banking and fiscal policies and, more recently, the systematic creation of international monetary liquidities through the international monetary system, have considerably increased the long term inflationary potential of the circular process of expansion. How far this expansion represents a process of wild growth and false production is a question which is attracting increasing attention due to the growing awareness of environmental disruption and the discussion of the limits of growth.

The socio-economic effects of high employment are not confined to detrimental effects on the environ-

13. It is perhaps significant that the termination of employment after prolonged activity in a given firm is experienced as a "depossession"—an expropriation of something to which one had developed a title. *See*, Paul Henry Chombart de Lauwe, "Le licenciment: des séquelles ignorées," *Le Monde* (Paris, 9–10 Sept. 1973).

14. P. H. Chombart de Lauwe, "Le licenciment."

ment; they are also reflected in wasteful and conspicuous output and rising prices. Inflation exacts a secondary toll from those who were already affected negatively by the expansion. They pay twice, in effect—once by bearing the social costs of the uncontrolled environmental disruption and again by being subjected to the negative (redistributive) effects of inflation.

The expansion of investment, production and employment is, of course, associated with higher incomes, both personal and family, and increased public revenues and expenditures. This is an improvement, provided GNP is accepted as a measure of economic performance. Indeed, this has been the premise of neoclassical welfare and growth economics: more output is preferable to less because it provides more income and more employment, which is better than less income and less employment. This superficially plausible premise has come increasingly under critical scrutiny in the light of the increasing deterioration of the physical and social environment.

Impairment of the work environment

The environmental crisis has demonstrated that increased production and consumption can, and under certain conditions will, have far-reaching negative socio-economic and ecological effects. Thus, economic expansion guided by the monetary calculus may give rise to a serious impairment of the physical and social environment, including working conditions.

High employment may affect the frequency and severity of accidents and occupational diseases as a result of the introduction of new and often toxic materials and new techniques, increasing work intensity, exposure to noise, overtime, overwork and fatigue.[15] In fact, the 10 most dangerous industries in the United States show increasing accident frequency rates per million hours worked; accidents increased 23 percent during the period of relatively high employment between 1958 and 1967, as did the number of workdays lost due to industrial accidents.[16] These work accidents do not include traffic accidents during travel to and from work. Health damages resulting from persistent exposure to noise and the relationship between noise, accidents and chronic diseases have been the subject of detailed investigations.[17]

The effects of working overtime during periods of high employment deserve special emphasis. Overtime yields extra pay and may be profitable and rational inasmuch as it permits fuller utilization of equipment and lowers average fixed costs. However, longer working hours may have deleterious effects, especially on the health of older workers. Because "those extra hours are murder," as one worker in a Detroit auto plant expressed it, unions have begun to insist on voluntary rather than mandatory overtime. This demand, which may but need not stand in the way of rational production schedules, has already become one of the issues of what is know as the "work content" detrimental to physical and psychic health. Other sources of impairment are automated work processes and speed-up in times of high employment.[18]

15. Council of Environmental Quality, *Toxic Substances* (Washington, D.C., 1971), p. iv. *See also*, Rachel Scott, *Muscle and Blood* (New York: Dutton, 1974); and Paul Brodeur, *Expendable Americans* (New York: Viking, 1974).

16. The data upon which these calculations are based are incomplete due to the manner of their collection; only 16 states submit their data to the Department of Labor. According to estimates of labor unions, the annual number of accidents is four million, and according to a private research organization which conducted a study for the Department of Labor, the number of workers affected by work accidents is even higher.

17. R. A. Baron, *The Tyranny of Noise* (New York: St. Martins Press, 1970), p. 85.

Environmental disruption and unequal distribution of social costs

Uncontrolled economic growth tends to give rise to increasing social costs in terms of environmental disruption, particularly if the rate of expansion is determined by decisions based upon calculations of entrepreneurial costs and returns.[19] Under these conditions the development and choice of technologies, the selection of inputs, and the scale and location of production are determined on the basis of a monetary calculus which permits omission of important and far-reaching environmental consequences and social losses. The resulting impairment may take various forms, including, in addition to air and water pollution, the spatial concentration of industries, traffic and populations in some areas while others remain underdeveloped, stagnant and depressed.[20]

The socio-economic effects of deterioration of the physical and social environment threaten all members of society, but they affect different income groups unequally. Just as the emerging industrial proletariat during the 19th century carried most of the burden of social costs in terms of low wages, long working hours, high rates of accidents and occupational diseases, and social insecurity, the contemporary environmental deterioration affects different population groups unequally. No only do higher and middle income groups have greater job security and better working conditions, but they are also able to evade the worst impact of pollution, noise and traffic chaos by moving to less polluted suburbs in the green belt areas and by spending vacations regularly in less affected areas. The poorer sections and ghetto populations have no means of avoiding unhealthy working and living conditions and are forced to live and work in polluted city centers with far fewer opportunities for recreation. The result is an unequal distribution of social costs in real terms.

The concentration of toxic substances such as carbon monoxide and sulphur oxides is 10 times higher in cities than in the country. In the city centers of the United States, which are more heavily populated by blacks and other minority groups, these toxic levels are much higher than in the suburbs. Similarly, the lead content in the blood of city dwellers in Cincinnati, Los Angeles and Philadelphia increased noticeably during 1962 to 1969, and

18. For evidence that conflicts over "work content" are becoming objects of labor disputes, *see*, Emma Rothshild, "GM in Trouble," *New York Review of Books* (New York: 23 March 1972), pp. 18–25.

19. K. William Kapp, *Environmental Policies and Development Planning in Contemporary China and Other Essays* (Paris and The Hague: Mouton, 1974), pp. 57–75.

20. The spatial concentration of industry and urban settlement assuming all the characteristics of a megalopolis is not confined to the United States. It has its counterpart in Japan with its Tokyo-Osaka axis versus the stagnant North, Kyushu and Shikotu; in Germany with its Ruhr area; it is emerging in developing countries like Brazil, with its Rio–Sao Paulo axis.

higher concentrations were found among inhabitants of the city centers than among suburbanites. It is estimated that there are more than 400,000 cases of abnormal lead content in the blood in the United States alone. Lead poisoning in children in New York City in 1970 was found in 2,649 cases by a survey based on a sample of 87,000 children.[21]

This unequal distribution of the effects of environmental disruption represents a secondary redistribution of real income, particularly but not exclusively in times of high employment.

Sales promotion and wasteful consumption

Production and supply have always shaped demand and consumption. In modern industrial societies, periods of high employment are marked by high pressure salesmanship. These activities can be traced back to the oligopolistic market structures; they are part of the managerial functions of large corporations operating with capital intensive technologies. Under these conditions, the risks of investment induce management not only to anticipate demand and sales volume, but also to influence and plan them by all available methods and techniques. The age of mass media has provided new outlets for sales promotion, making them increasingly effective. In periods of high output and employment, the material and financial means devoted to sales promotion are not only substantial, but also tend to increase as a proportion of total entrepreneurial outlays varying from industry to industry. In any event, sales promotion has become an effective instrument which channels consumers' choices and consumption in accordance with the requirements of large scale production.

In order to appraise the socio-economic effects of sales promotion, it is insufficient to point to the notorious waste of resources, including manpower. The real problem lies elsewhere: what is the effect of sales promotion on the volume of consumption and the consumer's behavior, life style and personality? In this connection, the *modus operandi* of what has come to be known as Veblen's demonstration effect of conspicuous consumption is of particular interest. Each layer of society tends to model its style of life and its outlays for consumption by a comparison with, and imitation of, the next so-called higher social layer. High pressure salesmanship using modern mass media is playing upon this pattern of social and individual behavior. In order to increase the volume of sales, high pressure salesmanship does not simply inform the consumer by appealing to his rational judgment, but plays upon his emotions and sensibilities in a continuous effort to transform the potential consumer into an effective and profitable customer. That is to say, sales promotion is designed to persuade the consumer, by all means known to applied psychology and psychiatry, to commit his present and future earnings to specific purchases of differentiated commodities; in short, it goes all out to motivate human action and human aspirations by setting in motion a conscious and subconscious process of envious comparison. For this purpose it will deal with and play upon preferences for immediate, present consumption; it encourages all, and particularly the lower income groups, to mortgage future incomes by going into debt with the inherent threat of insolvency despite high employment. By playing upon the propensity toward variety and the expansibility of human desires and by lending its support to the creation of artificial novelties in appearance, design, style, packaging, fashion and the virtues of ostentation, sales promotion constantly stimulates new wants and a continuous drive for new goods, no matter how damaging to human health, or how trivial and unessential. Indeed, by playing upon the human propensity for envious imitation and by stimulating the desire for constant variety and supposedly higher standards of living, sales publicity seems to have succeeded in replacing the old whip of the subsistence wage by a relentless drive for new commodities.[22]

Thus, sales promotion plays a key role in making the individual at all income levels the outer-directed personality and the compulsive consumer characteristic of modern industrial societies. More than any other single factor, it has brought about a continuous adaptation of human motivation, human behavior and the personality structure of the individual to his society. Such adaptation may be compared to the general process of enculturation which shapes the individual in the image of his society.

However, in contrast to other forms of enculturation, high pressure salesmanship is undertaken by people and groups who have a commercial interest in the outcome of their actions. They use techniques and devices of which the individual is not aware and against which he is unable to defend himself. The fact that these techniques and devices include the systematic creation of artificial images and illusions, plus the promotion of fears and anxieties of losing one's status and prestige by falling short of the norms and standards of the majority, must ultimately give rise to a heavy toll of human suffering, mental imbalance and pathology.[23]

Conclusions

Economic instability with alternating periods of high and low employment has not been brought under control despite all attempts at fiscal and monetary anti-cyclical policies. The relatively high levels of employment during the postwar period were probably the result of continuous high military expenditures and of deficit spending by all levels of government, industry and consumers. The resulting inflation of all monetary values was only one of the consequences of maintaining relatively high rates of economic growth measured in GNP. Other consequences were the cumulative social and environmental costs incurred over the years and, more recently, a new period of low employment with millions of workers losing their jobs while essential human and social needs remain unsatisfied.

Market economies have continued

21. The incidence of lung cancer is 37 percent higher in cities of more than one million inhabitants than in cities housing one-quarter to one million. *See*, Barry Commoner, *The Closing Circle* (New York: Alfred A. Knopf, 1971), p. 135. *See also*, Council on Environmental Quality, *2nd Report* (Washington, D.C., 1971), pp. 189–200; Paul C. Craig and Edward Berlin, "The Air of Poverty," *Environment* 13, no. 5 (June 1971), pp. 2–9; and Richard England and Barry Bluestone, "Ecology and Class Conflict," *Review of Radical Political Economics* 3, no. 4, pp. 31–55.

22. Daniel Bell, *Work and Its Discontent* (Boston: Beacon Press, 1956), p. 32.

23. We have dealt elsewhere with these psycho-pathological consequences of sales promotion. *See*, K. William Kapp, *Social Costs of Business Enterprise* (Bombay and London: Asia Publishing House, 1963), pp. 237–247.

to define their objectives and to gauge their performance in terms of questionable economic indicators which fail to take adequate, if any, account of social and environmental costs of productive processes. As long as these national income indicators, expressed in market values, continue to serve as a basis for the formulation of our goals, we shall continue to misuse our productive capacities and to develop technologies which threaten the quality of life, including the working and living conditions of millions of people and ultimately the process of socio-economic reproduction.

Is there a way out of this threat to human life, human health and human survival? Are there alternative ways of guiding the process of production and, if so, of what nature would the criteria of decision making have to be? An alternative model is at least conceivable, even though its feasibility depends upon far-reaching institutional changes. New criteria and guidelines of economic and technical development, which must be directly related to individual and social needs, seem to be essential. This means that goals, objectives and criteria of performance must be based upon a concept of human needs. The identification of such needs can not be left to arbitrary judgments and decision makers. Their formulation is not possible without a theory of individual and social needs, their dynamic structure, and the consequences of their neglect or nonsatisfaction.

Such a theory is in the process of being developed, and it is possible to identify some general principles: there exist basic individual and social needs which can not be sacrificed with impunity. While these needs can be identified factually, tested empirically and expressed in terms of social and environmental indicators, such indicators, as their name implies, do no more than indicate a state of affairs. They are not norms of action. However, they can be transformed into social norms with the aid of a fundamental value premise and the demonstration of the inevitable effects of continued neglect of such basic or minimum needs as useful and rewarding work, human health and socio-economic reproduction.

Stated simply, the fundamental value premise is as follows: the value of fundamental minimum requirements of individual and social reproduction must be accepted unless we are prepared to deny the value of our own lives and survival, or that of society. Once this premise is accepted, we are able to establish a link between social and environmental indicators and norms of action. Of course, there may remain a lack of consensus as to priorities, distribution of costs, and the extent to which we maintain and improve minimum requirements for all. But this is a problem of socio-political choice, preference and conflict which can and must find its solution within the framework of representative government, with a maximum of participation of all members of society. By formulating policies of output, technology, location and employment in accordance with individual and social minimum requirements and not in accordance with maximum output regardless of social costs, genuine full employment and the improvement of the quality of life can become a fundamental objective of economic policies. These goals are bound to remain a continuous challenge both for industrialized and underdeveloped countries.

CHAPTER 7

IMPLEMENTATION OF ENVIRONMENTAL POLICIES*

Preliminary Observations

The implementation of environmental policies in developing countries raises important issues of resource allocation, of social controls and of institutional requirements which will be discussed in this order. These issues must be explored in the light of the causal chain which gives rise to environmental disruption in general and the special conditions which aggravate its impact in today's less developed countries. Environmental disruption also raises important issues related to the objectives of economic development.

The causal chain which leads to the disruption of man's natural and social environment is not only a physical but also a social dynamic process. Hence, to concentrate only on ecological problems and the physical chain of causation or to view the problem in isolation from the institutional framework in which it takes place is bound to convey only an incomplete and therefore a false picture. Population increase, density of settlement, urbanization, modern technologies and techniques of production, climate, topography, soil conditions, stream flows etc. may all be regarded as factors which have an impact upon the social and physical environment and hence upon human well-being. However, superimposed upon these factors and their interaction is a system of institutional arrangements and a customary way of allocating resources, that is to say the determination of the input and output pattern and hence the pattern of distribution and consumption.

Again, it is important to emphasize that many elements of the environment like air, water or the esthetic beauty of a landscape or even certain underground resources which have traditionally been

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*United Nations Conference on the Human Environment. Panel of Experts on Development and Environment, Geneva, 4-12 June 1971. Working Paper No. 8 (revised). Reprinted by permission.

regarded as "free gifts of nature" are not only exhaustible or destructible, but cannot be freely reproduced. For these reasons, their deterioration or exhaustion will not be adequately accounted for in economic calculations carried out in market prices or monetary terms. Hence the process of decision-making takes account only part of the costs of production; it disregards almost all negative consequences which economic activities relating to production and distribution may have on man's natural and social environment. Today it is more or less generally agreed that market or price systems have a built-in, institutionalized tendency of disregarding those social costs and negative effects which occur outside the exchange relationships between different producers and between producers and consumers of final commodities. Even if an individual firm wanted to and would be in the financial position to avoid some negative environmental effects of its actions, it could apparently do so only by raising its costs; in other words, any economic unit which works within the market nexus and is tied to national (or international) competition will do everything to keep its costs at a minimum even if its action has a negative impact on the environment and hence on all members of society. While other great differences exist, in this respect there is little difference between highly developed countries and the economically less developed nations.

The process of environmental disruption is complex and cumulative... The quality of the particular environment or, for that matter, of society, must always be understood as a function of the combined effect of all sources of disruption which, in modern industrial societies, go far beyond air and water pollution and include excessive noise, urban congestion, long hours spent in travel to and from work in metropolitan areas under chaotic traffic conditions marked by long delays and high accident rates, the progressive absorption of free space and open landscapes, increasing specialization and monotony of work in some, and hectic performance requirements in other occupations. In less developed countries reduced vitality due to chronic poverty, deficient nutrition and poor health increase even more the actually felt effects of environmental disruption. To repeat, the experienced disutilities and damages caused by any particular type of environmental disruption are a function of the combined

effects of all sources of disruption. Hence, both environmental disruption and the quality of the environment must be understood as a totality.

Several factors need to be considered in determining the seriousness of the problem of environmental disruption in less developed countries. While these countries are at an early stage of economic development and while their real growth rates may still be relatively low, they enter the process of economic and social change under conditions which are in several respects less favorable than those which prevailed in today's advanced economies 200 years ago. Thus, their geographical location in tropical and subtropical regions of the world; the particular vulnerability and depletion of their soils; their high population growth rates; their inadequate infra-structure particularly with respect to sanitary conditions in rapidly growing urban agglomerations and large villages; the precarious health conditions of a chronically underemployed and under-nourished population; the relatively weaker political and social position of large parts of the population without adequate "countervailing" political power; the fact that the extended family system acts as a buffer and facilitates the support of the unemployed and the sick, the greater complexity and potential dangers of modern technologies as compared to those which were introduced 200 years ago - all these factors expose many developing countries to more serious environmental dangers than those existing during the Industrial Revolution.

In addition, there is the likelihood that polluting industries in the industrialized countries, meeting with increasing opposition and more stringent anti-pollution measures at home, may move their production facilities to less developed areas. Such migration of polluting industries which is actually under consideration may constitute an "exportation" of pollution to less developed countries and may give rise to a division of labor highly problematical for the latter in the long run - no matter how tempting the establishment of new industries may seem to be from a short-run perspective. The problem of environmental disruption needs to be seen in relation to the goal of economic development and its measurement. Traditionally this goal has been viewed in terms of rising "levels of development" expressed and measured by national income data such

as GNP, Net National Income or per capita income. These data as presently calculated do not take into account the impact of development upon the quality of the environment. As long as the less developed countries continue to measure their development in terms of such national income data, they do not take account of the full effects of their development policies on their social and physical environment.

Resources Allocation

As indicated above, the disruption of man's physical and social environment is the result of a complex process of interaction of many factors. In this process the institutionalized pattern of allocation plays a central role. More specifically, environmental disruption reflects a misallocation of resources resulting from an economic calculation that induces economic units to take inadequate or no account of harmful environmental effects of their investment (including location) and production decisions. Measures of social control and the implementation of environmental policies will have to aim at a different allocation of resources in accordance with a more comprehensive economic calculus taking into account the short and long run social costs and potential social benefits of alternative patterns of resource allocation.

Stated in different terms, costs do not express the actual total costs of production and as a result the revenues of the economic units are no adequate indicator of the actual or total costs. Such allocation and production decisions necessarily affect distribution; they give rise to revenues to some units at the expense of third persons (or society) who will have to bear the negative consequences of the disruption of the environment and/or the additional costs of its restoration. More than this, investment and production plans (including project designs, location, input patterns etc.) of different economic units are not compatible and may in fact interfere with one another. The monetary returns from investments are no accurate measure of the contribution made to development: in fact they tend to inflate the data traditionally used to measure the "level of development." In short, actual growth and development are lower than expressed in national income accounts. In this sense, environmental disruption resulting from the misallocation of

resources gives rise to a divergence of private costs and revenues from actual total costs and revenues (viewed from the point of view of society at the macro economic level).

Alternatively, environmental disruption may also be interpreted as a process in the course of which some economic units exert a dominant influence not only upon investment, production and distribution, but upon the whole direction of the development process. They determine the rate and direction of growth which may not be compatible with the preferences of third persons and indeed of society as a whole. In extreme cases, environmental disruption may slow down and indeed interfere with particular processes of development (as for instance when large-scale multi-purpose projects had to be abandoned due to faulty agricultural practices, or had to be redesigned at considerable additional public outlays). Furthermore, deforestation, erosion and a higher frequency of floods destroy property and other much needed implements of production; they reduce output and productivity and thus interfere with the development process. The financial expenditures and real resources required to remedy such damages place a heavy burden on public budgets and tie up scarce resources which are thus no longer available for other purposes.

Even in less extreme cases, the negative effects of environmental disruption on development cannot be ignored. The emergence and shifting of social costs of various kinds resulting from environmental disruption to the economically weaker parts of the population in less developed countries is neither insignificant nor without influence upon the development process. Such shifts are bound to perpetuate low levels of vitality and the unequal distribution of income. Hence, it would appear that the thesis according to which less developed countries cannot afford the controls required to combat or prevent the undesirable effects of environmental disruption and must nolens volens repeat the old "capitalistic trick" of ignoring or neglecting the environmental losses associated with production and growth, must be rejected as theoretically untenable and potentially self-defeating. The argument that the shifting of social costs would set the stage for a more dynamic and less costly process of economic growth is based on a problematical reasoning by an analogy

to the development process in the earlier stages of the Industrial Revolution (if indeed it had any validity then). It fails to consider the false identification of development with growth measured in terms of GNP; it ignores the different conditions that make today's less developed countries more prone to environmental disruption and overlooks completely the dangers likely to result from the migration of pollution producing industries to less developed countries. There is no prima facie proof that the neglect of social costs and environmental disruption in the economic calculation of economic units renders the process of development and modernization less costly and hence less difficult than it is anyhow.

It would instead be more correct to say that some of today's developing economies are less able than the developed countries to cope with the negative effects of environmental disruption. Thus, it has been argued, not without justification, that the market calculus and a policy of laissez-faire may well write the last chapter of the depletion of their soil and forest resources and drain important mineral and petroleum reserves before the end of the present century. While minimizing the costs of current production and concealing the long-term capital losses of scarce resources, this policy may raise output and yield foreign exchange in the short run but exhaust prematurely the resources base.

In other words, the less developed countries today face the same task which confronts the developed nations, including centrally planned economies: namely, to develop a more comprehensive economic calculus than that which has guided the allocation of resources and the development process in the past. It would be a mistake to believe that development planning and resource allocation can be approached effectively and economically by the same methods of minimization and maximization of fixed target or goal functions which have been the subject of theoretical discussions in recent years. Planning must be understood in a fundamentally different manner than has been the case hitherto. Allocation is not the relatively simple adaptation of given means to given ends. Neither the means nor the ends are "given." They must be explored and take into consideration the effects of production and development on the environment. To measure development in

terms of a single monetary indicator, as for example in terms of GNP, is a selection of one goal and hence an exclusion of other, for instance, environmental goals. Such a fixation of one's attention on one goal is always problematical. In the case of development planning, resource allocation and investment with its potentially negative environmental effects, it is nothing short of an "act of folly" as John Dewey once described any fixation of one's attention on one objective viewed as given and in isolation from a whole range or constellation of objectives.

For this reason, it would be essential that the less developed countries consider the process of development from the very outset as a "multi-purpose" undertaking including some definable concern for the quality of the physical and social environment as it affects individual and social well-being. Such concern could find its quantitative expression in environmental standards as one of the objectives of economic development. The elaboration and implementation of such standards must be made part of the planning process. Instead of defining economic development exclusively in terms of national income accounts, it will be necessary to include the quality of the environment in the appraisal and measurement of economic development. This will not be possible in terms of a single monetary denominator. In short, what is required is nothing less than the perception and definition of fundamental requirements of human life and survival as integral parts of the constellation of goals (objectives) of economic development and hence of economic planning and allocation. Economic policies and controls must serve these purposes as well.

More specifically, development planning must overcome its present uncertainty in its perception of the quality of the physical and socio-economic environment as a necessary requirement of considerable, and in some critical areas of almost overruling, urgency. That is to say, it must consider the quality of the environment or of particular aspects thereof like air or water as an end in itself, i.e. as a basic human and social need. To this effect it will be necessary to aim at an objectification of environmental requirements of human life and to make these requirements part of the constellation of the goals of the development plan.

Once this is agreed upon, at least in principle, it will become clear that economic planning and resource allocation are not identical with the allocation and decision-making process of an individual firm. For the goal of the latter is indeed clear and beyond discussion. Hence, its decision-making process is highly structured. It consists of the mobilization and choice of the physical or real means and hence the selection of the technique evaluated in terms of market costs in relation to expected returns without consideration of the impact of this choice on the quality of the environment. In contrast, economic development planning and allocation is (or ought to be) a process in which neither the goals nor the means (including the technologies) are predetermined. Their socio-economic and their environmental impact needs to be explored and appraised in the light of an inventory of the total situation. The planning act includes therefore first a kind of stock-taking as a point of departure and secondly the choice of the goals to be pursued as well as the choice of the means including the technologies to be applied. Unlike the theorist who in the interests of scientific objectivity assumes an artificial juxtaposition of given means and given ends, the planning and allocation process can be considered rational only if the planner faces openly and unequivocally the task of arriving at judgments and priorities in the light of objective criteria of human needs and requirements including the quality of the environment.

With respect to specific threats to the physical and social environment, development planning will have to start from an inventory of the present state of the environment with its actual and potential dangers for human health and well-being, to social productivity and indeed to human life and survival. The preparation and continuous correction of such an inventory in physical terms of the state of the environment, its "functioning" and its probable changes over time together with its negative effects on individuals and society will have to become a continuous preoccupation of the planner. In fact, such an inventory is the precondition and the basis for the definition and rational selection of environmental and developmental goals. It is a part of the process of decision-making in the course of which the relative importance of different goals are established and will have to be made transparent to

the general public and to the ultimate political decision-makers. In this process it is important neither to evade nor to conceal the fact that conflicting vested interests will be affected. Finally, the necessarily interdisciplinary research, diagnosis and prognosis must also aim at the determination of the appropriate techniques and technologies either available or in need of development in order to achieve the selected goals of environmental requirements.

It is no valid argument that our knowledge is always incomplete and that we are able to act and plan rationally only after all the relevant data have been assembled. This would be a counsel of perfection or despair and with regard to the prevention of the disruption of the environment it could lead only to a delaying of action. Besides many of the key pollutants and major sources of pollution have been known for decades or could have been known with proper research. The less developed countries can avoid many of the environmental failures of the industrialized economies if they applied the available knowledge in their development planning and allocation decisions.

Before proceeding with this analysis of allocation and planning decisions related to environmental goals it may be worthwhile to emphasize that the notion of planning suggested here is not an invitation to disregard costs. Nor does it support what is sometimes regarded as a technocratic approach. On the contrary, far from disregarding the costs of maintaining environmental standards and far from advocating the adoption of the first technique and input pattern that presents itself, we advocate the systematic exploration of alternative programs and alternative input patterns by which the desired goals can be achieved. This exploration must include a consideration of alternative costs, by means of cost effectiveness studies designed to ascertain the least costly method of attaining the stipulated goal. Such studies must indeed be regarded as an integral part of any development planning directed towards the maintenance of minimum environmental requirements both in developed and in less developed countries. Cost effectiveness studies would be necessary for deliberate and reasoned choices.

Coming back to the elaboration and definition of environmental minimum standards, it will be necessary first to establish environmental indicators. These are data or measurements providing the essential information on the nature and quality of the environment and its effects on the conditions of human life. Such indicators are designed to provide an account in physical terms of the state of the environment. Their purpose is to determine the particular environmental threats and to define the major pollution problems both actual and potential. While some of these problems may well be similar to those of highly developed countries, others may differ and be highly specific in less developed economies. Polluted sources of water and even scarcity of drinking water, problems of settlement, density and slums and the widespread absence of sanitary facilities, monsoon conditioned floods, malaria infestation, etc. are some of the specific manifestations of environmental disruption in less developed countries. To repeat, what is required is an identification of the key pollutants and the major sources of pollution by establishing indicators of the present state and the possible trends of environmental pollution together with their harmful effects.

These indicators would make it possible to determine by means of monitoring or observation systems, for instance the amount of specific contaminants in samples of water, air, soil or organisms with a view to providing the required information on the present state of the physical environment: if carried out systematically and periodically, monitoring would also provide the data in the light of which it is possible to trace the changes of a particular environmental system (e.g. of a river basin system, or of a system of relationship between climate, topography, settlement density and atmospheric pollution). Understood in this broad sense, environmental indicators are an important aid in determining environmental standards or norms. They are also an essential tool for the continuous evaluation of the effectiveness, of costs and the choice of alternative methods of social control.[1]

[1]Cf. "Man's Impact on the Global Environment," MIT 1970, Cambridge, 1970, pp. 167-222.

Environmental standards are both definitions and at the same time evaluations of critical zones of environmental disruption as for instance maximum acceptable levels of concentration of toxic materials in the atmosphere or water relating to specific regions. Such safety standards differ from environmental indicators inasmuch as they already represent an element of evaluation in the light of past experiences and currently available knowledge of essential environmental requirements from the point of view of human health and survival. They are thus substantive "welfare" criteria. Definitions of essential minimum requirements (with respect to sanitation, nutrition, public health and elementary education) are not seriously questioned, at least in principle, although their application may still be open to discussion. The environmental crisis calls for an extension of the principle of social minima to a problem area in which individual preferences and supply and demand cannot be relied upon.

The subject of environmental safety standards raises complex technical and methodological questions as to their reliability which need not be taken up in detail within the present context. Special difficulties arise, for example, from the cumulative character of the causal process which gives rise to environmental disruption and particularly from the fact that different pollutants and toxic substances act and interact upon one another. Even if each of these substances is emitted in "tolerable" quantities they may, in their interaction, become dangerous to, and incompatible with human health and survival. Moreover, different age and income groups in different localities may be affected to very different degrees.

Such environmental minimum standards must, of course, be kept open to modification; they need to be revised in the light of new experiences and new knowledge. Less developed countries may have to apply at first only the most essential minimum standards below which any further deterioration of the environment cannot be tolerated under any circumstances. With increasing prosperity, these standards could then be extended and revised upward with a view to improving the safety factor.

Since the establishment of environmental safety standards constitutes a fundamental break with the utilitarian principles that underlie past and current economic theorizing, it may be worthwhile to deal briefly with their justification. The utilitarian tradition rests on the conviction that the determination of what is morally good, and by extension what is useful or desirable (in the narrower economic sense), must be left to the individual himself who alone can and must decide what is "good," useful and to be preferred. Despite its eccentric formulation as a calculus of happiness in which the utilitarian principle became part of the political economy and economic theory, it was and remained a radical assertion in favor of individual rights and human freedom. Systematized into a pure theory of optimization by abstracting from disparities of income and wealth, and by disregarding the manipulation of consumers' preferences through sales promotion under conditions of oligopoly and by not taking account of the absence of information regarding the environmental consequences of human action, the utilitarian principle has itself become a dogma that serves vested interests rather than the individual whom it was once designed to protect. Under these circumstances and because of the nature and magnitude of the environmental threat the objectification of criteria of human well-being in the form of environmental standards seems to be called for as an approach to a more effective control of the quality of the environment in an effort to protect the individual and society.

While environmental standards are a step beyond the elaboration of environmental indicators they specify only what needs to be done but do not indicate the costs. In other words, their implementation is still a problem that calls for a solution. However, once environmental standards are accepted as a goal of planning and allocation, they provide the basis for working out alternative production and investment patterns together with the respective inputs and techniques to be employed.

We are not arguing that all less developed countries will be able to establish environmental indicators and work out environmental safety standards in the immediate future. The institutionalization of both environmental indicators and standards is a long-run desideratum; it calls for a scientific

infrastructure for which the financial and manpower resources need to be developed. For these reasons and since the protection of the environment cannot be postponed even in less developed countries, it will be necessary to establish pragmatic criteria of resource allocation which, though less systematic than those envisaged above, may nevertheless serve as a first step to induce (or compel) individual decision-makers and planners to minimize the negative effects of their allocation and investment decisions on the environment.

As a step in this direction it would be important, for example, to ascertain beforehand the physical interdependencies and cumulative processes which specific projects or the economic plan as a whole are likely to put in motion. Among the factors and questions which may have to be considered in all major allocation decisions are the following: the quantity and quality of available and required natural resources, the possible effects and probable date of their exhaustion; the availability or deliberate development of alternative technologies (including their relative costs); the suitability of alternative sites, ascertained in terms of their environmental effects for example on the density of population, the level of air and water pollution, and available opportunities for waste disposal. It may be also be necessary to ascertain whether and how and at what costs effluents and residual products (garbage) can be disposed of. Are they bio-degradable? Can they be reused or recycled? In agriculture (and forestry) which is going to remain a major section in many less developed countries for some time to come, it will be necessary to ascertain the effects of alternative investment and allocation patterns on the water-household and water management in particular drainage areas, on the rate of erosion, on soil fertility and the potential effects of required pesticides and chemical fertilizers.

The social costs of environmental disruption and the social benefits sought by environmental controls make it necessary to focus attention on larger aggregates or regions viewed as systems of physical and economic relationships. In the last analysis what is called for is the setting up of criteria of evaluation which are appropriate for the social costs and benefits at stake. That these are complex

and heterogeneous and often intangible makes the application of the traditional economic calculus in monetary terms difficult if not impossible. What is needed instead is a comprehensive system of social accounting in the light of explicitly stiipulated environmental objectives (e.g. minimum environmental standards) as part of the development plan. Environmental planning and development planning must thus go hand in hand and this will have to be reflected on techniques chosen, investment patterns adopted and project designs.

Such a comprehensive system of social accounting will have to operate with a much longer time horizon than the individual economic unit. By thus reducing the divergence between private costs and total costs (or private net revenues and social net benefits) the rate of economic development may be reduced in some countries. However, in the long run, it may actually be increased even if gross and net national product data, as presently calculated, did not reflect such an increase. This would be particularly true in all those cases where the additional costs of improved project designs drawn up in accordance with environmental safety standards would actually be compensated by correspondingly higher additional social returns or benefits.

Social Controls

The preceding discussion should have left no doubt that environmental disruption raises fundamental issues with respect to resource allocation and development planning. Pollution effects are not minor side-issues and cannot be easily corrected by isolated ad hoc measures of legislative control, chosen and preferred because they are more or less compatible with the market system. In fact, what has always been put in question by the phenomena of environmental disruption and social costs is the rationality of allocation and production patterns guided by market prices. What is called for are new criteria of allocation and new methods of decision-making and control.

Such new criteria will not be found as long as one assumes tacitly or explicitly that the market system offers the fundamental criteria for a solution of the problems raised by the environmental crisis. For this reason it is important to examine

the relative effectiveness of different methods of environmental policies and controls.

Social controls currently under discussion include a wide spectrum of alternative and complementary measures. At one end of this spectrum there are suggestions which leave the protection of the environment to private business supported only by the collection and dissemination of information on the state of environmental disruption or the establishment of inter-industry, advisory or consultant services. A similar, although slightly more specific suggestion relies on private business to develop pollution abatement equipment on a commercial basis. The other end of the spectrum would be the collectivization of investment and production under central, state or public auspices. Between these poles there are proposals for indirect controls of the quality of the environment by taxes, penalties or subsidies; and direct controls of factor inputs and output patterns and/or the systematic development of new technologies and techniques less detrimental to the environment.

This spectrum of social controls and anti-pollution measures will be examined in the present section. Problems of legislation and legal reforms will be considered under institutional requirements as will be the doctrine of "zero growth."

Suggestions for controlling pollution by providing polluters with more detailed information about the causes and negative effects resulting from environmental disruption and proposals to establish inter-industry or nationwide advisory services to business and consumers on how to reduce pollution are not likely to yield results as long as the costs of environmental control exceed the expected revenues. However, there may be differences from country to country depending on the willingness of industry to subordinate private interest to social needs and requirements.

Another approach to environmental control which relies on individual incentives for the avoidance of environmental disruption and social costs is the development of new anti-pollution equipment by private industry as a profitable business proposition. Some investigators in developed countries speak of a new industry engaged in research and production of

pollution abatement equipment. While such an industry may be interested in promoting the necessary abatement equipment and may in fact act as a kind of lobby favoring anti-pollution legislation, the chances of improving the quality of our environment in this way can be easily overestimated because the introduction of pollution abatement equipment is expensive and yields no additional private revenue (except perhaps in those cases where the new equipment lowers costs and the recovered pollutants have a marketable value or can be recycled). In addition, pollution abatement equipment relates primarily to some specific cases of air and water pollution and perhaps noise control. Problems of congestion in urban areas would not be affected quite apart from the fact that the considerations advanced in connection with certain effects of indirect controls, would apply to this form of control of the quality of the environment by ex post abatement.

Indirect controls have attracted the relatively greatest attention. They may take the form of subsidies (including accelerated write-off rates for the installation of waste treatment equipment) or of taxes or penalties for violations of regulations (e.g. charges on effluents) on those economic units which continue to pollute by emitting residual untreated waste materials into the environment. Such controls are measures which operate through existing price and cost relationships. That is to say they are appealing to private incentives or are enlisting disincentives as a means of changing the choice of inputs and the use of residual waste materials. They are advocated because they are making use of market principles in order to restore or maintain environmental quality. The explicit aim of these indirect controls is frequently the "internalization" of the unpaid social costs of production; they are often defended on the ground that polluters should pay for the costs of preventing pollution and/or of improving the current disruption of the environment. Taxes and panalties are also advanced as a possible method of providing the necessary funds for the elimination of environmental disruption. In the great majority of cases indirect controls constitute ex post remedial measures although they may in fact also exert an ex ante preventive influence. They are said to achieve their aim with a minimum of interference with decentralized

decision-making. While indirect controls may be distinguished from direct controls which constitute a quantitative "intervention" with the market process the two methods may also be used in a complementary manner as will be pointed out later.

Subsidies paid to polluters who introduce waste treatment or filter equipment are often advocated as an incentive to reduce pollution while the decision to do so is left to the individual firm. However, the effects of incentives can easily be overestimated. Polluters have always had an incentive to introduce abatement equipment insofar as the installation of such equipment would have been tax deductible. If they have not introduced it in the past this must have been due to the fact that the tax deduction was not sufficient as an incentive and that it was more profitable to operate without anti-pollution equipment. Hence subsidies would have to be much higher than the incentive provided by existing tax laws. Massive subsidies and hence public expenditures would be called for in order to make these indirect controls effective.

However, since subsidies call for additional taxes, they give rise to questions of equity and redistribution of income. In fact, they constitute a redistribution of income: Taxpayers (who may be affected by pollution) are called upon to pay the polluters to stop polluting. This procedure is sometimes advocated as a way of compensating the polluter for a loss of a legitimate interest; what this argument overlooks is the fact that the incidence of pollution represents an inequitable shifting of costs to third persons or to society which can hardly be considered as legitimate whether considered from the point of view of common law or the perspective of current price theory. Anti-pollution policies start from a prevailing state of price distortion and inequity of distribution, and subsidies may distort this inequitable distribution still further. In addition, subsidies have very different effects on different polluters depending on their market position; nor can we determine how high the subsidy must be in order to be effective and actually reach environmental standards.

Penalties and taxes (e.g. excise taxes on materials which are pollutants or effluent charges) may be more effective than subsidies. Their actual

effectiveness depends again on the tax and the market position of the polluter. While it is correct that a tax on the volume of discharge of pollutants (e.g. 10 cents per pound of untreated waste materials dumped into rivers), leaves the choice of control to the individual firm and may act as an incentive to reduce the volume of such discharges and to install abatement equipment, it must not be overlooked that such charges have very different and unpredictable effects on different firms. Firms operating in a more competitive market situation may be unable to shift the tax to consumers whereas oligopolistic firms occupying a more dominating position in markets may find it relatively easy to shift (or, alternatively, to absorb) the charge, particularly if such charges could be treated as a cost and hence be tax-deductible, and continue to pollute. Here too, we do not know how high the tax or penalty must be in order to be effective as a measure of control. In addition, general penalties for each discharge of pollutants are ex post measures after the pollution has taken place and thus may come too late; in addition, they may be entirely ineffective if they do not exceed substantially the private costs saved by the discharge of untreated waste materials.

To summarize: Indirect controls raise issues of equity and contribute to a "distortion" of the price structure. In addition, the exact rate of the tax and the amount of the subsidy cannot be determined and their effect is not certain. Moreover, as methods of control, subsidies tend to perpetuate an uneconomical bias inasmuch as they would promote the construction of abatement equipment for existing polluting techniques whereas more economical and effective methods of control such as the development of new technologies and alternative input factors would be neglected. For these reasons, indirect methods of controls operating through the price system and relying on incentives to change the behavior of the pollutor cannot be regarded as reliable and sufficient measures of counteracting the disruption of the environment. This applies also to countries in the initial stages of development, particularly if they permit foreign polluting industries to migrate to their shores in an effort to evade the more effective controls of their home countries.

In short, indirect methods of control fall short of what seems to be required in order to protect or improve the quality of the environment. Their effectiveness is problematical, their utilization can be justified at best only as a stopgap measure pending the development and enactment of more effective methods of control although they may become part of a comprehensive anti-pollution program. An effective system of environmental control will call for more fundamental measures than penalties, taxes and subsidies.

Direct controls aim at safeguarding the quality of the environment by stopping the pollution before it occurs, or by sharply reducing it. The most far-reaching of such direct controls are outright prohibition and statutory regulations or curtailment of production of toxic materials. Cases in point would be the prohibition of the production of leaded gasoline or the use of automobiles in the center of cities, and the closing down of factories in selected areas with high and unacceptable rates of pollution. Other direct controls are the statutory regulation of the use of particular inputs and the prohibition of the emission of specified pollutants (e.g. sulphur dioxide, mercury, cadmium, etc.) or, deliberate measures to channel the location of industries in order to limit the maximum density of industrial production in accordance with a general location, land use and zoning policy.

In view of the rapid deterioration of the environment also in some less developed countries, direct controls will have to play an increasing role as instruments of environmental planning. They are relatively more effective than indirect controls. However, even direct controls are neither the last word nor the key answer to the danger of environmental disruption. Their use must be coordinated with systematic research and the development of alternative technologies and new techniques. Nothing seems to be more urgent than the planned development of technologies and techniques designed to reduce or to eliminate environmental disruption. They are of particular relevance to less developed countries because these countries still have - within the constraints placed upon them by their poverty - the option of adopting techniques and of choosing capital inputs which are less disruptive of their environment than those currently used in

industrialized nations.

Thus, developing economies have drawn substantial benefits from DDT for the control of malaria and from other pesticides for the management of plant diseases and pests. The demand for such pesticides is likely to increase as the development of high yielding varieties will be extended to other varieties than corn, wheat and rice. While the increasing use of DDT and other chemicals of a non-degradable type has reduced the incidence of malaria and its consequences, (expressed in terms of lower morbidity and death rates from "fevers" and increased vitality and labor productivity) DDT (and other chemicals) are affecting both flora and fauna and are today recognized as health hazards to man. Instead of viewing this problem simply in its status dimension as an inevitable option between the continued use for example of DDT and its discontinuance (with increasing death rates from malaria and reduced productivity) there may be the alternative of developing new methods of controlling pests. This may be achieved, for instance, by biological agents or by breeding plants with greater resistance to attacks by pests and insects, or new methods of insect control through the sterilization of the male insect through radiation. This search for new technologies in order to replace harmful (capital) inputs, while offering perhaps no absolute safety, may well turn out to be the most economical and effective method of environmental control in the long run.

The control of the environment by developing new techniques is not confined to alternative technologies in agriculture and pest control. It is applicable, at least in principle, to all production processes that pollute our environment. In fact, in some countries the substitution of technologies is not only under discussion but underway. Experiences in Sweden and Japan seem to indicate that the use and emission of mercury by certain industries into lakes has been reduced or eliminated thanks to the systematic effort by government research (in cooperation with industry) to develop new techniques. Thus, in the case of Sweden, some firms (in the pulp industry) have reduced the use of mercury and as a consequence their dependence on water, which had previously determined their choice of location. Firms are reported to have moved their production

facilities closer to their raw materials thereby reducing their transport outlays.

Another possibility of reducing pollution is the re-use of residual waste materials which may also lead to a reduction of costs. We may note in passing that the development of new techniques under government or joint public-private auspices may be fruitfully combined with a policy of subsidies in order to hasten the conversion from polluting to non or less polluting techniques. Other illustrations, in addition to the systematic recycling of residual waste materials, are the replacement of presently non-degradable detergents, the development of new synthetic materials (plastics) which are subject to bio-degradation, photo degradation or oxydization. Another case in point would be the replacement of the gasoline motor by other and less polluting engines or sources of energy.

Technology substitution is often identified as a "technocratic" solution which in reality may only achieve a shift of pollution from the stage of production to another or from air to water pollution (or vice-versa). While it is correct that all production (and consumption) processes leave residual waste products it is not correct to assert that all productive processes and techniques must necessarily have polluting effects, or for that matter, the same polluting effects. Our present technology and the industrial techniques currently in use are the result of past research and an unqualified attitude toward "growth" which did not take into account the negative effects of these techniques and of their residual materials on the environment. Hitherto research and development budgets did not include expenditures for the development of non-polluting techniques and there is no a priori reason why the development and use of new techniques must necessarily be uneconomical, particularly if their effectiveness i.e. their total benefits and total costs are compared to the effects of current techniques of production which have given rise to the present pollution of the environment. Modern science and contemporary technological research have hardly begun to concentrate their attention on these matters.

However, it has to be stated clearly that the worthwhileness of such research cannot be decided upon on the basis of private cost and benefits.

Second, the development of new technologies has to be guided by a new orientation and has to consider priorities in harmony with the urgency of the pollution problem [See Chapter VIII]. Third, the necessary research work has to be interdisciplinary and has to take full account of the ecological, social and economic interdependencies (i.e. their systems character) which go beyond the scope of the specialist trained in his particular field. In any event it cannot be expected that this kind of research can or will be conducted in the less developed countries. In short, the development of such "cleaner" technologies, techniques and capital inputs belong to the most important tasks of foreign technical assistance and foreign aid in general. Indeed, the need for this type of foreign support is today equally as urgent as that which led to the development of high yielding varieties of crops.

The collectivization of investment and production under public auspices represents the other pole of the wide spectrum of measures of social control under review. It is sometimes believed that investment and production under public auspices offer a guarantee of the avoidance and elimination of environmental disruption. This thesis cannot be accepted without qualification. Even though public sector industries may not be set up to produce at a profit, they are operating under budgetary restraints and are forced to minimize their costs which they may do at the price of a negative impact on the environment. In addition municipalities and regional public authorities are known to use temporary tax reductions and other means to attract new industries in order to enlarge their tax or public revenue basis. They may thus "trade off" the quality of the environment for public revenues.

There seems to be a prima facie presumption that in socialist countries environmental disruption and social costs could be taken into account in allocation and investment decisions. Thus it could be argued that the socialization of the means of production and central planning leads to a more comprehensive assessment of the consequences of alternative production patterns and alternative techniques. Production facilities causing environmental damage can be stopped with relatively greater ease. Direct and indirect controls can be introduced and enforced. And yet, this presumption holds true only

with certain qualifications. Even in the socialist countries legislation may remain a dead letter particularly if production goals are pursued at any price or if competition with non-socialist countries becomes a primary preoccupation either for internal reasons or for considerations of defense and security.

Even more fundamental than these observations is another more general consideration: Socialist countries and centrally planned economies have found it necessary to increase the role of "profits" within the internal management of economic units in order to enlist additional material incentives for an improvement of the efficiency of management and in order to achieve a better coordination between production and distribution within the economic plan. Even if the principle of centralized planning and investment is maintained, these economic reforms in socialist economies may induce economic units to sacrifice environmental quality in an effort to reduce costs to attain their output targets and to maintain their (short run) financial solvency. In short, the prima facie presumption that socialist countries will not use polluting techniques holds only if, and as long as, cost minimization is not made the overruling criterion of public production. In other words, even socialist developing economies will find it necessary to develop effective methods of environmental control and non-polluting techniques and capital inputs.

Institutional Requirements

In view of the fact that less developed countries are particularly vulnerable to environmental disruption and considering the speed with which environmental conditions can deteriorate under the impact of uncontrolled economic development, particularly in areas of high population density, it will be important to set up new or strengthen existing institutions for the protection of the environment. In this effort methods of control and implementation of the industrialized countries could be transferred and adapted.

However, more will be needed than the setting up of new administrative environmental agencies. Even the enactment of new legislation and legal controls, important as they are, will not suffice to come to

terms with the dangers of environmental disruption set in motion by uncontrolled development. In fact, what needs to be "institutionalized" is also a general concern for and a new attitude towards the environment as a basis for environmental planning. Understood in this broad sense the term "institutional requirements" refers not only to administrative, legal and political arrangements but includes also the attitudes and valuations which influence and motivate human behavior and action.

In line with this broad interpretation of the term institutional requirements the less developed countries must develop a greater public awareness of the urgency of their environmental problems. They must recognize the fact that uncontrolled development is bound to have harmful effects on the quality of their environment and that these effects cannot be safely ignored in development planning. These negative effects must not be considered as inevitable side-effects of secondary importance as compared to an allegedly overruling primary objective of material progress measured in terms of GNP data. This calls for the inclusion in the planning agency of a staff of environmental experts who would have to collect the relevant data and to advise the planner with regard to the formulation of environmental goals.

The first step would be the establishment of agencies concerned with the collection and appraisal of data showing the present state and probable trends of pollution. As pointed out before, the environmental conditions in less developed countries may be highly specific. Scarcity of drinking water or polluted sources of water, lack of sanitary facilities, settlement density and slums, monsoon conditioned floods, malaria infestation, salinization of the soil and water logging require special attention. In all these instances the collection and appraisal of data for specific regions and for the country as a whole are a prerequisite for the formulation of environmental goals as well as remedial action and environmental planning.

The collection and appraisal of such data will call for the setting up of a scientific infrastructure with the appropriate personnel. This will be necessary in order to identify the key pollutants and major sources of disruption of the physical (and

social) environment and to explore systematically the causal relationships between productive activities and the disruption of the environment. To this effect it will be essential to maintain, at least in the more exposed rural and metropolitan areas of human settlement, environmental observation or monitoring stations to gather data on the above problem areas. It may even be necessary to attach this scientific infrastructure (laboratories, monitoring stations, etc.) to the planning agencies.

While it is true that this scientific infrastructure calls for new administrative agencies, both at the state and local level and requires funds as well as trained personnel, these requirements need not be beyond the reach of some of the less developed countries. Many of the sampling techniques and instruments have been developed or are in the process of development in several industrialized countries.

For each project the planning agency needs not only a technical feasibility study in engineering terms but also a cost effectiveness study including an assessment of the specific pollution hazards, ecological contingencies and possible social consequences. Such an assessment calls for a systematic interdisciplinary research effort which will have to explore the possibilities of alternative locations and technologies together with estimates of alternative costs.

While the need for a systematic assessment of environmental consequences is accepted at least in principle, its institutional implementation is still under discussion. Specific suggestions advanced go beyond the recognition of the principle. There is need for the establishment of Environment, Technology and Location Assessment Boards to assume the tasks outlined above. Such boards would have to conduct their work openly and with adequate representation of the population affected; their conclusions must be given full publicity. Its members must possess the required professional competence and must be under obligation to secure advice from independent experts. While the work of such boards would be time consuming and add to the costs of project planning, it would provide the development agency with the data that are absolutely essential for rational decision-making. While it may be less costly and hence more profitable in the short run to

develop and operate projects without prior assessment of the environmental and social consequences, it will be more economical in the long run to act upon the data provided by the assessment board.

Another institutional requirement for the maintenance of the quality of the environment is education on a broad level. Educational systems, even in industrialized countries, have never been set up with a view to developing an understanding of environmental problems and of man's active role in creating his own environment. This cultural lag can be overcome only by introducing the study of environmental problems and the causes of environmental disruption into the curricula of elementary schools, colleges and universities (including those of adult educational programs). Particularly the training of scientists, engineers, economists, lawyers and other technical experts will have to include the study of the interrelated issues of production, technology and environmental disruption; such training must be interdisciplinary in character.

In addition, intelligent action and rational policies with regard to the environment need the support of an informed public opinion. This in turn calls for a systematic dissemination of information regarding environmental disruption by mass media (radio, television, films, newspapers, etc.). Here again there is considerable scope for foreign assistance and technical educational aid under international auspices.

Since the market mechanism provides no safeguard against environmental disruption and since it does not generate an effective demand for the elimination of pollution and will not supply such essential common goods as "clean" air and water, the problems raised by the disruption of man's physical and social environment call for legal reforms. Legislation and legal reforms relating to the environment are a relatively new field which is bound to assume increasing importance also in less developed countries.

The social controls discussed earlier call for specific legal and administrative reforms such as the establishment of new specialized agencies, the promulgation of new tax laws, direct controls by legal prescriptions and injunctions as well as

penalties within the scope of administrative, civil and criminal law. These legal forms need not be discussed in detail, but we wish to refer briefly to certain legal innovations which the protection of the environment may require. Thus, a relatively new field of legislation with doubtless far-reaching consequences would be the enactment of specific laws establishing norms for the maintenance of clean air and clean water. Such acts would have to prohibit or restrict the use and/or emission of untreated toxic materials in specific areas with manifestly high degrees of pollution. They may even have to prescribe explicitly the use of specific capital inputs in accordance with a systematic program of technology substitution. The main difficulty will be adequate supervision and enforcement.

Another legal reform concerns the further development of new liability legislation regulating the compensation for environmental damages. In the past, liability laws have not proved to be effective in providing for such compensation due to the fact that it has been difficult and costly to prove or identify the sources of pollution, or to establish causal relationships and legal responsibility. As a result, endless litigation and delays have stood in the way of making liability laws effective quite apart from the fact that traditional liability laws provide at best remedies after the damage has already occurred. The failure of the market to prevent environmental damage and social costs may be said to have gone hand in hand with the failure of the law to provide for an effective system of compensation. This failure of the law was perhaps due to the fact that liability laws were never designed to deal with cases of environmental damage. As in the case of work accidents and occupational diseases they placed the burden of proof of responsibility, causal relationship and damage on the injured person.

Under these circumstances it may be necessary to develop more effective compensation laws by placing the burden of proof that inputs, products or the disposal of waste materials are "safe" on the producer or the seller. As in the case of workmen's compensation acts, the new legislation would have to be based upon the principle of presumptive responsibility of those who produce or sell products and in the process cause environmental damages or social

costs; they must be held responsible for the payment of adequate compensation. To the extent that this principle would be effective in actually altering the input and output pattern and would prevent or reduce the disposal of pollutants into the environment, the new legislation would have a preventive effect ex ante. This "feedback" effect could be further reinforced if the use of manifestly noxious materials in production or their disposal into air and water (or for that matter the sale of products harmful to human health and human life) would be made a criminal offense.

Another legal innovation may take the form of the enunciation of common or collective property rights with regard to such "free" and hitherto legally unprotected aspects of the environment as air, water, esthetic values etc.

It is also possible to establish a constitutionally guaranteed right to clean air and water as part of other fundamental human rights not subject to abrogation without due process of law. This would be in sharp contrast to the present situation where a human right to clean air and water is not guaranteed and where those who insist upon such a right are in effect treated as if they imposed upon the polluters an unjustified and unreasonable constraint. Such rights could be established either by constituional amendments or by reinterpreting existing constitutional provisions. However, no matter how desirable the enunciation of such fundamental rights to an adequate environment may be, problems of definition, interpretation and enforcement may render this approach of legal reform cumbersome and unenforceable, if not entirely ineffective. Without wishing to discourage efforts in this direction, their ultimate effects in protecting the environment are subject to reasonable doubt unless the legal norms are at the same time supported by a new attitude and responsiblity towards the environment.

Finally, specific dangers of environmental disruption will ultimately call for new international and in fact world-wide laws of environmental safeguards and protection because pollution respects no boundaries. Three factors need to be mentioned in this context. First, international waterways, oceans, air currents, etc. carry pollutants across international borders and thus may cause

international frictions. Second, different laws of environmental protection and environmental standards in different countries may place some producers at a competitive advantage which may be regarded as a case of concealed price dumping in international trade. Third, as noted before, there is the danger that industries are able "to export pollution" by moving polluting plants to other countries. The last factor may be of particular relevance for less developed countries. All three factors will call for the evolution of international and indeed world-wide legislation, agreements and conventions.

Legislation and international agreements are, of course, integral parts of the political process. Their purpose may be said to consist in substituting public power and the rule of law for the unrestrained pursuit of individual interests and private power. In view of the deterioration of the quality of the environment, new legislation must provide some form of protection for individuals and society against environmental damage for which the market mechanism offers no reliable avenues of settling conflicting interests and/or for compensatory adjustments. Thus, new obligations and responsibilities will be placed upon individuals and groups with a view to preventing them from polluting the environment shared by all. The struggle for appropriate protective measures and legal constraints is thus ipso facto a political struggle in the course of which conflicting interests will be articulated and opposition to specific laws and legal arrangements will be brought into the open. Laws will have to be enacted and enforced. Their implementation will raise new and familiar issues of collusion and corruption. Which groups in society can be expected to play an effective role in this political struggle for the protection of the environment? The answer to this question is far from being self-evident. The movement for better sanitary conditions during the Industrial Revolution was inaugurated and supported by Benthamite reformers and had to overcome the resistance of local and private groups. In almost all countries the struggle for better working conditions and social protective legislation had the active support of the labor union movement. Can such support for environmental control and institutional reforms be expected from union quarters? Perhaps. So far it appears that the struggle for environmental improvements has not found the support

of any group in particular. In less developed countries there may be in fact considerable reluctance on the part of organized labor to support the political struggle particularly as long as unions remain weak and convinced that the additional costs of environmental control will be shifted to workers in the form of a reduction of wages. Furthermore, environmental disruption in localized areas may not attract the attention and political interest of people in other areas sufficiently far removed to remain unaffected by the damages caused.

At the same time, environmental disruption raises conflicts and antagonisms that differ in scope and character from those which have marked earlier periods of economic and social development. Environmental disruption affects all members of society. However, it does not affect them equally. Higher and middle income groups may for a time avoid some of the consequences of air, water and noise pollution. They may move out of the most affected areas. But they cannot evade chaotic traffic conditions or the deterioration of certain foods, the pollution of the oceans, etc. Moreover, one industry may be affected by the disposal of toxic materials and residuals by other industrial establishments located further upstream. Their costs, their profits and hence their commercial survival may be jeopardized. Thus, environmental disruption and the distribution of the costs of environmental controls raise conflicts of interests not only between consumers and producers, but between different industries particularly between small and large business units. These new forms of conflicts are likely to become more frequent and more characteristic with increasing environmental disruption. For this reason the struggle for environmental improvements is bound to become part of the general political process. Those groups and political parties which promise, enact and implement effective measures of control will be able to mobilize public opinion and thus carry elections.

Within the broad sense in which the term "institutional requirements" has been interpreted in the present context, it may not be irrelevant to inquire into the merit of recent suggestions to reduce the rate of growth and to develop an altogether different attitude toward material progress. Under the impact of the progressive deterioration of the

environment a doctrine of "zero growth" has been developed in recent years. Has this doctrine any relevance for less developed countries? Obviously not. For these countries find themselves at poverty levels of consumption for the great majority of their population. They operate with low levels of productivity and face high rates of population increase. These factors make it imperative to increase production and productivity and to make appropriate use of the opportunities offered by new scientific developments and advancing technologies in all fields. Furthermore, to follow the advice implicit in the doctrine of zero growth would increase international disparities between "rich" and "poor" countries and support those who proclaim that the economic development of the underdeveloped world is neither possible nor desirable because it would increase the ecological disequilibrium and the environmental disruption on a global scale. In short, as far as the less developed countries are concerned, the doctrine of zero growth cannot be seriously entertained. Its premises are unrealistic and its promises undesirable and self-defeating. Even if population growth rates and family size could be drastically reduced, population would still continue to increase over the next three decades. Science and technology offer new opportunities of increasing output and productivity. In fact, the doctrine of zero growth seems to rest upon a false and oversimplified association of the causes of environmental disruption with modern technologies and population growth. It fails to take account of the fact that it is the complex interaction of technology, production and the allocation mechanism under given institutional arrangements which causes the disruption of the environment. The doctrine fails to take adequate account of the fact that alternative methods of allocation and alternative technologies and input patterns could be developed which would reduce the level of environmental disruption while increasing the level of production. Less developed countries have every reason to reject the doctrine of zero growth.

It is sometimes argued that the protection of the environment depends in the last analysis on man's attitudes towards nature and that less developed countries may follow a less destructive course of action because traditional notions of a fundamental unity of man and nature and ethical concepts such as

man's duties towards the earth are still strong enough to exert a restraining influence on development policies.

While it is true that attitudes and norms of human behavior with regard to nature and the environment influence human action and man's awareness of the need for their protection in the interest of present and future generations, it is not safe to rely on the metaphysics of an earlier age particularly in an era of rapid social change. No doctrine of a fundamental unity of man and nature and no ethical norm is strong enough to prevent the disruption of the environment when either poverty and famine or the opportunities of private gains militate for the unrestricted exploitation of the "free gifts of nature." Neither ethical nor aesthetic norms will arrest this predatory process.

This is not to say that there is no need to develop new attitudes and explicit norms of human behavior with regard to the environment in contrast to those implicit or explicit norms which had their origin at a time when man perceived nature as hostile and unmanageable and had no other alternative than to adapt himself passively to his environment in view of his limited knowledge and primitive techniques. Today man has acquired the capacity of doing irreparable damage to his environment with far-reaching negative effects for his own well-being and the survival of the species. Man lives today in an environment which he increasingly creates. Under these circumstances he is indeed in need of a new code of action with explicit responsibilities and new sanctions. This new code of norms and responsibilities towards the environment will have to be based upon the scientific analysis of the interrelationships which connect man's social and economic systems with those physical and biological systems upon which human life on this planet depend.

CHAPTER 8

GOVERNMENTAL FURTHERANCE OF ENVIRONMENTALLY SOUND TECHNOLOGIES AS A FOCUS OF RESEARCH AND ENVIRONMENTAL POLICIES*

An examination of present practices and policies has made it clear that the support of environmentally sound technologies poses a series of tasks and problems for research and environmental policies that are new in many respects and have hardly been systematically covered in the literature. Questions are involved that are partly of a very basic and partly of a practical nature. To the former belong the problems of research policies and planning, as for example the formulation and the identification and setting of goals and of priorities of conflicts. The practical tasks comprise questions of organization and coordination of the research system, of the financing of the research, as well as the problems that result from supporting the introduction of recently developed technologies. We will be concerned with these problems and possibilities in this part of our investigation. For this purpose, the main results of the foregoing investigation will be summarized.

Summary of the Results of the Foregoing Investigation

The report in Part 2[1] of our work has shown that today there are already numerous ideas and concrete suggestions for solutions for lessening or avoiding environmental damage through the development and introduction of alternative technologies. These alternatives are in various stages of development; in part they are merely concepts, others are in the

*From K. Wm. Kapp (with the collaboration of H. Baumann and P. Wachtl), Staatliche Förderung Unweltfreundlicher Technologien, Göttingen, BRD, Otto Schwartz & Co., 1974, Part 5, pp. 114-196, Report No. 74 of the Kommission fur wirtschaftlichen und sozialen Wandel (Commission on Economic and Social Change), Federal Republic of Germany. Translated by J. E. Ullmann and F. J. Churchill.

[1]References are to Parts 2, 3 and 4 of the original volume - Ed.

experimental stage; for further alternative technologies, pilot projects now exist and others are more or less operational.

Our report has further shown that in the majority of cases we are dealing with projects, the results of which are still uncertain and in part involve considerable risk. Many involve high costs; others are energy or capital intensive, or while technically feasible are not yet commercially competitive with the technologies being applied today, especially if, as hitherto, one largely neglects the social costs and environmental harm of currently used technologies. More generally, it can be said that every serious discussion of environmental and energy problems sooner or later poses the question of alternative technologies, including those oriented toward conservation; in other words, technology can no longer be considered as a given, constant factor, but has become a multi-dimensional variable which is to be defined in terms of societal goals or the determination and satisfaction of individual and societal needs.

Furthermore, the report has shown that a large number of possibilities and tasks exists for governmental policy of support of environmentally sound technologies and their introduction in the private as well as the public sector. In this connection let it be again emphasized that various proposals for lessening or avoiding environmental damage present a danger of transferring it from one medium (for example, air) to another (for example, water), especially if research support concentrates on partial solutions. The interdependence of all environmental problems must therefore be central to the research and its support.

Alternative technologies, such as for example, a better use of existing energy resources, their more efficient utilization as well as conservation technologies for industry as well as the consumer, will have an increasing role in the future. Of course, it must be expected that for a considerable period, environmentally sound and unsound technologies will be applied at the same time even with intensive efforts in research and development. The support and introduction of environmentally sound technologies poses diverse problems and require various approaches, depending upon whether they are to be used

in industry, agriculture, services or community problems. Further, the distinctions between individual technologies and complete technology systems and between technologies for meeting needs and conserving resources, point to problems that, due to their diversity, require specific solutions in research and applications.

Our analysis of today's research system in Part 3 of our work was concerned with the general problems of the organization of research support as well as with the research system in the Federal Republic of Germany. In this connection we pointed out particularly the increasing significance of governmental support of research which in America, but also in Europe, has manifested itself in a concentration on military, space and nuclear research, as well as data processing. In Europe it has further been a matter of strengthening industry in international competition (technology gap), as well as support of general and undifferentiated growth. This concentration on specific and in part narrowly conceived research goals has been accompanied by distinct disadvantages for the civilian sector and has led especially to neglect of the development of environmentally sound technologies.

It can hardly be expected of industry that it will be guided by goals that are oriented toward society and that possibly diverge from criteria of profitability, unless societal goals are explicitly built into the market mechanism. But the governmental system of research, with its multiplicity of financing and directing agencies and its lack of coordination needs a new orientation.

In Part 4 of our investigation we were concerned with today's support of environmentally sound technologies and their limits. There it was shown that governmental research institutions only function in a relatively limited way. A large part of government funds for the support of environmentally sound technologies flows to the private economy by means of grants and direct research contracts. The traditional measures for supporting innovations in general, such as for example the patent system and tax incentives, do create a more favorable climate for innovations, but do not particularly further environmentally sound technologies. The effectiveness of "market-oriented" measures and environmental-

political measures based on the direct responsibility of polluters is limited, especially as long as the effort does not succeed in legally forcing those guilty of environmental damage to prevent or at least reduce it by appropriate technical means.

Finally, it can be said that the methods to date of environmental politics and especially the lack of coordination of the decision makers in the area of research have led to a fragmented application of limited means, where short term, partial solutions are most prevalent, instead of a properly focused total program oriented towards societal priorities.

Problems of Research Planning

The support of environmentally sound technologies should be regarded as an integral part of all effective policies for environmental protection. Present ecological policy operates with a varied and diffuse economic-political set of direct and indirect measures that are guided by general goals, without centering on the support and application of environmentally sound technologies.

Umweltgutachten 1974 treats the realization of an environmentally sound technology as a central component in the framework of an environmental program, as well as environmental planning, the assignment of responsibility, the awakening and strengthening of environmental consciousness and more effective international cooperation.[2] The evaluation does not, however, treat the question of how and in what way the conceptual framework for the realization of environmentally sound technologies can be turned into practice and do justice to the given general goal of environmental policy. Also, the specific rankings or the necessary setting of priorities for the support of environmentally sound technologies with consideration of societal and individual needs, receive no special treatment in the Umweltgutachten -- and were perhaps outside the scope of its authors. On the other hand, we are rather inclined to give significantly greater importance to the support of environmentally sound technologies as

[2]Umweltgutachten 1974 (Environmental Evaluation 1974), Stuttgart 1974, p. 6.

part of environmental policy. This support must, in our opinion, be central to all effective environmental policies as a concrete goal concept or one to be made concrete.

Research report No. IV of the Federal Ministry for Research and Technology provides a definite formulation of goal concepts that is directed towards the development of environmentally sound technologies and substantiates these concepts at least in principle.[3] Thus the report determines that the federal government sees as its task "to orient science policy towards societal needs by means of a planned determination of points of emphasis..." The support and development of technologies for shaping and protecting the environment, including unconventional new developments, are central in importance and are to be supported as a responsibility of the federal government through expansion of research facilities and better coordination of research contracts.[4] The research report explicitly substantiates the necessity of supporting environmentally sound technologies by pointing to the fact that human activities in science and industry have contributed significantly to environmental damage and that the resulting damage and dysfunctions should in the future be lessened or removed with the help of science and technology.[5] The research report further establishes that "for a more effective research policy goal that better meets societal needs, it is essential to involve the public right at the beginning of planning, that is at the point where goals are being set"[6] The report also emphasizes correctly that it is the task of science and research (including the social and economic sciences) to clarify the origin, consequences and effects of environmental stress; to analyze the interactions between society and environment; and to prepare an exhaustive inventory of the present state of the biosphere and especially the total impact and combined effects of harmful

[3]BMFT, (Federal Ministry for Research and Technology), Forschungsbericht IV (Research Report IV), Bonn 1972, pp. 9, 11.
[4]Ibid., p. 104.
[5]Ibid., p. 106.
[6]Ibid., p. 11.

materials and their duration. "At the same time with the development of new techniques, their consequences for the environment must be pondered and considered."[7] Even though the research report does not specify how the above-mentioned tasks and problems could be solved, it still indicates a series of basic planning problems and planning tasks, which will receive our attention later on.

Essentially, we see two problem areas in supporting the research and development of environmentally sound technologies: problems of goal formulation including evaluation and problems of the choice of goal (that is, who shall decide how far public participation, emphasized in the report as necessary, is to go and how can this participation be assured?). Both problem areas are of such basic importance and bring out such a multiplicity of still open questions, that definitive answers can hardly be expected at this time juncture within the framework of this chapter. However, a number of points of departure and possibilities for solutions to the problems are becoming apparent which will be discussed in what follows. We will first treat the problems of goal formulation and evaluation; problems of choice of goals will be examined in the section on "participative" planning.

Goal Formulation

It probably is indisputable today that environmental goals and especially their relative importance are not certain at the outset. Quite generally, environmental goals are understood to an increasing extent as societal goals; there also seems to be wide agreement that a determination of societal needs is necessary, so that environmental objectives can actually be oriented to societal needs. But how this could come about is not yet clear today. Many methods are up for discussion. For the purposes of our investigation we first differentiate between ecological and economic criteria.

Purely ecological criteria such as limits of environmental impairment, rates of exhaustion of resources (for example, with fossil fuel and other

[7] Ibid., p. 106.

raw material supplies per capita of population) can have significance as danger signals and base levels in strategic planning. As such, however, they still provide no adequate criteria for formulating goals for environmental policy and for the support of environmentally sound technologies, since with them it is a question of physical, real and not of evaluated amounts. Despite this it must not be overlooked that in certain cases, as for example, the eutrophication of a lake, ecological viewpoints can play a decisive role. The value of ecology in its relationship to economic and social criteria is today by no means clear. At any rate, environmental policy without consideration of ecological dangers is just as unrealistic as not considering socio-economic criteria (including the costs). By this is not meant that the "natural environment" can remain untouched. The question is rather to what extent intrusion into natural cycles for the survival of humanity is supportable, without endangering or destroying "nature" and thereby also itself.

The value amounts that the market provides in the form of prices are inappropriate criteria for goal formulation. The market, i.e. the system of supply and demand, offers no guideposts or at least no adequate ones for determining these goals. Environmental values and goals are values and goals for the evaluation of which the market offers no criteria. They are outside the market. The market neither offers environmental goods, nor does it protect them. Producers and consumers of the goods offered by the producers can neglect or destroy them with impunity. It is a question of values such as human health, the quality of life and the maintenance of the requirements of economic and societal continuity. Based on these considerations, we are of the opinion that the repeated attempts to enlist the help of direct or indirect criteria oriented to the market or to price cannot lead to a determination of goals or to their evaluation. These criteria do justice neither to environmental problems nor to the tasks that result from determining research goals. They cannot fulfill the requirements that must be met.

Without entering into an exhaustive discussion of

these problems[8], it should at least be pointed out that, for example, the employment of cost-benefit analysis in goal selection and in the evaluation of big projects oriented towards social need is meeting with increasing criticism and rejection in theory and practice, and not only on the basis of technical difficulties in calculating costs and yields, but also for basic reasons (cognitive theory).[9]

The conventional methods of formulating and evaluating goals might be justified as long as simple, one-dimensional problems and pure efficiency considerations are involved in the attainment of set objectives. Programs of environmental protection and projects for developing environmentally sound technologies are, by their very nature, associated with consequences that are long-lasting and difficult to assess. In other words, the effects that transcend groups of people and time periods (for example, the long-term burden on future generations) are of central importance in these projects. Here conventional methods of goal formulaton and the choice of goal offer no applicable criteria or aids in decision making. While these methods can quantify the present value of the expected tangible advantages of a project or technology (on the basis of suitable but problematic assumptions, for example with respect to the discount rate), they cannot cope with future dangers and uncertainties, which (as, for example, in nuclear energy projects) can stretch over thousands of years. The quantified benefits therefore seem to be real and tangible advantages, whereas the disadvantages and dangers are estimated

[8]Cf. K. William Kapp, "Social Costs, Neo-classical Economics, Environmental Policies: A Reply," especially pp. 95-100 in Environmental Policies and Development Planning in Contemporary China and Other Essays, Paris - The Hague, 1974.

[9]See, for example, Stewart and Streeten, Little-Mirlees Methods and Project Appraisals, 1971 (Ms); Paul Streeten, The Economics of the Environment: Problems of Method, Paris, 1972; Dieter Weiss, Infrastrukturplanung (Infrastructure Planning), Berlin, 1971; and R. A. Musgrave, "Cost-Benefit Analysis and the Theory of Public Finance," Journal of Economic Literature, September 1969, Vol. VII, No. 3, pp. 797-806.

or underestimated by methods and rules that do not correspond to expressions of democratic will. These are also the reasons why, in connection with the nuclear reactor program, Allen V. Kneese, the former research director at Resources for the Future, Inc. arrived at a rejection of benefit-cost analyses in an opinion solicited by the U.S. Atomic Energy Commission:

> "I am submitting this statement as a long-time student and practitioner of benefit-cost analysis, not as a specialist in nuclear energy. It is my belief that benefit-cost analysis cannot answer the most important policy question associated with the desirability of developing a large-scale fission-base economy. To expect it to do so is to bear a burden it cannot sustain. This is so because these questions are of a deep ethical character. Benefit-cost analysis certainly cannot solve such questions and may well obscure them."[10]

Cost-benefit analyses are not adaptable to formulating and choosing environmental objectives. They cannot answer the questions needing a solution: they mislead and are scientifically and politically irresponsible and dangerous.

Our skepticism about these and similar orientation criteria in goal formulation is not the result of ignoring the importance of costs (that is, the short supply of funds available); our skepticism is based on the basic concept that problems of environmental formulation and planning must be solved normatively, that is, on the basis of explicit societal value-premises. Prices (and costs, i.e., an appraisal of available means) are by no means insignificant, but they must have a lower priority than real and physical values and considerations.

Formulating the goal depends primarily on defining the problems (including the ecological ones) to be solved, and this can be attained only in real or physical measures. If we rely on monetary measures,

[10]Allen V. Kneese, "The Faustian Bargain," Resources for the Future, Inc., Washington, D.C., September 1973, p. 1.

then it turns out that these hide the actual constraints and have no relationship to the real physical processes and conditions. Prices need not have any relationship to costs (for example, energy prices); they are, moreover, to a high degree "planned" by economic and political decision makers and have led us to a false interpretation of actual conditions and to false goal concepts and strategies -- and not only in the energy sector, but with respect to environmental problems in general.

In our view, the setting of goals in the area of environmental policy and support of less burdensome technologies require that, instead of abstract economic categories, goal formulations be worked out that are based on societal and, to the extent possible, on objective requirements and goals with concrete content. For only in this way can the goals of research support and planning be defined and oriented towards societal criteria of need. More precisely, for goal formulation it would be necessary to determine criteria and data, which, by means of continuous monitoring, make it possible to create the bases for a scientific data set (situation analysis). In this way the necessary judgments can be made of the limits of the tolerable or unacceptable limits to the burden on the environment and on humanity. Thus decision aids for determining the urgency of the necessary research tasks can be worked out indirectly. The question can also be answered, for what reasons certain research tasks (and not others), out of the many possible ones, should be undertaken and are in pressing need of solution. The central question is the kind of criteria and data required and how they are to be determined.

The necessary societal criteria and measures are, in our opinion, simultaneously of an ecological and societal nature in the specific sense that individual requirements of individual need and especially of human health, as well as the assurance of economic and social continuity must not be called into question. The development of ecological criteria as well as those of individual and social need is technically and methodologically still in its beginnings. In regard to ecological criteria it is above all a matter of comprehending the effects of single as well as groups of harmful materials on natural cyclical systems, including their synergetic (that

is, long-lasting and combinatory) effects, especially with respect to specific, ecologically relevant research subjects (for example, watercourse systems, population nodes as well as transnational units such as international rivers, streams, lakes, oceans, the atmosphere, etc.) Secondly, there is need of an analysis and estimate of the emissions of harmful materials by individuals or groups of emitters. Also the degree of use of non-renewable resources (for example, energy sources) as well as land and water will have to be forecast and put into relationship to present and future societal needs. If we succeed in collecting and systematizing appropriate knowledge in the most quantitative form possible, then it would be possible to work out specific indices of environmental burdens. On the basis of such indices and with the help of further knowledge in regard to the cumulative effects of the harmful materials introduced into the ecological cyclical systems on the one hand, and the requirements of human health and of socio-economic renewal on the other hand, the upper limits of environmental burdens (input limits) can be developed and socially relevant environmental norms and standards of environmental quality can be formulated. Here it would be necessary and possible to link the total knowledge and experiences to regular control of the most varied environmental components on a broad basis, and not only for isolated localities but also for regions and global burdens of the atmosphere (radioactivity, temperature rise, etc.). The methodological beginnings for such a system of "ecological bookkeeping" are available and merit being further refined.[11] Finally, through comparisons of present and future environmental burdens from the various harmful materials (with corresponding maximum input concentrations) or their upper limits, indices could be devised for relative environmental burdens,

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[11] In this connection we are reminded of the work of Allen V. Kneese and his co-workers on material balances and input-output analyses. With the latter and their extension to environmental analysis there still exist significant reservations in regard to the use of historical coefficients of emission. For extensive bibliographies on this subject, see, for example, Georgio Nebbia, Detailed Economic Models of Industrial and Other Activities, World Health Organization, Working Group on Regional Residuals, Rotterdam, October 1974, (Ms), Appendix, pp. 17-27.

which then could be used as a basis for ordering of projects, in the sense of an urgency index for the focusing of research tasks for environmentally sound technologies.

The interim report of the project group Methods for Evaluating R and D Projects in the Area of Environmentally Sound Technologies comes to the conclusion that ecological criteria are quantifiable in a pragmatic way, to the extent that relevant results of measurement are at one's disposal, and the group suggests the following as a process for evaluating alternative projects of environmentally sound technologies for specific harmful materials:

1) Quantitative estimates of the effectiveness of relief (reduction of emissions, displacement of emissions, removal of waste materials, reduction of water needs in manufacturing).

2) Qualitative formulation of technical-economic criteria.

3) Relative weight of the projects according to the fixed evaluations.[12]

We are of the opinion that purely "ecological bookkeeping" is indeed an absolute requirement for goal formulation of environmental policy and also for the support of environmentally sound technologies, but it is not sufficient for formulating environmental norms. Environmental indicators define a condition and in many cases they may point directly to what would be required if the predictable and already present environmental damage is to be avoided. In other words, it is a question of the technical content of the necessary evaluation, which content would, as a technical component, be open to technical criticism. But even the technical content of environmental indicators does not make these automatically into environmental norms or into goals of environmental policy and research.[13] Here, as

[12]Dechema, Institut für Systemtechnik der Fraunhofer Gesellschaft, Methodik zur Beurteilung von F und E Projekten im Bereich umweltfreundlicher Technologien (Zwischenbericht), 1974, pp. 64-5.

[13]We touch here upon the problem of the relationship between "facts" and "norms" or rather between

before, an evaluation is necessary, that is, a choice or an establishment of relative preferences (in this case, of collective preferences). In short, a political process of decision is needed.

What criteria exist for such a political decision? To answer this question, it is necessary, apart from technical knowledge and statistical information on the ecological effects to be aware of the relative importance or perceived value of alternative or desirable future situations or consequences. Such evaluations are likewise accessible to scientific analysis, specifically by first trying to make clear what has above been repeatedly called "societal need" or "societal requirements." Only when we are able to define these concepts more exactly or make them more concrete and, as far as possible objective, do we come closer to the problem of goal formulation for society as well as for research. We believe that this absolutely necessary concretization and objectivization might in the final analysis be possible only if there is substantial unity concerning basic human needs. Here too we find ourselves, methodologically, not on the supposedly firm ground of traditional decision theory, but at the beginning stage of a development in the social sciences and humanities. We see the start of a solution in the formulation of minimal requirements of human life. The very endangerment of the environment and thus that of humanity makes this start of a solution more necessary than ever. The question is not all the things that could or would have to be done, but what is indispensable[14] for preserving social continuity and with that the

"positive" and "normative" judgments. For a treatment of these problems in connection with goal formulation in the area of Environmental policy, see K. William Kapp, "Environmental Indicators as Social Use Values," in: Environmental Policies, Paris-The Hague, 1974.

[14]We choose this somewhat dramatic formulation consciously for two reasons: first, because we see the endangerment of the environment not as the sole, but yet as the central source of the endangerment of humanity; and second, in order to refute the possible criticism that we state the problem as the modest requirement of, so to speak, being just about able to maintain human life. That is a much broader

health and survival of humanity.[15]

In this fundamental sense, the concept of minimal requirements of human life and survival or of human basic needs has in practice played a certain role, implicitly and explicitly (for example, in social policy). Neither is there a lack of theoretical and methodological starting points[16], and these might receive new impetus in connection with the dangers of environmental burdens through human activity and through the unchecked introduction of dangerous technologies in the process of production and consumption. The dependence of economic cyclical processes on the maintenance of ecological balances (that is, on the fact that economic systems are basically open systems) makes it necessary to conclude that economic and social continuity and the satisfaction of human basic needs become problematic, once the burden on the environment oversteps certain limits. (Once again we recall here the all-embracing interpretation of the concept "environment," which includes the physical as well as the social surroundings, including human working and living conditions.)

The road from the technical components of environmental burden and capacity, by way of minimum tolerance limits to environmental values or norms that provide the relative importance of perceived value of various goals, and are detached from

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question which hardly needs to be emphasized. See K. William Kapp, "Zum Problem der Enthumanisierung der 'reinen Theorie' und der gesellschaftlichen Realität" (On the Problem of Dehumanization of 'Pure Theory' and Societal Reality), Kyklos, Vol. XX, 1967, pp. 307-330; also "Nationalökonomie und Rationaler Humanismus" (National Economy and Rational Humanism) Kyklos, Fol. XXI, 1968, pp. 1-25; and with reference to developing countries, Economic Development in a New Perspective; Existential Minima and Substantive Rationality, Kyklos, Vol. XVIII, 1965f, pp. 49-78.

[15]R. Jochimsen, "Strategie der wirtschaftlich-politischen entscheidungen" (Strategy of scientific-political decisions) Weltwirtschaftliches Archiv, Vol. 99, 1967, II, p. 72.

[16]François Perroux, Feindliche Koexistenz (Hostile Coexistence), Stuttgart, 1961, pp. 550-565.

subjective individual evaluations, is not necessarily a road to willful, authoritarian or elitist decisions. On the contrary, it is in principle egalitarian and results from empirically provable relationships among effects and from logical considerations, which force us to recognize definite criteria and measures: "Whoever ... affirms his own and social life, ... cannot possibly negate the value of all things that are an indispensable condition of it."[17]

Indispensable conditions in the form of minimal requirements or upper bounds to environmental burdens can be worked out in the first instance from a material viewpoint in the light of scientific-empirical knowledge, data and criteria. But such a definition of the maximum burden of humanity is also possible in principle from a psychological point of view. Of course such kinds of limits will have to be changed with increasing knowledge and experience. Within certain limits they will also be different depending on the social surroundings. Their formulation depends on whether minimal requirements in the sense of indispensable preconditions or maximum limits of burdens cannot be removed from empirical analysis and are derived from controllable investigations and clinical knowledge (information, data) on the consequences of their not being satisfied. It is true, that such minimal requirements do not necessarily meet with general and automatic recognition or acceptance and explains the uncertainty and the skepticism with which their formulation is confronted. We shall come back to these problems in the next section. Here we emphasize only the basic certainty that the determination of environmental goals and with it a formulation of environmental and research policy is possible in principle, and can take place outside the market by considering basic human needs or the minimal requirements of human and social continuity.[18]

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[17]Victor Kraft, Die Grundlagen einer wissenschaftlichen Wertlehre (The Bases of a Scientific Theory of Value), 2nd ed., Vienna, 1951, p. 73.

[18]What is certainly lacking today and is urgently needed is a systematic determination of needs, which must be recognized as a task and a challenge to

Goal Conflicts

We have tried to show that the formulation of specific objectives of environmental policy and indirectly of research policy is essentially possible. As we have already indicated, this possibility of a determination of goals and their logically tenable deduction from empirically testable investigations and knowledge offers, however, no guarantee that these goals will meet with general agreement and be legally anchored by means of a political decision process. Logical validity and deduction of basic needs, even on the basis of scientifically provable relationships of effects, offer no guarantee of a general consensus. Such a consensus will be all the more difficult to attain, the more the goals give rise to conflicts of interest. And just that will often be the case with the formulation of specific environmental objectives oriented to social and individual needs. Environmental and research policy as well as the support and introduction of environmentally sound technologies will thus have to reckon with goal conflicts of the most varied type, which will have to be clarified and whose importance must not be underestimated. The neglect or underestimation of goal conflicts and interest conflicts is characteristic of every partial treatment of environmental problems. On the other hand, goal conflicts are frequently considered as insoluble obstacles to every sensible solution of the environmental problem and can become an excuse for inactivity or for preserving the status quo. Thus it is important to be clear about the various types of goal conflicts, in order to indicate their role and significance as well as possible solutions.

A goal conflict that often comes to the fore involves the high costs of alternative processes and measures for protection of the environment. Here one usually works with cost aggregates that are spread over several years and decades. Apart from the fact that these cost calculations are very often based on uncertain estimates, singling out costs without consideration of the sought-for social

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natural scientists and humanists, which becomes all the more urgent as we become conscious of the threat to humanity through environmental degradation.

benefits is misleading. For such an attitude usually fails to see that an attempt is being made to lessen or avoid the social costs or the environmental harm by the introduction of appropriate means and measures.

Those who always point to the costs of environmental protection or alternative technologies, without taking into account the social advantage of avoiding the destruction of the environment -- consciously or unconsciously -- block the path to considerations and comparisons of benefits (that is, the avoidance of harm) and expenditures that are relevant to society. Actually in many cases it is a matter of the distribution of costs or the maintenance of the present distribution or shifting of the burden of environmental harm. The much discussed conflict between quantitative and qualitative growth has a similar basis. Here too one often works with concepts that seem to imply fundamental goal conflicts, whereas a more careful investigation might reveal that it is a matter of wrongly posing the problem. Qualitatively differentiated growth is not necessarily in conflict with a quantitative increase in production. As long as one holds to the traditional measures like gross national product which systematically underestimates social costs, ignores them or even includes them in GNP, then the false impression arises that the satisfying of basic needs or the assurance of certain indispensable requisites of human life and of social continuity must go hand in hand with considerable loss of economic values. The opposite would be the case if one could and would proceed to the evaluation of differentiated growth with appropriate criteria of measurement and evaluation.

Other goal conflicts that are often emphasized in the discussion also need to be viewed critically. That the development and introduction of environmentally sound technologies in individual industries can lead to raised costs and prices cannot be denied. That the number of jobs and workers in certain industries could thus decrease, cannot be dismissed lightly. The international ability to compete can also be negatively influenced in some industries through those kinds of measures, especially if competing foreign industries are subject to less strict regulations and levies. Here conflicts of objectives and interests are possible that could give cause for legitimate fears of industry

and for an organized resistance from the workers. Especially with a general lack of information and in view of the lack of clarity in the cost, price, and profit situation, such circumstances, as the Federation of German Trade Unions expresses it, lead to employers "presenting themselves as lawyers for the occupational interests of their employees."[19] It is also possible that environmental and technological policy will reach the point where certain processes will no longer be used at all and certain products can no longer be brought to market and must be replaced by alternative processes and products.

Goal and interest conflicts of this type can reach the point where people cannot agree on minimal needs and indispensable conditions for the maintenance of human health despite empirical proof of deleterious effects and thus the road to a consensus is made difficult. In these cases the temptation will exist to use the argument of insufficient knowledge of basic human needs and to cast doubt upon the concept of minimal requirements.

We are far from trying to minimize these problems. Yet it should be briefly pointed out that it is in no way certain that every lessening of environmental burdens, for example through alternative technologies, must necessarily be in contradiction to the interests of industry and of those involved. Without wishing to generalize in an inadmissible way our example of Swedish cellulose production,[20] we should at least once again remind ourselves that the development and introduction of alternative technologies by no means stand in the way of lowering

[19]Deutscher Gewerkschaftsbund, Umweltprogramm des Deutschen Gewerkschaftsbundes, (Environmental Program of the German Trade Union Federation), Dusseldorf, 1974, p. 20.

[20]The reference is to the functionally successful and highly profitable water management and purification system installed at the pulp plant of Munksjö AB at Vaggeryd, Sweden, in response to increasing environmental damage caused by its previous methods of operation. R and D costs were shared equally by government and the industry. See pp. 51-5 in the original volume - Ed.

ing costs, of improving the ability to meet competition (internationally as well) and of a greater independence in the choice of future locations with long-term savings in transport costs. In short, here there is no fundamental goal conflict and no contradiction between the lessening of environmental burdens through alternative technologies on the one hand, and the interest of industry, of its employees and of other social goals on the other.

It would, however, be wrong to fail to see certain compensatory effects even in those cases in which, contrary to the Swedish case cited, the substitution of environmentally sound processes and products for the harmful ones leads to higher market costs and a limitation of production and employment. Thus, for example, a state supported research and investment program for the purpose of development and introduction of environmentally sound technologies can be combined with new capacities and employment effects that do not have to be economically insignificant. To be sure, it is a question of a change in the structure of production and employment, in the course of which certain industries will be forced to limit production and workers will suffer job and income losses. These, however, can be compensated by appropriate adjustments of unemployment insurance and by retraining. At the same time, these considerations point to the fact that state support of the development and introduction of environmentally sound technologies can turn out to be a way of stabilizing the economy.[21]

Thus we finally come to those fundamental conflicts of goal and interest that can arise from the introduction of new technologies. Three cases can

[21]Thus, for example, in Sweden subsidies have been used to a limited extent for environmental protection measures, in order to stimulate production during the recession of 1972. This means a combination of anti-cyclical budget policy and environmental policy, which could also be of importance in the future for the particular support of environmentally sound technologies. See Lennart Lundquist, "Sweden's Environmental Policy," Ambio, Vol. I, No. 3, June 1972, p. 100.

be distinguished here, that we have indicated in another context. A relatively simple example is the displacement of environmental burdens from one environmental sector to another as a consequence of state support of technology. Such a displacement will come about especially when the analysis of the situation and the formulation of environmental goals focus on too narrow an area or on only one environmental sector. The more research is conscious of the system-wide ecological interrelationships the less is the danger that goal conflicts will arise in alternative technologies through displacement of environmental burdens. If in supporting and introducing environmentally sound technologies one neglects the wide-ranging interdependence of all ecological and social systems, the greater is the danger of merely moving troubles around.

The second case can best be illustrated by the development and introduction of new seed types in some developing countries. Here we have the introduction of new technologies that have already decisively influenced the structure of societies and economies and have given rise to considerable conflicts of objectives and interests. This technological and agricultural policy has had just as far-reaching consequences for the developing countries as change from coal to oil has in the industrial countries during the last 10-20 years. In both cases one proceeded without the necessary technology assessment and failed to ask the question whether and to what extent the consequences of the new technology corresponded to what could be defined as a desirable future.

The development and encouragement of the introduction of new, especially fruitful seed types was one-sidedly directed at the raising of production and productivity. The question of the necessary complementary capital goods, such as fertilizers, water, pesticides, as well as the energy needs for the manufacture of these inputs or the foreign exchange for their importation, was at first neglected; nor was the institutional framework (e.g. agrarian reform) provided for a sensible introduction of the new technologies on a broad basis. The result was not just that the new technology could only be introduced by the middle-sized and big farmers with capital, and that land rents and prices rose, but also that the small tenant farmers became

landless workers and inequality of income and possessions became further exacerbated, quite apart from the fact that the "green revolution" itself very quickly reached its limits.

Of even more fundamental significance are those conflicts of goals and interests that show up when considering the time factor, i.e. that the effects of environmental damage transcend long time periods. This is especially noticeable in the problems of water and air pollution as well as of the destructions of the land (erosion, deforestation) the encroachment on the landscape through unchecked land use and quite especially with the exhaustion of non-renewable natural resources or the use of nuclear energy. In all these cases the decisions of one generation can come into basic conflict with the interests and goals of future generations. Here the socio-political character of the choice of specific technologies becomes especially clear. The destruction of the soil or of a landscape and the waste and exhaustion of non-renewable resources affect future generations just as does the support and introduction of technologies that degrade the environment. True, the introduction of nuclear energy as an alternative source may have certain advantages when compared to the use of fossil fuels, although that is considered debatable. Moreover, the issue is nuclear plants can be associated with consequences and dangers for especially long periods of time and thus for future generations. The dangers arise from the possibility of plant accidents, terrorism and acts of war, earthquakes, and the storage and transportation of radioactive wastes. In view of the long life of the radioactive residues, storage involves periods that extend over thousands of years. This fact alone would make it necessary to introduce monitoring and safeguard systems and to maintain them over time periods that go far beyond the life expectancy of organized society and political states as we know them up to the present time.[22] These uncertainties and dangers are not "events with

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[22]"No government has lasted continuously for 1000 years ... it may turn out after seriously studying the questions, that one will conclude that ... man cannot in the very long run live with fission." A. Weinberg, "How can man live with fission?," Proceed-

slight probability." They must be at the center of the political decision process.

Societal Assessment of Alternative Technologies as a Prerequisite of Selecting an Objective

The goal conflicts that result from the support of research and the introduction of environmentally sound technologies are of decisive importance in selecting the goal or setting the priorities. What further requirements must be fulfilled for a democratic expression of will and decision, in order to arrive at a consensus? What information and knowledge are necessary so that an informed and committed public can sensibly take part in the process of selecting the goal? These are questions that will occupy us in this and the next section. In our previous discussions we concluded that environmental and research policy must reckon with a host of conflicting objectives that extend over both the short and long run. Thus, as we noted, the introduction of new seed types led to considerable changes in social structures and conditions of life within a time span of five to eight years. The same is also valid in principle also for the introduction of environmentally unsound and sound technologies, which, for example, can be the cause of production stoppages, of the loss of jobs and above all of changes in the structure of production and employment. In short, decisions on the support of research and especially the introduction of new technologies are decisions on the future structure of the economy and of society. Conflicts of interest and goals are thus an integral part of the process of decision and of the setting of priorities.

It is considerations of this sort that have increasingly led to the realization that all decisions about technical innovations, especially when big projects are involved, require systematic prior

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ings of IIASA, Planning Conference on Energy Systems, Luxemburg, Institute for Applied Systems Analysis, July 1973, cited in K. M. Meyer-Abich, "Neue Ziele der Energiepolitik" (New Goals of Energy Policy), B. P. Kurier, 1974, 26 (2), p. 32 ff. See also Allen V. Kneese, op. cit., p. 1.

clarification of their consequences in the broadest sense. That sort of assessment must go beyond information on the possible technical consequences of one technology; it will necessarily include a prognostic analysis of the social consequences of the introduction of alternative technologies, as well as alternative solutions of the problems under discussion. In other words, it is not only a continuing estimation of possible technical effects and as complete a clarification as possible of the social consequences of alternative technologies, but simultaneously it is a search for and clarification of alternative solutions for the attainment of social goals. That this has not happened thus far and has neither been brought into discussion by experts in the technical or the social and economic sciences has contributed to injuries to the environment being neglected and looked upon after the fact as unforeseen "unavoidable" side effects.

Technology assessment in the broad sense of the word must be seen as an integral part of the support of research and introduction of environmentally sound technologies and must be accepted as such. Such an estimate is in fact a prerequisite and a central aid in decision as well as an instrument of all policies on science and technology. It is the necessary bridge between research and development and the needs of society.[23] Impact studies, as we understand them, are not an expression of a technocratic orientation towards the problems with which we are involved, but on the contrary are an instrument for the uncovering of, and the search for alternative solutions to societal problems. They are one of the prerequisites for working out desirable futures. They show once again the importance, repeatedly emphasized by us, of the development of the most objective possible criteria of human basic needs with the help of environmental indicators that are in turn to be seen as part of a system of social indicators. The critical element in this regard is

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[23] "Technology Assessment is thus conceived as a tool of technology management, as a necessary link between research and development and the needs of society." Francois Hetman, Society and the Assessment of Technology, OECD, Paris 1973, p. 7.

close cooperation between the social sciences and the humanities and in the natural sciences and technology research, so that "unintended side-effects" can in the future become evident in the developmental stages of new technologies and can be reduced to a minimum. Of decisive importance is the orientation of impact studies towards the comprehension of the social consequences of alternative technologies as primary effects and not as effects of secondary importance. For this there is needed a broadly based quantitative representation or, if nothing else is possible, an analytical description of the social advantages as well as the disadvantages (abandonment of objectives). The advantages and disadvantages can appear in the form of monetary as well as social, structural and cultural consequences.[24]

It seems to us to be one of the weaknesses of previous impact studies that too much weight was attached to the purely technical consequences at the expense of neglecting the less easily understood social consequences. They depend on being comprehensive and understandable enough so as to enable an informed and committed public to form a picture of the potential uses and harms of alternative technologies and alternative solutions. It hardly needs to be mentioned that impact statements are time consuming and, moreover, involve considerable expenditure. We do not consider this as much of a weakness, but we consider it as unavoidable and potentially as an advantage, inasmuch as the process of information gathering and distribution and the working out of alternative solutions can contribute to the formation of a consensus.

To be sure, a basic problem of every impact study results from the fact that technologies for specific purposes within a sector are supported by interested parties or can come into conflict with other interests.[25] These brief indications of the tasks and

[24] See To Choose a Future, Royal Ministry of Foreign Affairs, Stockholm, 1974, p. 70 and p. 71.

[25] "Each technology has a vested interest support of the manufacturers of the technology and of the groups gaining clear calculable benefit from its use. In addition, there is often vested interest in the technology by a government department whose

problems of impact studies should have shown that they are an instrument which, in spite of its central importance, cannot take over the function of a political decision-making body in a democratic society. We see the function of assessment in the distribution of information to the public on the one hand, and to legislative and executive branches of the government on the other. Only with the help of such an institutionalized process of information could it be possible at all to arrive at rational decisions and controls relating to the use of environmentally sound technologies. Elements of such an institutionalized estimating of consequences exist today in the USA and in Sweden and are under discussion in Japan.[26]

In the USA there exists a legally established Office of Technology Assessment, which has the task of making "independent" estimates of consequences (so-called "impact statements") or reports on the effects of technological decisions that are before Congress, as well as, among other things, identifying alternative technological methods for implementing specific programs. This office, which is composed of equal representation from the House and the Senate and is part of the legislative branch, does not itself carry out the necessary studies, but awards contracts for impact estimates to university institutes and other non-profit research groups, upon whose independence the results depend.

In Sweden the impact estimate of technologies is incorporated in the environmental protection legislation, in such a way that a special office exists for the awarding of licenses for all new industries and those wishing to expand their plants or change their methods of production. The Environmental Protection Board makes approval contingent upon the new investments not leading to environmental damage. The Board can give financial aid in the form of subsidies to industries and communities and at the same time it monitors compliance.

mission is to promote a particular sector such as agriculture, transportation, or industry." François Hetman, op. cit., p. 334.

[26] Ibid., pp. 340-343.

In Japan the problem of impact estimation of new technologies is in the discussion stage within a commission of the Japanese Economic Council, for the purpose of working out guidelines for technology policy, especially but not exclusively in big projects. Here too the impact estimate would be a part of governmental scientific and research policy and would affect all research initiatives and technology developments and projects that involve the preparation and choice of "desirable and possible characteristics of the future."[27]

Although we do not consider it our task to enter into a detailed discussion of the problems and limits of social impact studies, let us again point to the danger that by limiting impact studies to definite and tangible quantifiable effects they may be incomplete or influenced by vested interests. However, we are of the opinion that the basic importance of impact studies of alternative technologies will in the future increase as a decision aid and as a prerequisite for the participation of a wide segment of the public. The importance of impact studies of alternative technologies as a prerequisite and integral part of scientific technologies and not least for the rational use of finite resources, seems to us to be of such a basic nature that its incorporation into the legislative process in a representative democracy ought to be, sooner or later, essential. This sort of discussion is already taking place. Thus in the relevant literature the possibility is being weighed of making a social impact study of innovations the permanent task of a special governmental bureau within the framework of existing government agencies, where a "fourth" governmental branch (Innovative Branch) would have the

[27]See the resume of the deliberations of the First Panel of the Japanese Council for Science and Technology in: François Hetman, op. cit., pp. 342-343. See also Keichi Oshima, Technology Assessment in Japan, in: M. J. Cetron and B. Bartocha (editors), Technology Assessment in a Dynamic Environment, New York, 1972; the suggestions of the director of the Institute of Future Technology go considerably further. See Yujiro Hayashi, "A New Approach to Societal Development," Technology Assessment, Vol. I (3), 1973, pp. 171-177.

very responsible task of reporting regularly on the present state of society (for example, with the help of social indicators, including environmental indicators), as well as of submitting to the legislature and the executive branch suggestions for alternative solutions and future measures.

> "It would be 'independent' in studying desirable social futures and in framing possible futures and feasible variants of political action. Its main duty, consistent with its main task, would be to make available to all institutions and the public at large the results of its investigations and proposals in such a form that they be fully understood and that a deep public discussion of future issues could be engaged in all relevant parts of the social body."[28]

Since a detailed discussion of these suggestions for the support of environmentally sound technologies would go beyond the limits of this work, we are content to point to Figure 1 which presents a detailed and extensive structure which might be suitable for such an agency. A development in this direction could simultaneously be an inevitable first and long-term step in the direction of better coordination of all social research tasks and those concerning the future in modern industrial societies.

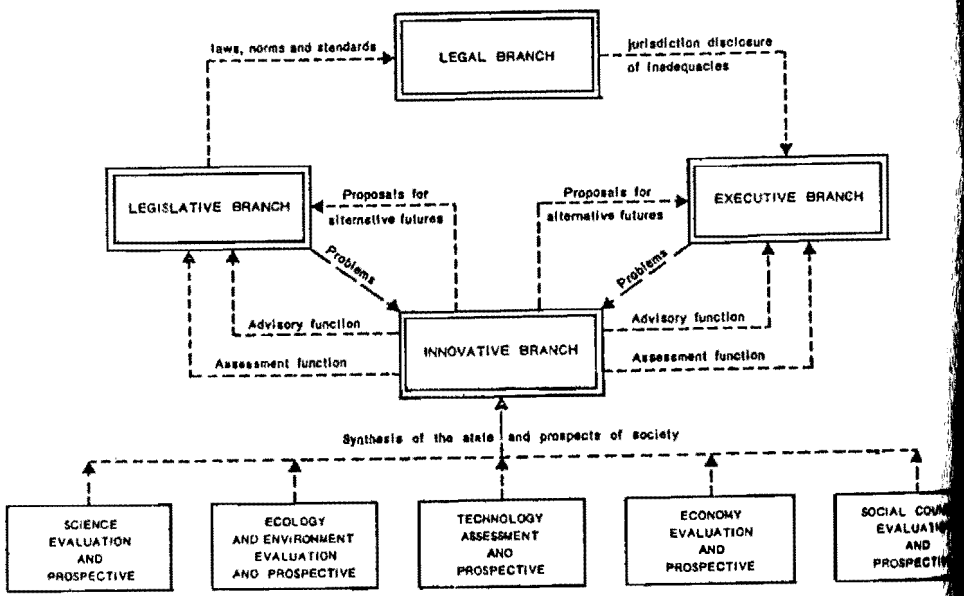
Choice of Goal and Participation in Research Policy Decisions

We now turn to the problem of choosing a goal or deciding on one. This is not only the question of who makes the decision, but of how the priorities can be set so that the research policy decisions will be consistent with social needs and be oriented towards them. How can the choice of objectives and the evaluations that result from the setting of priorities be formulated so that they are in harmony with the needs of society, that is, with the preferences of the public? How must the decision process be structured so as to take account of the problems and the necessities that arise? That these questions

[28]François Hetman, op. cit., p. 349.

FIGURE 1

The Innovative Branch of Government



Source: François Hetman, Society and the Assessment of Technology, Paris, OECD, 1973, p. 348.

are extremely real and will have increasing importance in the future is shown by a rapidly growing literature on the subject[29] as well as a series of demands and observations in the present political situation.

Before we address ourselves to the problems of participatory goal and priority selection, let us remind ourselves that there is no lack of statements in the literature on the importance of public participation.[30] In connection with research planning and goal formulation and especially with research policy decisions, Research Report IV emphasizes the necessity for public participation, openness of information and parliamentary control within the framework of a democratic process.[31] This is all the more important since in the case of the support of environmentally sound technologies, it is a question of research oriented towards social needs, which needs to be discussed and evaluated by society. The problem is clearly put, but conceivable modalities and processes for a practical development of these social decisions are not yet available.

In fact, up to now decisions on the development

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[29]See the collection of earlier basic writings of Jürgen Habermas, in: Technik und Wissenschaft als "Ideologie" (Technology and Science as Ideology), Frankfurt am Main, 1970. Joachim Hirsch, Wissenschaftsförderung und Politikberatung (Science Support and Political Counseling), Frankfurt am Main, 1971. Ulrich Lohmar, Wissenschaftspolitik und Demokratisierung (Science Policy and Democratization), Düsseldorf, 1973. Rolf Berger, Zur Stellung des Wissenschaftsrates bei der wissenschaftspolitischen Beratung von Bund und Ländern, (On the Position of the Science Council as adviser in science policy to the German federal and state governments), Baden-Baden, 1974.

[30]Thus the report of the Project Group 'Environmentally Sound Technologies' spoke about the necessity of getting all areas of society to take an active part in scientific and technical decisions. This also requires that they take part in the decision process; see BMFT, op. cit., p. 32.

[31]BMFT, op. cit., p. 11.

and introduction of new technologies, production plants, choice of location, etc. have been widely made without public participation. This is true not only for private undertakings, but also for public agencies. As a reaction to such decisions that had been withdrawn from public scrutiny, one can observe in all industrial countries not only a general uncomfortable feeling towards science and technology, but also an opposition that is becoming increasingly obvious. This has repeatedly resulted in protests, citizen initiatives and open resistance to the introduction of new technologies, and to locations for processing plants, airports, etc., when they endanger the environment and the landscape. In other words, the public and especially the directly affected populace refuse to accept decisions made without consultation. This rejection of decisions already made can lead to direct actions (as, for example, in Japan)[32] or to initiatives and referenda (for example, in Switzerland).

This increasing and, in our opinion, justified opposition is directed towards an undemocratic bureaucratization of the decision process and against an arbitrary setting of priorities that are of immediate relevance to society. It is to be expected that this opposition will increase and acquire a political base, so that a willingness to share appropriately sharing in the choice of technology and plant location will be extended. This is equally valid in establishing priorities in research policy including what environmentally sound technologies are to be supported.

Another fact of direct relevance to the necessity of bringing the choice of goals or preferences in research policy into harmony with societal needs and preferences, is the empirically verifiable discrepancy between the order of preference of the state and of the individuals on the merits of important research projects in areas such as medicine, food, education, space travel, nuclear research, etc. Surveys have repeatedly shown that the population

[32]Jun Ui,"Pollution and Residents Struggle," Kogai - The Newsletter from Polluted Japan, Tokyo, University of Tokyo, 1974, No. 4, pp. 2-3, 11-14.

or specific population groups have quite different preference structures from those who determine scientific and research policy.[33] Habermas poses a basic question about the relationship of technology and democracy, or, as he puts it: "How can the power of technical decision be brought back to the consensus of activist citizens' political dialogue?"[34] This question has special importance in the tasks that interest us in this chapter.

What possibilities are open for participative planning of research and choice of goals? What ways would be possible and necessary for consulting the public in establishing priorities for research and science policy?

We have repeatedly pointed out that the market as an information and signal mechanism offers no adequate tool for choosing objectives and establishing priorities for research. For the large majority of research projects there exists no market demand, and for other projects (for example certain remedial technologies) the legal framework and requirements must be created, in order for demand to arise. Even the conventional decision aids or maximizing and optimizing calculations are not sufficient, and in fact are unsuitable, because they assume the definition of objectives, whereas here it is a question of the choice of goals, that is, the evaluation and

[33]See various contributions on this theme by Helmut Krauch, especially Helmut Krauch and Wilhelm Vollmann, "Die Diskrepanz, zwischen der staatlichen und der offentlichen Präferenzordnung der Wichtigsten Forschungs - und Entwicklungsaufgaben in der BRD," (The Discrepancy Between the Order of State and Public Preferences in the Federal Republic of Germany), in: H. Paschen and H. Krauch (editors), Methoden und Probleme der Forschungs- und Entwicklungsplanung, (Methods and Problems of Research and Development Planning), Munich, 1972, pp. 21-24, as well as the literature mentioned there on the criticism of demography and the determination of group preferences.

[34]Jurgen Habermas, "Technischer Fortschritt und soziale Lebenswelt," (Technical Progress and the Social World), 1965, in Technik und Wissenschaft als "Ideologie", op. cit.

establishment of priorities, with goal conflicts and with considerable uncertainties that are not quantifiable. In planning research neither the goals nor the means are given to start with. Rather, we have a process of innovation and decision that must be oriented towards long-term individual and societal needs of the kind that the market does not register or does so insufficiently.

Many of the ways being suggested for choosing goals and setting priorities are limited to the support in the dissemination of information and elucidating the possible effects of existing technologies and technical innovations. Among the tools that can serve such dissemination of information there are, for example, the hearings before legislative investigating commissions, which play a special role in the USA (but also in other countries). There is a desire to start a "dialogue" with the interested public and a resultant hope to get better awareness of the wishes and preferences of the public. Another way of disseminating information is in the continuous information network of parliamentarians, which in Sweden has been institutionalized in the form of an informal commission of members of parliament, scientists and technicians.

We have already pointed out the necessity of an institutionalized social impact study for the purpose of clearly seeing problems and consequences, as a prerequisite of forming a democratic will to act and appropriate participation. As important as that sort of clarity and dissemination of information may be with respect to the effects of alternative technologies, it is not enough by itself to subordinate the process of goal choice on environmentally relevant research proposals that deserve support to a democratic participatory formation of evaluation. Even the publicizing or futherance of public discussion, or of official reports (for example, about the urgency, use and dangers of alternative technologies in the energy sector) before parliamentary votes, offer no guarantee of appropriate participation in forming political tendencies and decisions. In all these cases it is a matter, at best, of acceptance or rejection in a plebiscite after the fact, of proposals worked out by professional advisory committees.

In the Federal Republic of Germany there are attempts to "let Parliament and the public know as early as possible on what significant questions and by whom the ministry [for Research and Technology] will let itself be advised."[35] The consultation plan gives data on tasks and members; it distinguishes topics and tasks, and identifies the members of 87 ad hoc committees and 24 professional groups, who make decisions on research proposals in specific areas of work. If one examines the composition of these committees, it is revealed that they consist primarily of scientists and representatives from industry.[36] There is no provision for representation of other interested segments of the citizenry (for example, workers, unions, consumers, Nader-groups, farmers, city and land-use planners, environmental experts, ecologists). If one further considers that those who represent the interests of various industries are also in a position in later aspects of the legislative process to exercise organized influence on the political decision process, then it turns out that there is no representation of those less organized or unorganized parts of the population. Whereas the organized sectors of the interested parties have various possibilities of exercising influence, the others, i.e., the non-organized groups, can express their political influence only through the ballot box.[37] In other words, the debate and planning process within the public sector of research is in danger of leading to decisions by experts[38] and interest

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[35] BMFT, Beratungsplan 1974 (Consultation Plan 1974), Bonn, 1974, p. 4.

[36] Ibid., pp. 5-35.

[37] "Interest organizations are able to exercise considerable influence over the political planning process by 'lobbying' activity or by submitting briefs on proposed legislation. This phenomenon deserves greater attention, not least in view of the fact that large sections of the community are reduced to exercise their political influence at the ballot box." Royal Swedish Ministry of Foreign Affairs, To Choose a Future, Stockholm, 1974, p. 107.

[38] René Dubos stresses the urgent need to "guard the guardians": "A society that blindly accepts the decisions of experts is a sick society on its way to

groups. Outside the public sector there is no control at all over the research and decision process. What is essential is to prevent the choice of goals in research policy and governmental support of environmentally sound technologies from being determined and fore-ordained by experts and interest groups on the basis of analytic prejudgments and evaluations. The present structure of the decision process rests essentially on the fact that in the preparation of decisions these very experts and interested representatives, through their presence and by virtue of their profession, exercise a decisive influence on the choice of criteria as well as goals and on the supposed constraints that exist. The choice of criteria as well as the judging of the given possibilities and constraints reflect implicit value concepts; they are not free of prejudice, as has already been demonstrated in our presentation of goal conflicts. These very value judgments and conflicts must be held up to question and must become the object of an open discussion, if one wants to establish a policy on research and technology that is oriented towards societal needs.

If science and research policy is to be oriented towards social need, then, as early as the preparation of decisions and the development of necessary knowledge and information, suitable representation should be provided for those whose basic needs are at stake, that is, whose needs could be fulfilled more or less through a suitable policy of science and research.

As noted, this presumes a determination of basic human needs as well as a clarification of the consequences of alternative technologies, and it also presumes the development of alternative solutions

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death. The time has come when we must produce, alongside specialists, another class of scholars and citizens who have broad familiarity with the facts, methods and objectives of science and thus are capable of making judgments about scientific policies. Persons who work at the interface of science and society have become essential simply because almost everything that happens in society is influenced by science." R. Dubos, Reason Awake: Science for Man, New York 1970, p. 227.

to problems, so that in the light of this knowledge those alternatives can be selected which fit in with the existing value concepts of the citizens. It need hardly be mentioned that, in the course of such a clarification of the consequences, costs and conflicts of alternative technologies and solutions, the values and preferences of the citizens might change. This lies within the nature of a participatory decision process and is to be welcomed, especially because in this way of negotiating, the dialogue, i.e. the possibilities of a majority consensus, could improve.

Without including participation in choosing goals and without a corresponding representation of the public in the decision process it seems unavoidable that choices of technology and plant location will be accompanied by environmental destruction and will lead to economic and even to social crises.

A policy of research and science that is oriented to the future must therefore start with the determination of basic human needs and social impact studies as well as with the necessary dissemination of information in an institutionalized communications process that includes all parts of the population. Support for inclusion of the public or of representatives of various groups of the population (even in the regional sense), who are today excluded from decision making[39] can be countered with the

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[39]The trade unions seem to be clear about this necessity of including broad groups of the population, both with respect to the critical cooperation in environmental policy and with research: "It is the task of the trade unions to influence the development of policy on the environment in the interest of the workers. That makes cooperation necessary in the governmental environmental policy. On the other hand, however, a critical distance from governmental planning and activities is always necessary when it is a matter of questioning decisions that are inimical to the interests of the workers and have come into being because of the influence of other societal groupings. The critical cooperation of the trade unions in state environmental policy must not exhaust itself in taking positions opposed to the positions of the state. It must extend itself so

argument that these parts of the population lack the necessary professional knowledge. As we have already emphasized, however, decisions about selecting priorities of research policy are not matters merely of expertise but of social evaluation. Professional skills offer neither special abilities for such evaluation nor do they legitimize playing the sole or even a privileged role in defining the direction of research.[40]

What would be needed is permanent cooperation for the purpose of shaping political wishes on a non-bureaucratic and non-elitist basis. This cooperation would offer a new possibility of making decisions about technology and research of considerable social range. While open and latent conflicts between particular interests would not be eliminated, they would be replaced by a consensus of the majority. Participation in this sense would mean a reintegration of the citizen into a central part of the political process (specifically, the process of research and technology policy), which would offer a better guarantee than today's decision processes not only for the protection of the citizen but also for a rational social use of limited resources in the light of articulated and interpreted social needs or requirements of human life.[41]

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that it can effect comprehensive and at the same time generally understood enlightenment of the public, through appropriate demands on the legislators and administration, but also through its own activity. Only in this way can the unions give the necessary emphasis to their environmental policy demands. . . The determination and the treatment of environmental problems must take place in public. The more this succeeds, the more will the workers and their unions as well as other affected parties be able to be politically important forces in this area." See DGB, Umweltprogramm des DGB (Environmental Program of the German Trade Unions), Dusseldorf 1974, pp. 21-22.

[40] Allen Kneese, op. cit.

[41] We know that we are raising more questions than we can treat in this report or can answer at this time. We briefly commented on some of these questions in the previous section (for example, the delay in deciding). That the coherence of the

At any rate, it seems to us not possible to have a choice of goal and an establishment of priorities in the support of environmentally sound technologies without articulation and formulation of elemental basic needs on the one hand and without societal impact studies (in the sense used by us) on the other hand. Goal decision in research policy requires an orientation to societal need and to the social consequences of alternative technologies which in turn are to be evaluated by society and politics. Such an orientation of the goal choice and of research "means first of all setting up public debates on alternatives, making clear the impact of research policy, estimating the social consequences of technological developments, and deciding the resulting controversies and conflicts in public. . . Research policy is thus placed right in the center of political controversy. The goal of this dialogue must be to find out whether what can be done technically agrees with what is socially desirable. Research policy thus turns out to be a social policy that shapes the future."[42]

In this sense we address the question of the relationship of technology and democracy. The control over technology can only be attained by the political consensus of organized and active citizens. It presumes the articulation and interpretation of human basic needs. In this way decisions can be made about the desirable future through the democratic process, with consideration of the technical possibilities and their impact, that is to say, "in which direction and to what extent we wish to develop technical knowledge in the future."[43]

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selected societal goals will not always be guaranteed would be a further problem. Also the modalities of the representation and of the identification of participating groups yield difficult, far-reaching and still open questions.

[42] Volker Kauff, "Regierung, Parlament, Öffentlichkeit -- Träger der Forschungspolitik," (Government, Parliament, Public -- The Sponsors of Research Policy), in: Hans Matthofer and Volker Hauff (eds.) Forschungspolitik für eine lebenswerte Zukunft (Research Policy for a Future Worth Living), Grafenau, 1974, p. 15.

[43] Jürgen Habermas, op. cit., pp. 118-119.

Problems in Coordinating Research

We now briefly turn to the problem of the coordination of research. We do so for two reasons: First, the efficiency of science and research and the possibilities of their advancement depend on the organization and coordination of the research system. Second, the support of environmentally sound technologies involves a new, society-oriented task which poses new problems for research and its support and which cannot be carried out efficiently without a corresponding coordination of research planning and facilities. The organization of research is an institutionalized system of conditions that are the result and the expression of social structures and especially of economic structures and development tendencies. Such structures and organizations develop a life of their own and only change slowly and under the pressure of new tasks. Nevertheless, these structures can at least be influenced by suitable science and research policies.

Above all a better coordination would be required at the national level in order to make possible or facilitate an application of public funds that is oriented towards society. In this it is above all a matter of coordinating the individual sponsors of research and the individual programs. Beyond this it becomes ever clearer that certain large-scale technological projects can only be carried out with international or European cooperation. In the case of research projects on environmentally sound technologies, international cooperation could also increase the work pace of the research or make it more efficient. In this connection we think of the development of modern systems of transportation and new technologies of energy conversion. No less important is international cooperation in the national environmental policies of various countries and their protective measures. In this way it could, under some circumstances, also be possible to remove or avoid tensions between individual countries caused by different research environmental policies.

Coordination of Research on the National Level

Research Report IV of the German federal government is fully aware of the necessity for

coordinating the large number of national research sponsors. "The large number of planning, deciding and financing groups, which with their environmental politics are pursuing partly common goals, present the problem of an encompassing and coordinating framework of research policy. At the moment, the Federal republic is far from solving this problem."[44]

There are in particular three areas that require better coordination than exist today. First, there is the so-called departmental research of the various federal ministries. Second, there is research of the states (of the Federal Republic), which, for their part support and promote a number of rather small research institutes and are not necessarily coordinated or inadequately coordinated with the research on the federal level. Third, there are the large quasi-autonomous science organizations such as the Deutsche Forschungsgemeinschaft (DFG) and the Max-Planck Society (MPG).

Critics of the present organization of research see the weaknesses of departmentalized research in "personal and ministerial concepts of 'turf' that encourage a departmental separatism which is bent upon keeping everyone else away from its area of power."[45] A further cause for the inadequate coordination and planning of departmentalized research is the lack of reliable and all-encompassing possibilities of information. The continuing expansion of the data bank system for planned research support (DAVOR), which simultaneously stores the attained results of research, could counteract this lack of information.[46]

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[44] Research Report IV, op. cit., p. 16. On the necessity of better resolutions of problems in structure, organization and financing, see ibid., pp. 90-91.

[45] cf. R. Berger, "Forschungsplanung als Kommunikations- und Inhaltsplanung" (Research Planning as Communication and Content Planning), Wirtschaft und Wissenschaft, 1975, No. 1, p. 21.

[46] Such a data bank system was developed by the BMFT and is being installed in the Federal Ministry for Development and Science. cf. BMFT, DAVOR - ein Instrument aktiver Forschungspolitik (DAVOR - An

It will be significantly more difficult than the coordination of departmentalized research to synchronize the support programs of the Federal Republic and the states, because here "the 'separatism' is constitutionally anchored in a federal system."[47]

In order to approach coordination of research policy and research support, a structural agreement on mutual support of research of the states and the Federal Republic was recently submitted to the federal government. It is supposed to encompass the following organizations: The Deutsche Forschungsgemeinschaft (DFG), including special areas of research; large-scale research facilities; the Max-Planck Gesellschaft (MPG); the Fraunhofer Gesellschaft (FHG), as well as independent research facilities and related support and service organizations insofar as they are of multi-regional significance and of national economic and political interest and make significant contributions.[48] Research plans of trans-regional significance and of national economic and political interest are to be likewise supported, if there is significant demand. For the time being the lower limit for such research projects is to be set at 500,000 DM.[49]

In this way the large autonomous scientific organizations (such as DFG and MPG) would be subject to increased requirements of coordination, from which they have, up to now, kept themselves aloof, claiming self-coordination and freedom of inquiry.[50] This view is not fully convincing, since support of environmentally sound technologies means fulfilling socially necessary tasks in the planning and preparation of which a broader sector of the public would have to participate.

The problem of the coordination of research with-

Instrument of Active Research Policy), Düsseldorf, n.d., p. 7.

[47] R. Berger, (Research planning as communication and content planning), op. cit., p. 22.

[48] cf. F. Heerwagen, (Research policy in the Federal Republic) Wirtschaft und Wissenschaft, Number 4, 1973, p. 25.

[49] Ibid., p. 25.

[50] cf. R. Berger, op. cit., p. 22.

in industry turns out to be much more difficult. We have already referred to the lack of coordination as well as the duplication with its corresponding doubling of research facilities.[51] It seems doubtful to us or at least to be an open question, whether this duplication and lack of coordination and the concomitant excessive effort of project groups and research centers can be overcome. Cooperative research and the increasing importance of specialized research-consultant firms show perhaps that some industries are aware of the poor efficiency of traditional application of research efforts. At the same time one could imagine that the increasing governmental support of innovations including environmentally sound technologies might exert an influence towards better coordination in at least some industries.

However, the coordination of industrial research depends in the last analysis upon whether and to what extent it is at all possible to include industries in a public organizational framework and to organize the efforts of available public and private research and governmental capacities as rationally as possible. In this respect, some new beginnings are certainly discernible, but we still seem to be far from real coordination.

Finally, University research would have to be enlisted more than so far in environmental research and in the development of environmentally sound technologies. Up to now this has been the case only to a limited extent and, within today's institutional framework, it can take place only through careful contract awards and through financing of research plans by the DFG and the MPG. Basic research in the universities occurs according to traditional rules of freedom of inquiry. Despite all the changes since then, the characterization of university research expressed during the Second World War by a French scholar seems to us to have lost almost none of its relevance:

> Research at universities is characterized by a far-reaching anarchy which results from the tradition of complete freedom as well as the

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[51] p. 93 of the original volume - Ed.

checked individualism which prevails in the laboratories of the universities. Actually scientists all too often have a tendency to support total anarchy as a doctrine. Stories, e.g. how Archimedes discovered his immortal principle when a falling apple touched the tip of his nose, have had a destructive effect in the heads of scientists. They have given misleading, but nonetheless deceitful arguments to those who proclaim that discovery is solely the child of imagination, that research looks down upon all organization and that every effort to rationalize scientific work is a bureaucratic measure which could only limit the intellectual freedom of the scientist and consequently the process of discovery. This disastrous doctrine has still not changed its harmful effect, ... scientific research at universities has until now escaped every beneficial restraint on organized freedom.[52]

We are aware of the fact, that rather than promoting better coordination of research, some take the view that the simultaneous exploration of research ideas by different researchers and sponsors (state, industry and university) has its advantages and can even be more effective. This may be the case with less pressing problems. But let it be pointed out again that with environmentally sound technologies we are dealing with projects that are complicated, multi-disciplinary and involve considerable risk, and that the available facilities and trained researchers are in short supply. Under these circumstances the argument is strong for overcoming the present fragmentation of research and for coordination of the multiplicity of institutions that now commission or finance research, as well as for better synchronization of pressing research problems as part of a total research-political program. The choice, coordination or creation of the necessary infrastructure is then a secondary question. Whether it would be sensible or necessary to create a federal umbrella-organization in science and research in the form of an "Academy of Environmental Research and Science" is a question which we

[52]H. Laugier, "How Science Can Win the War," in: Free World, I (1941), No. 1, p. 59.

raise because of the urgency of the problems, but which we cannot examine in more detail.

In conclusion let it be emphasized again that clearly defined research programs and a coordination of support policies on the national level are an indispensable prerequisite for international cooperation in the field of research and development of environmentally sound technologies. In short, we are again involved, even if in a different context, in the search for a new strategy and policy of research organization.[53]

International Cooperation

In view of the fact that environmental burdens and their control involve national and transnational problems (air, water, radioactivity), research will have to go beyond national boundaries, quite apart from the fact that in some countries the material means and scientifically educated researchers are not available at all or are not sufficient to attack on an adequate level and overcome the multi-dimensional and interdisciplinary problems that result from the development of alternative technologies.

But this will be a long-term and difficult process, since "research and development represent today an economic and concomitant political power-factor that can hardly be underestimated. Therefore, along with the idea of cooperation, comes the reality of competition,"[54] and, as we must add, of sovereignty. At any rate, the striving for a coordinated international science policy has up to now had no decisive success. We have already discussed the lack of coordination and the lack of planning of science and research on the international level within the European continent.[55]

[53]cf. Georges Ferne, In Search of a Policy, OECD, The Research System, Vol. I, Paris, 1972, pp. 25-60.

[54]G. Marcus, "Zwischen politischer Opportunität und Sachlicher Erfordernis," (Between political opportunity and objective exigency) in: Wirtschaft und Wissenschaft, No. 4, 1973, p. 2.

[55]cf. p. 103 [of the original volume] and R. Dahrendorf, "Aktuelle Probleme Europäischer

In spite of these failures, it seems to us important to emphasize that the necessity of cooperation in the field of environmental research and support of environmentally sound technologies could become so pressing in certain trans-national problem areas, that joint concerns would force national interests into the background. Problems, like the pollution of the Rhine or the Baltic Sea, to name only two examples, cannot be solved at all without coordination of research and a joint establishment of new methods. Starting points exist within the OECD for cooperation in international research on the economic aspects of environmental policies. An extension of this cooperation to areas of natural science research, and especially of development of environmentally sound technologies, would be a pressing necessity here, and indeed not only within the European framework, but also at the international level, including the socialist countries. The beginnings for such international cooperation on a world-wide basis would be available with the creation of the environmental organization of the United Nations in Nairobi.

In conclusion let us again summarize the essential questions that are pertinent to the discussion. Whoever poses the question about the possibilities and problems of government support of environmentally sound technologies must tackle the question whether the traditional organization, non-existent coordination of research and science, and the support offered to date are appropriate for doing justice to the new tasks that result from a social goal of environmental protection. How can one improve on the application to date of specialized research? To what extent is the criticism justified, that space research and programs and other large-scale research were supported with excessive resources? What are the chances of success for the development and support of environmentally sound technologies by supporting research by private industry (subsidy, research contracts, etc.)? Can we altogether do without the inclusion of private industry given the shortage of funds and of trained researchers? In view of the social

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Forschungspolitik" (Present Problems of European Research Policy) in: Wirtschaft und Wissenschaft, Nos. 2 and 3, 1973, p. 2.

importance of environmental objectives and of the complex, interdisciplinary character of environmental problems, might there be a need for new federal institutions and arrangements that would have the task of opening up and coordinating new paths of science and for public and private research by means of an appropriate program? To what extent, finally, are new initiatives needed in respect to international coordination of research on environmentally sound technologies and their furtherance?

Financing the Research and Promoting the Diffusion of Environmentally Sound Technologies

So far we have discussed the problems of research planning including participatory decision-making and the necessity of better coordination of today's system of research. That concluded for the time being our treatment of the basic problems of promoting environmentally sound technologies. Before we try in the last section to draw some further conclusions, two problem areas will be dealt with briefly: the possibilities of financing the promotion of research and the diffusion of environmentally sound technologies.

Possibilities of Financing the Research

The financing of research received our attention in Part 3 [of the original volume], specifically in connection with commissioned research, with allowances and subsidies to private industry and public research institutes of the Federal Republic and of the states, which are financed by public funds. If we go briefly into further financing problems in the promotion of research and development of environmentally sound technologies, we do it out of concern that there are special problems because we are dealing with research tasks that, as has been repeatedly emphasized, are oriented towards social and not towards private-economic criteria of need. In other words, the question that interests us is whether and to what extent special problems will result from this fact. To be further investigated here is whether and what possibilities exist of having funds returned to the state by means of a system of sharing in the results, e.g. by recycling or by a revolving fund, which funds can then be used again for financing the promotion of environmentally sound

technologies. Problems of financing of innovative research are in general covered by separate research projects of the commission.[56]

State Profit-Sharing

Let it first be noted, as already mentioned, that there are today a lot of environmentally sound technologies and processes which, under pressure of existing environmental laws, some industries have developed and installed either in their own plants or have produced and offered them as so-called "remedial" technologies to meet the demands of the market. In these cases public financing of the research is no problem at all or only a marginal one. In the latter case (meeting a demand of the market) the well-known methods of financing, such as allowances, state loans with favorable payment and interest conditions, tax concessions (accelerated write-offs), investment credits for specific projects, all offer a deliberate inducement to speed up innovative investments as well as offering a contribution towards reducing certain risks. But then the questions arise right away whether it would not be appropriate to link such financial aid to conditional repayment obligations, so that the public funds expended (that is, taxes collected) are again directed towards the state for the purpose of continuing re-use for the future promotion of research tasks in the field of environmentally sound technologies and as relief for state budgets and taxpayers. These questions are being debated today, and people are more or less in agreement that the state's sharing in the proceeds can be appropriate. There are, to be sure, certain technical difficulties in determining and estimating the amount of the share, since the state's share would have to be set by reference to the actual financial proceeds to the industry, and determining these profits touches upon questions of cost calculation including the depreciation and price policies of the firms concerned.

We do not look upon these difficulties as insurmountable and consider it appropriate and necessary that the financial support of the promotion of

[56](West German) Commission on Economic and Social Change - Ed.

research in those cases in which the research leads to commercial sales or to success in the private sector will be completely or partly returned to the public budget through an equitable share of the proceeds.

This objective could be realized in the realm of patents and licenses by the state being given a share of any patents and licenses that result from its financing or co-financing of research projects; in other words, it would be a matter of long-term profit sharing. Here conflicts could arise concerning patent claims, especially if the state only contributes a small percentage of the total research costs. If the state should make too high demands on the resulting rights and profits, then the research enterprise would lose its incentive for innovation. It would therefore be necessary to determine the details of participation case by case.

No problems of profit-sharing arise with direct government research activity and awards of research contracts for developing environmentally sound technologies, provided that the public sector actually acquires the rights to research results and can fully transfer them to interested parties in the form of licenses.

State Support of Research Projects with Great Risk and Relatively Small Prospects of Commercial Utilization

In all cases where high costs and small prospects of commercial value are involved, incentives for private innovative research can be provided through specific state contracts, joint ventures, subsidies and government loans, or through tax reductions. Here is it a question of the instrumentalities which we partially dealt with in Parts 3 and 4 [of the original volume] and which is to be discussed only briefly here.

Government research contracts to industry and universities, for specific purposes defined by the state, have played an increasing role since the Second World War. In other words, such research contracts are a method that has already been widely used to develop research capabilities in the area of applied as well as basic research. Research contracts for the development of environmentally sound

technologies can also be awarded to private research institutes, to private industry, or to individual researchers. In all cases the state defines the objectives of the research and in this way exerts influence on the direction of the research. On the one hand, the state assumes the full costs and the risk when success is not attained. On the other hand, with contract research, the state acquires the rights to the results. As already mentioned, this makes it possible that through appropriate contract agreements a part of the eventual commercial profits flow back to the state. It is an open question whether government research contracts with industry are not associated with excessive costs, because such contracts are often on the basis of costs plus profit (including amortization). Moreover, the advantages of so-called spill-overs accrue to research contractors in the form of extensions of their technical know-how; these are usually not taken into consideration in calculating costs.

Joint ventures involve joint projects or undertakings, in which the state assumes part of the financing and the industry involved supplies the rest of the funds as well as the technical know-how. For the promotion of research in environmentally sound technologies this form of financing seems to be sensible and promising of success only when the state can determine the content and objective of research project. According to the experience thus far, it is not yet clear to what extent joint ventures offer an efficient means of support of environmentally sound technologies.

A subsidy is a contribution to the fulfillment of a specific research goal which is awarded by the public sector without or only with partial repayment obligation. In this way innovations can be promoted that have long periods of gestation and high risk. A problem with all subsidy policies is a lack of selectivity, which in the case of environmentally sound technologies could lead to a situation where innovations are promoted that would be developed anyway, that is, without allowances, especially when the legal framework has been established (for example, pollution limits, etc.) In addition, there are problems in determining the amounts of the required subsidies.

Government loans are different from allowances in

that they must be repaid with or without interest. Obviously, they are only involved in financing research projects when the risk of failure is relatively small and prospects exist for commercial use. In these cases state credits are only appropriate for businesses when they offer more favorable terms of repayment and interest than bank loans. Tax reductions and benefits, as for example increased write-off rates with R & D investments, are methods of financing which can improve the general climate for innovation without, however, promoting environmentally sound technologies in any special way. A differentiation of tax benefits according to the social desirability of the innovation (for example, by means of different depreciation rates) would make it possible to apply them to the promotion of environmentally sound technologies. An even more direct incentive for promoting research would be the granting of investment credits for specific research projects for developing environmentally sound technologies.

In order to be complete, let us here mention the so-called venture capital corporation, which can be established so as to supply capital for specific innovative projects in environmentally sound technologies within the framework of objectives set by the government. If these goals are not prescribed, then venture capital companies, with participation of the federal government, are hardly appropriate for promoting environmentally sound technologies.

The role of private foundations in financing research in environmentally sound technologies has hardly been considered up to now, although in other countries (USA) large private foundations have played a role in developing new technologies (e.g. new seed types), albeit with the problematic effects discussed earlier. In other words, what we have said about venture capital companies is also valid for the private foundations. As long as the necessary framework and environment goals or priorities do not exist for the environmentally sound technologies that are to be developed, then private foundations are at best appropriate for making up for certain omissions in public financing. Activities of foundations could be extended through appropriate legislation that includes selective determination of priorities, with emphasis on environmental objectives and especially on environmentally sound technologies. Private foundations could then

dedicate themselves increasingly to the financing of research projects that meet society's needs. However, that will depend upon an agreement as to the input of private and public funds, in order to avoid duplication and to assure a certain measure of cooperation within the framework of environmental and research policies.[57]

Corresponding principles are valid for the increased and directed utilization of the facilities of quasi-autonomous research societies such as the DFG, the MPG and the FhG,[58] for promoting environmentally sound technologies. The problems here concern the composition of review committees, to which we have already referred in connection with the discussion of public participation in the selection of objectives.

State Research Institutes

It is doubtful whether the financial assistance discussed above for the promotion of research in environmentally sound technologies is sufficient to meet the needs of the innovative technical tasks that environmental degradation presents today. In many environmentally sound technologies, complex, expensive and multi-disciplinary problems must be solved and priorities determined in line with the needs of society. This seems to us to be one further reason why many of these tasks would in principle have to be put in hand and financed by public, i.e. governmental, research institutes, as is already the case with the four big governmental projects. The fact that these research projects involved considerable uncertainties, likewise speaks for greater utilization of governmental research institutes.

Furthermore, areas of research, that are not now based in the public research sector but could be accommodated there, include, for example, the development of complicated, alternative systems of public

[57]For problems of private foundations cf. U. von Pufendorf "Stiften wozu?" (Why endowments?) in: Neue Ziele für Stiftungsinitiative, Economic-political Society of 1947, Frankfurt am Main, 1974, p. 15. cf. also Research Report IV, volume 3, supplement to Report VI/3251 of the German Parliament (lower house), 6th election period, p. 60 ff.

[58]Fraunhofer Gesellschaft - Ed.

transit and all those technologies that are being taken over by private industry only with great reluctance, if at all. Research in the area of alternative energy sources, e.g. solar energy, belongs here, as does also the development of new engines, if research results from within the automobile industry are too long delayed. At any rate, it is to be expected that the public research sector will increase in relative significance to the extent that the development of environmentally sound technologies is recognized as a very pressing sociopolitical task and is made the objective of the public research policies. Here it would be less a matter of expanding the capacity of existing state research facilities than creating new and specialized research institutes. According to the experience of Sweden, an expansion of state research facilities does not preclude certain industries from taking part in these research plans and, in any case, from being included in joint financing. Practically speaking, this would result in a considerable expansion of the public research sector. In other words, it will be a matter of setting up public research institutes that are especially concerned with environmentally sound technologies, are financed with public funds and operate under direction of the state. This is today the case only to a limited extent.

At the same time it must not be ignored that industry has at its disposal considerable research talents that must be used directly for the development of environmentally sound technologies; this is all the more important, since industry already has at its disposal considerable experience and trained researchers and is directly familiar with technical problems of the production process. It would therefore be wrong to do without the input of these resources and this knowledge.

Measures for Promoting the Dissemination of Environmentally Sound Technologies, Methods and Products

The previously discussed problems of financing research on environmentally sound technologies will now be supplemented by a short treatment of some of the problems and tasks that result from promoting the dissemination of environmentally sound technologies. Here it is above all a question of creating the necessary legal and institutional conditions, to

which we have referred repeatedly. Beyond this, there are the problems and tasks of providing the necessary information on environmentally sound technologies, changes in patent and license regulations as well as financial aid. In other words, instrumentalities and measures should be investigated that would be necessary to promote the introduction of environmentally sound processes and products, in private industry as well as in communities for the purpose of planning an appropriate and environmentally safe infrastructure and land use. Here, presumably, direct measures, such as emission prohibitions and regulations on abatement methods must be in the foreground, since, as previously noted, we cannot do without these measures for attaining the intended objectives.

Legal and Institutional Bases

More is involved here than what is understood by legislation on environmental protection or is under discussion in most industrial countries. With regard to promoting the dissemination of environmentally sound processes, it will primarily be a question of creating the legal prerequisites for determination and assignment of responsibilities for enforcing direct measures of environment protection, such as prohibitions, regulations and injunctions of various types, as well as the determination of limits on environmental degradation and emissions, and environmental norms in general. These measures presuppose the creation of institutions and authorities whose task it is to create a basis for formulating objectives and selecting the priorities by establishing social criteria. A further task consists of making clear the costs of environmental pollution and of environmental measures, as well as of comparing, with regard to their social consequences the alternative technologies that are coming into use or are new. Further, it is a matter of institutionalizing the dissemination of information to industry and to the public. Also, the monitoring and control of the above-mentioned measures and prescriptions and of the responsibilities of the various decision-makers and authorities require institutionalization and a legal basis.

We have proceeded from the assumption that government support of environmentally sound technologies and their introduction represent an integral

part of environmental and economic policies, which relates to an alternative and desirable development of society. We have not considered it our task to look into the connections between promoting environmentally sound technologies and economic policies in general, although it is clear to us that efficient research and environment policies could require legal and institutional measures, that in the end could bring about a new economic direction as well.

Dissemination of Information About Environmentally Sound Technologies

The spreading of knowledge and information about latest development of techniques is one road, but not the only one to governmental promotion of technology transfer. In the case of environmentally sound technologies, spreading scientific-technical information and the possibility of expert consultations certainly represent a necessary but still not sufficient condition for the dissemination of alternative technologies. A well-planned information system is of little use as long as no demand develops for such techniques, because many of these technologies could result in higher costs. However, if this demand is created because of the provisions of environmental law, then technical consultation and information are necessary, above all in smaller and medium-sized plants and communities that have fewer opportunities to get the needed knowledge by themselves. With the help of government, e.g. through centers of public information, documentation, and consultation or suitable conferences, the necessary process of dissemination could be promoted.[59] Special liaison groups could be charged

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[59] In the Federal Republic the Environment Information System (UMPLIS), already in preparation, could take over the task of making available to interested parties the latest developments of alternative techniques cf. Bundesrat, Bericht über die Ausgleichsabgaben auf Verbrauchsgutern und die Förderung umweltfreundlicher Produktionsprozesse (Report on equalization payments for consumption goods and the promotion of environmentally sound production processes) Pub. No. 280/74, 23 ff, publication 280/74, p. 21.

with improving communication between research institutions and industry. One could also give thought to small state research offices in big industrial centers, which could process relevant, new technical information and counsel the firms.[60] The advisers should perhaps be given some authority in supervision and control; they could also be given the right to determine whether the firms are actually introducing the most efficient and economic environmentally sound technologies.

The formation of such state information and advisement systems would thus fulfill two functions at once: First the state could inform private industry and the communities as completely as possible about the latest technical developments and areas of environmentally sound technologies and thus promote the process of dissemination. Second, such a policy would contribute to the state authorities themselves being better informed about the latest development of environmentally sound technologies. As we pointed out earlier, this would also be necessary for the assessment, determination or change of environmental norms, for determining the direct responsibilities of firms as well as for developing new research strategies.

New Patent and License Regulations

While patent protection doubtless represents an incentive for research and innovation in market economies, it makes more difficult and delays the dissemination process of innovations. To promote the spread of technical knowledge that is in the public interest, the existing patent regulations could be so changed that the transfer of technology would be hastened in the area of environmentally sound technology. Government policies of this sort could also be applied to innovations that are being carried out without state financial support, as well as (quite obviously) being the results of publicly funded research. Thus the possibility could result for the state to take over the patent entirely,

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[60] cf. Gösta Lagermalm, "The General Swedish Pattern for Applied Research and Development - and the Role of the Swedish Board for Technical Development," Stockholm, n.d. p. 23 ff.

leaving commercial exploitation wholly or partly to the private firms. Legal bases could also be created that would grant the state the right to withdraw the patent from a company; if the results of state funded research have not been applied in practice within a certain time, or if they are turned over to third parties by means of licensing there could also be legal provisions for compulsory licensing of inventions in the realm of environmentally sound technologies.

A change of license and patent regulations for promoting the spread of alternative technologies cannot, however, solve those problems that result from projects being developed within private industry but which for various reasons do not reach the public or the use stage [so-called "file projects"].

Financial aids for Promoting the Dissemination of Environmentally Sound Technologies

Financial aids in the form of direct allowances or tax abatements for the introduction of environmentally sound technologies represent state measures that doubtlessly can contribute to the promotion of applications of alternative technologies in the private economy. In local communities one could also imagine increased furtherance of dissemination through financial help of the states and the federal government.

The distribution problems in financial aids of this sort require special care, however. Thus the question could be asked whether and to what extent tax funds, that have to be used anyway for repairing damage to the environment, should also be employed for financing the introduction of environmentally sound methods. As a matter of principle this should only occur in exceptional cases and when it has been clearly demonstrated that without financial help environmentally sound technologies would not be introduced. Financial support by the state should be advocated only in those cases where the danger exists that the introduction of alternative technologies collides with other socio-economic objectives. For example, as a result of governmental regulation of the technology to be used, a company could get into actual economic difficulties, so that in the short run, jobs could be threatened. Especially in small operations (e.g. in the

agricultural sector) the necessary expenditure for changes in the area of production or product planning quickly exceeds the financial capacity of such operations, so that government aid would be justified. As an alternative, one could consider long-term loans at favorable rates in place of "sunk cost" subsidies. Problems also arise from the fact that state authorities are often faced with a lack of clear records and possibilities of control, and can judge only with difficulty whether an operation really would get into financial difficulties through appropriate requirements.

If state financial help is granted, then the authorities ought to have the right to influence the choice of the technology to be introduced. In principle it would be desirable that the granting of financial advantages take place within the framework of public environmental policy and be related to direct obligations of the private firms.

The problems are simpler with tax abatement or subsidies which involve consumer goods. In determining powered vehicle taxes, the more environmentally sound motors could without great difficulty be favored in their treatment. Likewise, private cars with low horsepower ratings, low consumption of gasoline, built-in exhaust filters, or engines with alternative fuels could receive tax advantages. As a further measure, the value-added tax or a part of it could be remitted for environmentally sound products, in order to make such goods more attractive to the consumer. In this connection we especially have in mind products (or their packaging) made of bio-degradable plastic; durable consumer goods with little physical obsolescence; foods that are produced with little use of chemical fertilizers or pesticides, and also of other such things. Such measures would be more feasible politically; they would hardly be sufficient, however, to solve the problems of environmental pollution.

The problems that result from the amount of financial help are mentioned here once again for the sake of completeness. Here it is to a great extent a matter of optimization, which can only be solved in the light of complete information, if they are not to give rise to unjustifiable demands on public funds.

From the Causation Principle to the Objective Principle: Technology as a Dependent Variable

In the course of our analysis of the possibilities and problems of governmental encouragement of environmentally sound technologies we came to the conclusion that it depends upon bringing the technically possible into harmony with the socially desirable. In our opinion, this can only be attained through articulation of elementary human needs while considering alternative technology possibilities and their consequences by means of participative planning. In other words, the development of alternative technologies requires a science and research policy and deliberate promotion of the introduction of new technologies that correspond to goals and priorities set by society. We are aware that such goal-oriented policies place today's industry in the West before new problems, that up to now have been confronted only very slightly and in few areas, and that impact assessments, which would be necessary to avoid negative "side effects," are still in the first stages of development. It is likewise clear to us that the new social tasks can hardly be attained with small changes; on the contrary they require a whole series of far-reaching changes of the social process of decision-making, which we have analyzed, as well as control measures that have been treated only peripherally. Environmental protection and the long-range improvement of conditions of life cannot be assured in the long run as the result of small steps and picayune solutions to problems. This does not mean that we reject that sort of solution on principle, but we only wish to emphasize that ad hoc solutions must also take place within the framework of a system-wide appraisal of consequences and with considerations of social goals and basic human needs.

Our thesis on the necessity and possibility of directing and promoting the process of technological development by means of suitable science and research policy stands in opposition to the concept, widely held today, that the development of science and technology has its own laws. This thesis of technology having its own laws rests upon the idea that technical progress is subject to internal laws, so to speak, is subject to an inner logic -- and is determined by it. In a system that is dominated by the principle of free scientific research, new

scientific insights and new possibilities for their practical use in the process of production would come about quasi-automatically. With the increasing number of these innovations and the resulting technologies the possibilities of innovations and their combination are presumed to increase exponentially. According to this view, humanity and society are not in a position to control this process of accelerating technological development; on the contrary, the exponential growth of technology determines, in increasing measure, the goals to be pursued, and without consideration of the consequences for society. In other words, for good or ill, man and modern industrial society are inextricably bound to this development.

Science and technology function as autonomous driving forces that impel modern industrial societies towards accelerated technical change. Even the systematic input of public funds for research and development has been able to change nothing basic here and is considered only the last phase of a developmental process that has been going on since the beginning of the great discoveries in the natural sciences. Society may indeed try to extricate itself from this process and the accompanying dangers, but in the final analysis it loses the battle and is a victim of the value-neutral "successes" and of the technological imperatives. In other words, scientific research is subject to a sort of self-regulation and determines the course of economic and social development by means of these technological imperatives.[61]

As plausible as the thesis of the autonomy of technology may seem, it first needs two important qualifications. Since the time when science and

[61]The thesis of a supposed autonomy of the development of science [as distinct from technology] will not be further pursued here; it, too, is problematic because it is increasingly clear that the development of science for its part is determined by the economic and social system or practice. Cf. Gernot Böhme, Wolfgang van den Daele, Wolfgang Krohn, "Alternativen in der Wissenschaft" (Alternatives in Science), Zeitschrift für Soziologie, Vol. 1, No. 4, October 1972, pp. 302-316.

research became the object of public support,[62] neither the research process nor its technological results can be regarded as autonomous. They are today, at least in some areas, the result of political decisions. It would be a serious error to overlook that thus far these political decisions have been determined by points of view and objectives derived from the organizational principles and interest groupings within the social system. While these goals and the decisions derived from them in respect to the promotion and choice of technologies in industrial societies have, during the last thirty years, become more or less exempt from public control, this does not mean that they cannot in principle be made subject to such control.

A further and not insignificant qualification of the thesis of the autonomy of the development of technology stems from the already mentioned fact that the choice of technologies that are introduced in industry takes place according to definite principles. These rest upon private economic profitability and on the cost and revenue calculations that determine this profitability. It is therefore quite possible and even probable that only those technologies have been developed and promoted that were promising success in the light of this profitability and were considered "rational." Therefore, up to now, a highly selective choice of technologies has taken place according to points of view that from the standpoint of society cannot necessarily be regarded as successful and rational but which on the contrary have led to undifferentiated economic growth. For this reason also, the thesis of the autonomy or self-regulation of technology needs major qualification. From a multiplicity of possible technologies and methods, capital inputs, choice of locations, etc., only those were developed up to now that promised success in the marketplace, while alternative technologies, which for example would have been necessary for the protection of the

[62]Which in almost all industrial countries can be traced back to the last century. Cf. the data on the origins of European policies in: Robert A. Brady, Organization, Automation and Society - The Scientific Revolution in Industry, Berkeley, 1963, pp. 79-88.

environment and the improvement of human living conditions (including economical conservation of scarce resources) have been neglected.

The environmental crisis, its social costs and the recognition of the fundamental openness and interdependence of economic and ecological systems demand a radical departure from the dogma of autonomous technology. The increasing degradation of the environment through emissions of harmful materials, exhaustion of resources and incompatibility of specific technologies and locations with ecological balances, as well as the endangerment of social continuity and the necessity of satisfying human basic needs, make necessary a fundamental reorientation of science and research policies and of economics. Every serious discussion of today's environmental crisis leads sooner or later to the question of the possibility of development and introduction of alternative technologies as well as the choice of technology and location in the light of their environmental compatibility. The development and choice of technology and of locations have thus become a problem. They should be discussed and must be studied and determined in the light of social goals and priorities, in order to prevent production and distribution from becoming the cause of the destruction of the ecological systems and of humanity. Thus the choice of technology becomes the key to policy for the environment economy and of society.

That this would mean a radical new orientation hardly needs to be outlined in detail. In contrast to every fatalistic position towards technology and the development of science, and to the view of current technology as a given measure (as an independent variable in theory) it will in the future be increasingly necessary to treat technology as a dependent variable. This would mean a reversal of our former thinking and actions, since it now becomes necessary to determine, change and direct the very factors which we have up to now considered as given. Such a new orientation necessarily brings up the problems dealt with in this chapter, on science and research policy, including participation in setting the objectives. The articulation of elementary human and basic needs with simultaneous consideration of ecological criteria, the social assessment of alternative technologies and alternative solu-

tions from the standpoint of their social desirability, seems to us to belong to the indispensable ingredients in future environmental policy.[63] In this sense we believe we can state that in the future the causal principle of today's environmental policy may be replaced by one based on final objectives -- a procedure in which explicit social norms become the starting point for policy on science and technology and thus for the social and economic policy. It might then turn out that the formulation and setting of objectives for the development of alternative technologies, as means to environmental and social policy, will transcend the national framework of today's sovereignties and require world-wide considerations of their global effects and the available resources.

SUMMARY

Research and environmental planning that is oriented towards the future requires the subordination of scientific-technical progress to the needs of society and conscious direction of technological development. This presents the special problem of how and by whom the social goals can be formulated.

Ascertainment of social objectives presupposes a systematic appraisal of the consequences of existing and possible new technologies: Only on the basis of such an analysis can goal-setting or priorities be worked out, especially with the help of "participative" planning.

The social nature of the objectives and the conflicts associated with the promotion of environmentally sound technologies, as well as the implications of science and research policy for the political order make it appear necessary to study the modalities of participative planning and if possible to refine them. We are exploring the possibilities of closer cooperation between research and parlia-

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[63] cf. K. William Kapp, "Umweltkrise und Nationalökonomie" (The Environment Crisis and the National Economy) Schweizerische Zeitschrift für Volkswirtschaft und Statistik, V. 108, No. 3, December 1972, especially pp. 244-247, and François Hetman, op. cit., p. 389.

ment, new composition of the advisory bodies as well as plebiscite methods, such as the kinds of popular initiatives and referenda common in Switzerland, as well as institutionalized hearings.

The value indicators which the market supplies in the form of prices are inappropriate for the formulation of objectives. Supply and demand offer no signals or at least inadequate ones for determining objectives in the promotion of environmentally sound technologies. The conventional methods of formulation and evaluation of goals, such as cost benefit analyses, might be justified, as long as they involve short-term, one-dimensional problems and of optimization analysis .for the attainment of previously set objectives. Projects for the development of environmentally-sound technologies, however, have long-range consequences that are difficult to grasp, and the specific goals must first be worked out.

Such goal formulations must be oriented towards social and basic human needs that have been formulated as objectively as possible; that is, the objectives must have concrete content. At the same time ecological indicators are an important prerequisite for formulating policy objectives for the environment and thus the promotion of environmentally-sound technologies; for the formulation of environmental goals, they are, however, inadequate. In order to set priorities, a political process of evaluation and decision is needed.

The basis for determining social needs is the scientific knowledge of what is indispensable, i.e., what cannot be done without, in order to ensure social continuity and thus public health. The possibility of a logical derivation of basic needs offers no guarantee of a general consensus. The latter is the more difficult to attain, the more the objectives under discussion give cause for conflicts of interest.

We can distinguish several kinds of goal conflicts. One of these conflicts concerns the high costs of alternative methods and measures of environmental protection. However, focusing on that type of cost, without consideration of the social usefulness or avoiding environmental destruction, closes the road to socially relevant evaluations,

comparisons of uses and expenditures. Many conflicts concern the distribution of costs.

In the short term, the introduction of alternative technologies can lead to a conflict situation, if the ability to compete and thus the activity itself is threatened through higher costs. However, a government program of support for the development and introduction of environmentally-sound technologies creates effects on new employment. If it comes to a change of the structure of production or employment, then employment and income losses must be compensated for by an appropriate social structural policy as well as by retraining programs.

In introducing new technologies, goal conflicts can arise because environmental damage to one environment sector is transferred to another, or the negative effects of technologies become the burden of specific social groups or future generations.

The promotion of environmentally sound technologies requires not only a continuous appraisal of possible technical effects and a clarification of the social consequences of alternative technologies, but at the same time requires the search for and evaluation of alternative solutions to attain the social goals.

The future policy for promoting environmentally sound technologies requires broad participation of the public. This participation is necessary both in the planning of the research projects and in the choice of objectives or the construction and location of production plants. The clarification of the possible effects of technologies and an increased dissemination of information are prerequisites for any democratic and participatory formation of opinion; it is, however, not sufficient. Those whose basic needs are at stake must participate even in the preparation of research-political decisions and work on the necessary knowledge. This requires their suitable representation within the total decision process.

For a goal-directed promotion of research and development of environmentally-sound technologies, a further need is the coordination of research on the national and international levels. The transnational character of much environmental pollution

and the fact that research and development demand high expenditures make international coordination and cooperation, as well as exchange of results, especially necessary.

In order to funnel to the state further financial means for research and development of environmentally-sound technologies, one might consider the state's sharing in the proceeds of projects that are financed with state help and where prospects exist for commercial success.

The financing of government promotion of research ideas with great risk and relatively small prospects of commercial value, might, in addition to the above-mentioned means, such as state research commissions and allowances, also call for joint ventures, state loans and capital-sharing companies, where for an effective promotion of environmentally-sound technologies the influence of the state on the determination of objectives would have to be institutionalized in all types of financing.

Part of government funds for the research and development of environmentally sound technologies will flow into government research institutes, which due to the costly, multi-disciplinary and society-oriented character of such innovations would be most appropriate as research contractors. However, it must not be ignored that industry has at its disposal considerable research sources that must be brought to bear directly on the development of environmentally sound techniques.

With measures for promoting the dissemination of environmentally sound technologies, methods and products, the most important thing is the creation of legal and institutional prerequisites; there direct measures, such as orders, prohibitions, regulations and environmental standards must be foremost, and appropriate institutions must be created to supervise and control them.

The dissemination of environmentally sound technologies could be promoted by the government through the creation of public information and advisement systems. Here, on the one hand, information on the latest state of the art would be passed on to the private economy and to the communities; on the other hand the state authorities could keep themselves informed of the latest technical developments by means of these systems. Patent and license regulations could be changed so that the process of dissemination is speeded up. Taking over of the patent by the government, as well as the compulsory awarding of licenses are among the possibilities here.

If the introduction of environmentally-sound technologies comes into conflict with other goals of society (e.g. full employment), because of the high costs connected with it, then state financial help would have to be granted. Especially in the realm of consumer goods the sale and thus the dissemination of environmentally sound products could be favored in their tax treatment.

Contrary to the fatalistic concept of and development of science and the practice of falsing existing technology as a given quantity (as an independent variable in theory), future analyses should treat technology as a regulated quantity.

It will also be increasingly necessary in the future to replace the causal principle of present environmental policy with that of the end result -- a process in which explicit social norms become the starting point for public policy on science and technology and thus in social and economic policy as well.