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Meeting No. 20: Population in Relation to the Development of Non-biological Resources

Preliminary draft report submitted by Frank W. Notestein, Rapporteur

(This draft is circulated for comment among participants in the Conference. It is not for publication in its present form).

Introduction

The object of this meeting was to assist in providing background for subsequent meetings by considering the non-biological materials and the energy on which man depends for his livelihood. With such a huge and highly technical topic, broad perspective is all that could be hoped for. For each of the major types of resources there was an attempt to indicate the regional distribution in the world in relation to: (1) existing levels of utilization by the population and (2) the possibilities of, and obstacles to, expanding the utilization of resources to meet the need for improved living conditions of growing populations in the near future.

A realistic consideration of the possibilities for increased utilization of energy and non-biological materials depends heavily on developments in agriculture, which was the topic of meeting no. 22, and in the economic field of capital accumulation, investment and employment, which was the topic of meeting no. 24. Participants in this meeting (no. 20) were therefore asked to limit themselves to the barest essentials in those fields. Two economic topics not adequately treated elsewhere in the Conference were included in this meeting because they were considered to be indispensable to a consideration of problems of resource utilization. One was the relation of industrial demand for raw materials to the opportunities for development of under-developed countries. The other was the use and limitations of international trade in overcoming inequalities in the world distribution of population and resources.

The background papers available for this meeting are mentioned elsewhere in this report.

The meeting itself took the form of a panel discussion with the following program:

Chairman — Dr. Gunnar Myrdal, United Nations

A. Population size and growth in relation to energy
   Dr. Edward A. Ackerman, U.S.

B. Population size and growth in relation to non-fuel minerals and creatable resources
   Prof. Ferdinand Friedensburg, Germany
   Dr. S. Zuckerman, U.K.

C. Problems of utilization and trade
   Dr. Stacy May, U.S.
   Mr. Folke Hilgerdt, United Nations

D. General summary

A. Energy

There is very little relation between the size of population and the amount of economic output in the world's regions. On the other hand, energy consumption and economic output are very closely correlated. For example, Guyol's background paper shows that at one extreme Asia, with 53% of the world's population, uses only 14% of the world's inanimate energy and produces only 13% of the world's economic output. At the other extreme, North America, with only 7% of the world's population, uses 41% of the world's inanimate energy and produces 40% of the world's economic output.

All improvements in the level of living involve a staggering demand for increased energy supplies far beyond anything indicated by a mere projection of past trends. The conventional world energy sources of today cannot possibly meet these demands of the future. Efforts need to be directed toward the development of new and non-conventional sources of low-cost energy.

So far as global energy resources are concerned, none of the authors of background papers foresees major difficulties in the years up to 1980. The two authors who treated the subject, Guyol and Schumacher, utilize somewhat different assumptions both as to population growth and as to the per capita increase in energy use. For illustrative purposes Schumacher suggests a doubling of annual energy inputs between now and 1980, and Guyol uses a multiplier of 2.9 times the 1950 figure

to reach 1980. Even such large multipliers do not contemplate any spectacular improvement in living conditions. Schumacher allows for a 2% and Guyol for a 2.5% annual increase in per capita energy use. But, as Schumacher points out, some appreciable increase in per capita use would be necessary just to prevent a deterioration of living conditions in a growing population. However, neither author foresees major obstacles in global terms to providing modest increases in energy inputs per capita for a growing population up to 1980.

Looking beyond 1980, Schumacher foresees difficulty before the end of the present century if there is continued growth of population and expansion of energy utilization along past lines. He holds "...that 'Western' industrialization, as it has grown up over the last 50-100 years, does not at present possess a permanent energy basis".

On the other hand he does not expect this prospect to become an "active force for change" in the next 25 years because oil and gas, in spite of their relatively short life expectancy, will be able for another 25 years or so to compete successfully with coal and to determine, on the basis of their own production costs, the general level of fuel prices. Continued expansion beyond 1980, on the other hand, would undoubtedly encounter severe obstacles.

Turning from the global to the regional situation so far as coal is concerned, Schumacher points out that regions outside North America, Europe and the U.S.S.R. and China contain almost half of the world's population but only 4% of the world's coal reserves. These figures make

it clear that coal can never in these "other regions" become the energy basis for an economy developed on the pattern of Western industrialism. Even in India and Japan any large-scale industrialization based on indigenous coal could only be short lived. Moreover, all agree that any substantial mitigation of regional inequalities in the distribution of coal by means of interregional trade would encounter insuperable obstacles of cost. There are, Schumacher recognizes , possibilities "that something might turn up. This expectation, supported by entirely premature hopes fastened on atomic energy, is likely to stand in the way of a realistic appreciation of the energy problems to be faced by industrialization on the 'Western pattern'."

In a background paper on oil and gas, Thom, without presenting estimates of either needs or resources, takes a much more optimistic view than Schumacher. He believes that world oil and gas production may "...reasonably be expected in adequate volume for many many years to come, which is to say, beyond the time when intra-atomic energies will have begun to replace oil, gas, and coal as the major source of energy for world purposes." It is also Thom's belief that it is entirely feasible technologically to supply natural gas to every large city and region of Europe, North Africa and Southwest Asia.

So far as fossil fuels are concerned, therefore, there seems to be general agreement that the world supplies are reasonably adequate until 1980. Thereafter, opinions range from the anticipation of rather difficult shortages of the most mobile fuels to high optimism based on

wide known occurrence, new economies in transportation, and the past achievement in discovery and production in North America.

Currently the fossil fuels are supplying between 75% and 80% of the world's inanimate energy. These are capital fuels, stored through the ages, which cannot be replaced once they are exhausted. The world, however, receives from the sun each day vastly more energy than man consumes. Indeed, Daniels points out in his background paper that the solar energy falling on an acre of land greatly exceeds the heat requirements for one person. The difficulty is that it is not possible at present to convert this energy into useful form except through agriculture and to a minor extent through water power. Income energy today constitues some 20% to 25% of the world's total. Fuel wood and other non-commercial fuels will doubtless continue to be important in isolated areas, but their continued use represents a failure to solve, rather than a solution to, the energy problem.

Outside agriculture, man's commercial use of income energy takes the form of water power which currently represents less than 6% of the world's energy but, as Aubert points out, is much more important than the figures on energy production would suggest because of its complementary products of flood control, irrigation, and navigation.

There is perhaps no better example than the case of water power of the need for detailed consideration of all the physical, economic, social, and demographic elements of the situation in initiating plans for development. Without the necessary population, skills, raw materials, and effective organization the development of water power can be a

costly failure. In the appropriate setting, and with wise choice among the alternative uses for water, its development can be much more important than figures on power alone would suggest.

At present, aside from agriculture, there is little practical use for solar energy because of the low efficiency and high capital costs of converting it into useable form. Where fuel is very expensive solar heat can now be used for small home cookers, and there are reasonable prospects, according to Daniels, that within a few decades solar energy will be used for at least partial heating and partial cooling of homes -- again at high installation but low operating costs. There are theoretical possibilities in the direct production of electricity, in photosynthesis, and the freshening of salt water, but Daniels thinks that nothing on a substantial commercial scale is in sight, and there is every prospect that initial applications will require high capitalization and be costly. Meanwhile, it is important in view of the heavy drafts being made on capital fuels to promote research on the application of solar energy.

Overshadowing all questions concerning the availability of energy from conventional sources is the prospect of energy from fissionable materials. Should this form of energy become relatively cheap, most of the problems would be solved, because the supply of potential fuel from this source is virtually unlimited and its transportation is almost costless. Nevertheless, Isard and Whitney do not expeot atomic energy to fill an appreciable proportion of the world's requirements by 1980.

Many technical problems of using atomic energy on a scale that would significantly affect the world situation remain to be solved. Even when they are solved, the present prospects are that capital investments required for its utilization will be extremely high. So far as is known now, the main prospects for the industrial use of atomic energy will arise in situations in which conventional fuel is expensive, capital abundant, and there is a ready market for products of fission other than heat. In short, atomic energy is, on present information, much more likely to provide a long-run solution to the fuel problem of the highly developed and heavily capitalized nations of the world than it is to contribute in the foreseeable future to poor, energy-starved, and under-developed regions of the world.

In the near future, and perhaps in the indefinite future, given hoped-for developments in the atomic field, the world as a whole will not face major problems of securing adequate energy. This conclusion however, loses much of its significance by virtue of the costs of transportation of most fuels. One of the most important distribution problems is that of moving adequate energy supplies from surplus areas to the great energy-deficient crescent of the Eurasian continent. Unless new energy sources are discovered to take the place of oil and gas before they are exhausted, many parts of the world will be in serious trouble - among them some of the most densely populated. Europe is already feeling the pinch on coal, and can only expand its energy use rapidly by increasing its consumption of oil and gas. Areas with vast resources include the U.S.S.R. and China, the Middle East and North America. Most of the rest of the world, including something between a third and half of the earth's population, has wholly inadequate supplies to provide reasonable levels of living for the present population, and rather poor prospects for obtaining them on a sustained basis in the foreseeable future. The solutions can now be imagined, but at present they cannot be realistically foreseen.

In the discussion following the summary of the background papers, Ackerman drew attention to a number of problems concerning the relation between population and energy resources which have yet to be adequately

dealt with. One was the effect of energy use of demographic changes - for example, the possibility that increased availability of liquid fuels and low-cost electricity in rural areas, by improving the quality of life in these areas and thus retarding the growth of cities, might result in an increase in the birth rate.

Energy resources need also to be studied in combination with other natural resources to understand how they together relate to population. In this respect, Ackerman pointed out that the use of energy is important to assist in the improvement of present low-grade primary resources in order to increase their productivity and to promote the use of the earth's more abundant materials as a substitute for the less abundant. For example, improvement in land productivity may be brought about through the use of low-cost fertilizers, refrigeration and air-conditioning, but the key to all these is low-cost energy resources.

Attention was called to the implications for public policy of prospective future energy shortages and to the possible desirability of diverting some consumption of liquid fuels away from purposes of low social value.

Other speakers expressed the view that the background papers took too pessimistic a view of possible future technical improvements and that considerable more research devoted to innovations on a national and international scale needed to be undertaken to provide a relatively cheap form of energy supply.

B. Non-fuel minerals and creatable resources

Iron, copper, lead, zinc, aluminum and sulpher constitute the principal non-fuel minerals which are indispensable to modern economic development. While the production of these minerals has kept pace with the rise in population in recent decades, the stage will eventually be reached when new resources will have to be discovered or better methods of utilizing inferior ores evolved to meet the demands of future population growth. Good deposits of iron ore are found in every continent and in nearly every country. Deposits of some of the other important metals are less plentiful and it has been estimated, in the background paper by Krishnan and Jacob, that at the present rate of exploitation the known resources of copper might be exhausted in from 30-100 years and those of lead and zinc in about 30 years. Supplies of bauxite occur in many countries and will probably enable the world to meet the demand for aluminum for many decades to come, particularly in view of expected technological improvements. Sulphur resources may be considered practically inexhaustible.

Technical development within the next 20 or 30 years and economic progress in the under-developed countries may bring an even faster exhaustion of certain of these minerals. However, as pointed out by Friedensburg in the discussion, the definite limit of supply may never be reached, owing to the progress of techniques and the utilization of new deposits of ores previously regarded as unminable.

A number of factors may tend to increase the cost of mineral production in the future. Those cited by Friedensburg include the greater depth of mining as the more easily reachable deposits become exhausted, increasing

distance between the mine and consumer, and the demand for rising wages on the part of the miners.

Mineral resources are not uniformly distributed by regions in relation to population. Moreover, the production of metals and usable products from these minerals does not follow the same pattern from country to country as the distribution of resources, for the highly industrialized countries utilize not only their own resources but also import considerable quantities from the less-developed countries. Thus, the smelting and manufacturing facilities in the different countries are not commensurate with the magnitude of the resources the countries possess. The industrialized countries, because of their advanced techniques are also better able to utilize ores of a lower grade and to recover most of the useful ingredients as by-products. Per capita consumption of metals and minerals bears a close relationship to the stage of development of different countries. The countries which show a high consumption are mainly those of North America, Western Europe and Oceania, while those of Asia (except Israel and Japan), South America and Africa are much lower on the scale.

In recent years there has been an increasing realization of the need for economic planning and industrialization as a means of raising living standards of the population. Mineral resources play an important part in increasing the national wealth and it has become apparent that local resources should be used not merely for export but should be developed to the fullest extent possible for internal use. Shortages of technologically trained personnel and of the required capital for the establishment

of metallurgical and chemical industries are obstacles to increased production and consumption of minerals in many countries. However, there are indications that the rate of consumption is rising and that under-developed countries are learning to consume more and more mineral products. While it may take a long time for these countries to achieve a level of consumption equal to that of Western Europe, the general trend is unmistakable, Messrs. M.S.Krishnan and K. Jacob conclude in their background paper on non-fuel mineral resources.

Recent decades have also seen a rising international interdependence in the world market of mineral raw materials. There is a growing tendency toward concentration of production of minerals in a relatively few places of mining, to a large extent in the so-called under-developed countries. As the contribution of the non-industrialized countries to the world supply of minerals is indispensable to economic progress, Friedensburg believes consideration should be given to the possibility of declaring mineral wealth an international asset not subject to the disposition of changing governments of a single country. It was pointed out, however, in the discussion that the less developed countries might look with some reluctance on giving up their main assets to international control and that it was desirable that these countries be permitted to use their resources first of all for their own benefits. One speaker held that the law of the market which rules world economy should be modified so as to promote consumption of materials in under-developed countries at the expense of some unessential consumption in industrialized countries.

In addition to the possibilities of creating new sources of energy and non-fuel minerals, increasing attention has been given to the prospects for meeting some of the world's needs for other raw materials through unconventional methods of production. The outlook for revolutionary progress in this direction does not appear very optimistic, however, at least for the next 25 years, according to Zuckerman. The development of new non-biological resources requires technical knowledge, power, and capital, and therefore the effective demand is likely to grow most quickly in the already advanced countries, while the need is greatest in the less developed countries where population growth is likely to be most rapid.

The development of synthetic nitrogen for use in agriculture may play a bigger part than any other single factor in increasing food supplies in the next decade The supply of nitrogenous fertilizer is a limiting factor to the amount of vegetable growth obtained from solar radiation, but unlike phosphoric and potash fertilizers, it can be chemically produced. Atmospheric nitrogen can be converted into fertilizer nitrogen for utilization by plants, but the process requires the use of fuel, a wasting asset and considerable capital. As the cost per unit of nitrogen production tends to be inversely proportioned to the volume of output, large-scale manufacture is favoured. This works a hardship on the under-developed countries, where the need for increases in food supply is most intense. Some promise is offered by recent developments in fixing atmospheric nitrogen in smaller plants which could meet the needs of under-developed countries with a supply of fuel.

Aside from nitrogenous fertiliser, the major creatable resources are sulphur and high polymers. Sulphur and sulphuric acid play such an important role in industrial progress that over-all consumption of sulphur can be taken as an index of total industrial activity in a country. In agriculture, sulphuric acid is used to convert insoluble rock phosphate into a form soluble in water, so that the phosphorus is immediately available for plant growth. The principal sulphur domes have been heavily exploited, and attention is now being turned to the production of sulphuric acid from iron pyrites and also toward discovering a suitable method of extracting elementary sulphur from these same raw materials.

The control of the intermolecular combinations of relatively-simple organic molecules in the process of polymerisation has led to the mass production of many new and versatile materials, including synthetic fibres such as nylon and dacron, synthetic rubbers, resins, and styrene and vinyl polymers. The raw materials for these products are obtained either through wasting assets, such as coal and petroleum, or from renewable assets, such as cellulose and proteins. As the cellulose is provided by vegetation of various kinds, the amount of land it requires as compared with that required for the production of natural fibres assumes importance. There is also competition between the use of land to produce cellulose or food and in the future, food is likely to be in greater demand than textiles.

The economic practicability of obtaining food supplies from unicellular organisms has yet to be proved. Even if the chemical industry could be expected to add significantly to the food supply, and wasting assets of coal and petroleum would have to be used in the process. It would be preferable for

synthetic chemistry to devote its efforts to the manufacture of essential food nutrients such as vitamins, certain specific amino-acids and other trace elements, which are obtained at small cost in energy and material, and release the land for the production of high yielding crops.

C. Problems of utilization and trade.

In his background paper on industrial raw materials Stacey May supported the following seven conclusions:

1. In 1950, "world" (excluding U.S.S.R., mainland China, Mongolia, North Korea, East Germany, East Central Europe, Albania, Bulgaria and Roumania) production of industrial raw materials amounted to about $46 billion, of which well over two-thirds were produced and over 90% consumed in countries with relatively advanced industrial economies containing little over one-third of the world's population.

2. Although the under-developed or "primary product producing" countries produced less than a third of all industrial raw materials, they supplied about half of all imports of such materials that the major industrialized areas received through international trade. This category of exports provided more than half of the total foreign exchange earnings of the under-developed areas from trade with industrialized countries.

3. Contrary to widely held preconceptions, the long-term record does not reveal any marked degree of price or demand instability in the markets for industrial raw materials or for primary products as a whole as compared with manufactured goods. In fact, since 1940 the terms of trade have favored most primary products to a marked degree and the evidence suggests that this trend is likely to continue for some time to come. This suggests the wisdom of a policy on the part of the under-developed areas of making a strenuous effort to increase their present share of the raw materials segment of world export trade and it raises sharply the question of whether

urgent proposals for international controls that would freeze the relationship between primary and manufactured product prices would not serve the interests of industrialized rather than under-developed nations.

4. The 1980 "world" consumption of industrial raw materials is projected at about $80 billion (in 1950 prices) of which about $50 billion might enter into international trade, as against $46 billion of consumption and $27 billion of trade in 1950. Such an increase in consumption should afford the presently under-developed areas an opportunity to increase their production of industrial raw materials from the $14.5 billion level of 1950 to something like $31.5 billion in 1980, and their exports from $13.5 to $28.5 over the same period. Increases of this magnitude, approximately double their expected population increase, should exert a markedly stimulating effect upon the economies of the under-developed areas.

5. The above projections are contingent upon a growth in the per capita demand for industrial raw materials in other parts of the "world" comparable to that which is projected for the United States as a continuation of its trend over the past 50 years.

6. The potential expansion of industrial raw material production and trade is dependent upon a sufficient supply of investment capital. The capital cost of raising the output of industrial raw materials by as much as $17 billion in the under-developed areas may be of the order of $25 to $34 billion, or $800 to $1,100 million per year over the thirty year period. Such a sum should not be beyond the means of even the capital-poor areas' own investment potential, although there should be a very strong incentive for the industrialized nations to provide this capital wherever reasonably

hospitable opportunity is afforded. This would free the domestic investment resources of the under-developed countries for commitment to manufacturing developments or other constructive internal purposes.

7. Finally, on the basis of this analysis it appears that much of the literature dealing with raw materials in relation to the under-developed areas requires rewriting. In most studies of the development process, raw material has been made the villain of the piece. The evidence assembled here suggests that it should be made the hero — not as a substitute for manufacturing and a generally broadened base of economic activities, but as the single best opportunity in sight for providing the means for achieving industrial progress. The under-developed areas should take vigorous advantage of the opportunities for increased production and trade offered by a very favorable demand and price outlook. They should use to the limit their special advantages deriving from the possession of the most economic stores of potential supply to inaugurate processing at the source rather than at the terminus of export. They should emply the need of manufacturing nations for raw materials as a lever to pry from them the funds for the capital investment upon which increased output depends. They should employ the foreign exchange earned from increased raw materials export to buy the equipment needed to found a domestic industry. In short, by adopting a wise strategy in this field, the presently under-developed areas can make that designation inapplicable, and move steadily toward the achievement of well rounded industrial economies.

In the discussion following the presentation of May's conclusions, Ackerman called attention to the fact that while under-developed countries

with a low population-resource ratio might profit from the opportunities for increased production and trade of raw materials offered by the favorable demand and price outlook, these conditions would not be so likely to prove advantageous to the densely populated under-developed countries, such as India for example, which have mainly their labor to sell. Another speaker urged that the under-developed countries not be looked upon solely as potential sources of raw materials, but that they should be given an opportunity to benefit from economic development as the present industrialized countries did in the past.

The question was also raised by other speakers as to whether May's conclusions would in all cases have been the same if his analysis had been broken down to deal with more of the particulars involved.

In commenting further on his paper, May pointed out that the fuel segment represented only 2 1/2 per cent of total industrial output which would indicate that even a considerable increase in cost of energy would not be an insuperable hindrance to a growing industrial output.

In his background paper, Hilgerdt cited the history of the last century as suggesting a refutation of the proposition that the movement of factors of production and trade in goods are "... alternative methods for offsetting inequalities in the distribution of resources." Instead, he says "...the movement of labor and capital has paved the way for trade." Trade, he holds, results from discrepancies in the geographic distribution of the factors of production, but it does not tend to equalize the supply of such factors. Indeed, by opening profitable channels of production, it may result in a further increase of the original discrepancies. It is frequently held that

if goods moved without hindrance, the uneven distribution of resources would be of little concern, and there would be no such thing as over-population in any given area. Hilgerdt thinks, however, that too much importance can be attached to the natural and institutional barriers to trade. Even without such barriers in under-developed countries, wages would not rise to the same level as in industrial countries. In this situation, the price of at least one factor of production, namely labor, hardly tends to be equalized through trade. In other words, a reduction in the discrepancies of national prices of goods and production factors that is brought about by trade, does not imply that the inequalities in the distribution of population and resources have been overcome to a corresponding extent.

The key to the issue, Hilgerdt believes, lies in the absence of capital accumulation and investment which "does not easily occur in societies that have not accepted modern ways of life." Nor does he think that it is by any means certain that "...the future economic life of these countries will be woven on the pattern of the Western world. The people may be quite unwilling to behave in accordance with Western notions of 'economic man'. Thus, obstacles to economic development are not only technological and financial, but result from valuations which can only be gradually changed."

One of the possible ways out of the dilemma would be, he thinks, to utilize modern technology in a manner permitting organic economic growth without the disturbance of village life, family ties, and highly regarded social values generally. Small-scale dispersed industrial production of many types of tools and based largely on locally produced materials might be

economical and permit a gradual change in mind and outlook. However, on one point such change is, he thinks, imperative: "without a new attitude with regard to family size and birth control little economic progress can be achieved in over-populated countries. The development of local markets not closely tied to those of the nation would not require heavy initial outlays, nor be mainly dependent on international markets which the industrially under-developed countries can scarcely hope to capture from the industrially advanced nations."

D. General summary

In the briefest possible terms, the results of the session may be summarized as follows:

1. Participants from the Communist countries expressed considerable optimism as to the future production of energy and materials to meet the needs of growing populations, citing as evidence the past experience of the industrialized countries, their own recent experience, and the possibilities of future technological and scientific progress.

2. None of the participants foresaw immediate difficulties in expanding the production of either raw materials or energy very substantially during the next quarter of a century.

3. However, many of the participants pointed out that the difficult problems were regional rather than global in nature, and that, if the object was to improve the quality as well as the quantity of life, the demands for both materials and energy would be almost insatiable.

4. Moreover, the needs for increased production were particularly

acute in the densely settled regions with low levels of living, and in many such regions the prospects for meeting these needs from conventional sources were not very bright.

5. It seemed to be rather generally agreed that both in the field of creatable resources and in that of non-conventional sources of energy present indications were that technological innovations are likely to be most significant for the industrially advanced and heavily capitalized nations of the world.

6. There are considerable possibilities of mitigating these difficulties through the further development of international trade, but such developments alone seem unlikely to solve some of the most pressing regional problems.

7. There is general recognition of the need for intensifying the search, at both national and international levels, for cheap energy resources and cheap materials, without which rapid rises in living levels are not likely to come to many of the world's poorest and most densely settled regions.

The meeting had available background papers by the following individuals: Jean Aubert, Farrington Daniels, Nathaniel B. Guyol, Folke Hilgerdt, Walter Isard and Vincent Whitney, M.S. Krishnan and K. Jacob, Stacy May, E.F. Schumacher, Taylor Thom, and S. Zuckerman. The following additional persons participated in the discussion following the summarization of the contributed reports: Edward A. Ackerman, Angelos Angelopoulos, A. Arca Parró, Josif Bogdan, Mordecai Ezekiel, J. Fourastié, Ferdinand Friedensburg, Ivan Kouzminov, Henri Laugier, Evgény Mateef, Clément R. Mertens, Timon Rjabouchkin and Alfred Sauvy.