Technological and Social Impact Assessment of Resource Extraction : The Case of Coal

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Environment and Behavior 1975 7: 307
DOI: 10.1177/001391657500700304

TECHNOLOGICAL AND SOCIAL IMPACT ASSESSMENT OF RESOURCE EXTRACTION
The Case of Coal

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There are essentially two methods for extracting coal: underground (or deep) mining and surface (or strip) mining.[1] There are significant differences between underground and surface mining,[2] the most notable of which is that in the former a mining technology is used which does not substantially disturb the surface of the land in proportion to the volume of underground material disturbed. In the latter, the technique employed results in disturbances of significant portions of surface area per unit coal actually recovered. This reaches one kind of extreme in contour stripping, where the geological formations overlaying coal seams (called overburden) are dumped downslope, thus affecting as much as five additional acres of surface otherwise unaffected for every acre of overburden actually removed. This difference between deep mining and strip mining is manifested in the fact that activities on the surface (such as agricultural production) can and do

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AUTHOR'S NOTE: *The author acknowledges the assistance of the National Institute of Mental Health through Grant RO 1 MH 25276-01. Other people contributing in the project include Mary McClure, Warren Haydon, Paula Selkowitz, Lana Buchman, and Vinny Farella.*

Environment and Behavior, Vol. 7 No. 3, September 1975

proceed while coal is being deep mined from shafts and slopes beneath. With strip mining, and particularly area stripping, simultaneous land uses are impossible; in periods when the land is being stripped of its overburden, it can be used for no other purpose. In some cases the long-term effect on the land has been to render it indefinitely unsuitable for use. There are tens of thousands of acres of land in the affected Appalachian states which have lain in waste for a generation or more.

The impossibility of simultaneous multiple uses while the land is being strip mined results in severe constraints on human activity in the environment. Affected populations may not conceive of or crystallize their perceptions and reactions to strip mining in terms of constraints on or confinement of their activities regarding land use, yet many do in fact react negatively to strip mining. Whether from a sense of moral indignation, perceived desecration of the God-given earth, or in terms of an analysis of political economy, many people in the Appalachian states of Ohio, Kentucky, West Virginia, Tennessee, Pennsylvania, and Virginia have waged continuing (though ebbing and flowing) battles directed at the abolition or at least substantial control of strip mining. I have watched some of these battles from a distance and have entered others directly. The striking point about the fact that these battles are waged is that populations are moved to action. As a professional sociologist, I am attempting to understand why people feel so strongly about strip mining that they are willing to expend usually limited resources (money, time, energy) in their struggle against strip mining.

Through four years' experience in the controversy, there have arisen what appear to be some pertinent questions concerning strip mining which relate directly to an emergent exercise now called social impact assessment (hereafter SIA).[3] SIA is a practical or applied activity taking form as a part of an emergent subdiscipline being called environmental sociology.[4] It is my intention in this paper to delineate what appear at this point to be a number of significant parameters in the SIA of coal extraction.[5] Because it is a report of research in progress, no definitive results can be offered at this time.

APPROACH TO THE PROBLEM

The thrusts of this research are several. I begin at the point of human activity in environments, then pursue systemic effects into human social systems and culture. The human activity in environments to which I make reference is coal extraction, and the research is directed at discerning any differential community impacts of the two methods of taking coal.[6] There may or may not be differential impacts; determining this is central in the research project.

Before proceeding to analysis, I must clarify the systemic nature of the alternative methods of coal extraction, their technological implications, and the human infrastructure attendant to each. The substance of the technological disciplines (mining, engineering, and machinery design and manufacture) is overlain by the substance of economics, sociology, and anthropology. Relationships among these become manifest in: (1) whether or not to take the coal; (2) deciding how to take the coal; and (3) how to justify, rationalize, and legitimize the decisions.

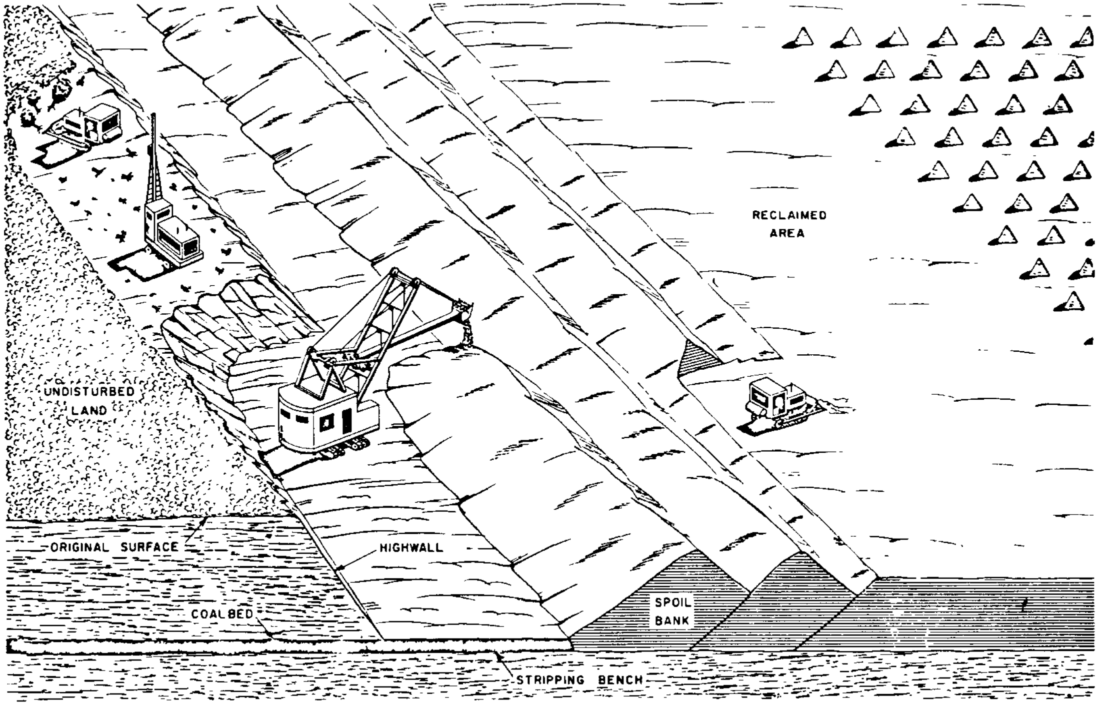
These relationships may be amplified by observing that there are human settlement patterns in the coal fields of the United States whose structural, functional, and processual characteristics appear to vary from one to another instance. Some of these differences seem to relate to: (1) whether the coal is being mined from the surface or from underground; (2) the magnitude of the operation, both in terms of tonnage production and method; (3) the technology employed in the mining operation; (4) the size and institutional infrastructure of the community; and (5) complementary or conflicting contiguous economic-productive activities and the relative strengths of each. Operational variables and relations on variables which constitute structural, functional, and processual characteristics seem to have value in explaining the stability or instability of communities.

STRIP MINING

Of the several methods of strip mining for coal, area stripping is of particular interest. Area stripping is the literal removal of overburden from acre after acre of contiguous land (see Figure 1). The aerial image projected is similar to that of a ground image of land which has been plowed by the contour method. The major difference is that which resides in scale: an aerial photograph of land which has been area stripped might be in a 1:600 scale while a visual ground image of land which has been plowed by the contour method is in a 1:1 scale.

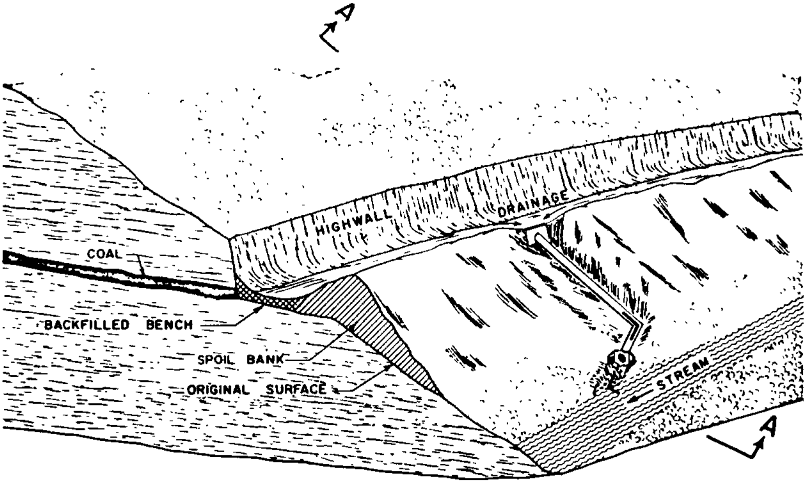
The major restriction on method of stripping (contour, auger, area) is topographical. Stated simply, given 1975 levels of technology in coal extraction, equipment design and capacity are such that it is not possible to area strip the mountains of West Virginia, southwestern Virginia, and eastern Kentucky.[7] Mention of Ohio is conspicuous by its absence because southeastern Ohio (that part of the state where coal deposits lie) is not mountain country. It is instead rolling hill country where local relief is rarely more than 200 to 300 feet.[8] Rolling hill country of this sort poses no problem for 1975 vintage strip mining equipment. In fact, equipment and machinery manufacturers such as Bucyrus-Erie seem to have designed shovels and draglines specifically for use in area stripping where local relief does not exceed 200 feet. Power shovels such as the "GEM of Egypt" and draglines such as the "Big Muskie" easily dispose of 200-foot hills, but that is about their limit.[9] Land with greater relief must either be left unaffected or other stripping methods used. A specific other method is contour stripping—a process which involves use of smaller, more maneuverable shovels which "follow" coal seams around mountains, usually dumping overburden downslope (see Figure 2).[10]

So there are 3. physical constraints on the type of stripping employed: continuity of the target coal seam or seams, local relief, and the engineered capacity of strip mining equipment. In some areas of southeastern Ohio, small-time independent operators cannot generate capital for purchase or lease of equipment such as the GEM of Egypt or the Big Muskie. Thus,

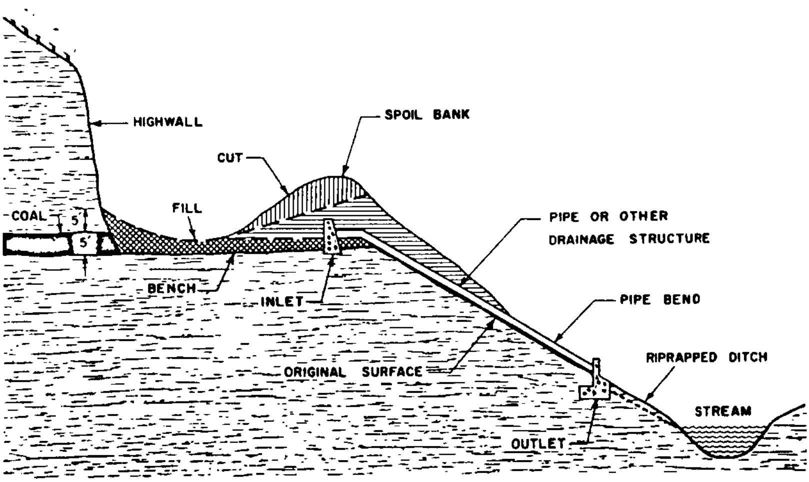


SOURCE: Study of Strip and Surface Mining in Appalachia: An Interim Report By the Secretary of the Interior to the Appalachian Regional Commission.

Figure 1: Area Strip Mining with Concurrent Reclamation



Contour Mining Site



Cross Section A-A

SOURCE: Study of Strip and Surface Mining in Appalachia: An Interim Report By the Secretary of the Interior to the Appalachian Regional Commission

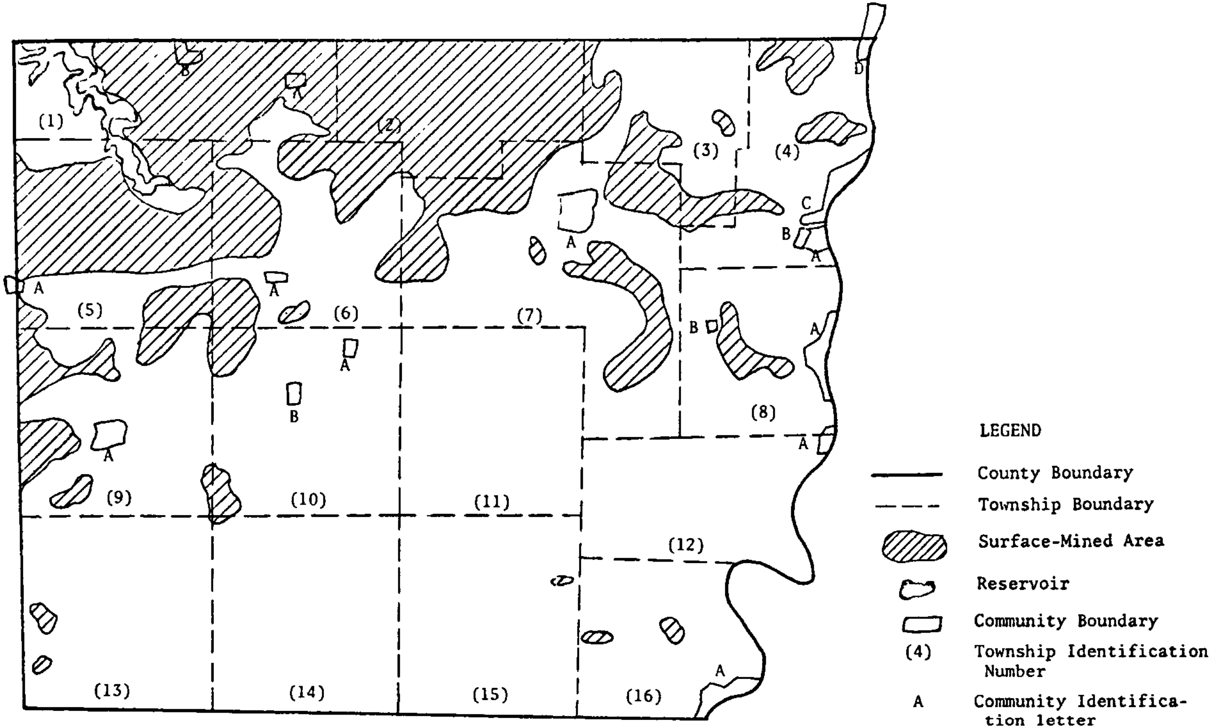
Figure 2: A Method for Backfilling and Draining a Contour Bench

while local relief is similar throughout southeastern Ohio counties, restraints of capital are apparent in the fact that small-time operators with less impressive equipment cannot strip away 200-foot hills; only the big corporations can float the capital necessary for the likes of the GEM of Egypt and the Big Muskie.[11] Since it takes equipment of the GEM generation to move 200-foot hills, GEMs and Muskies should be found where rolling hill country is being area stripped. This has happened in parts of southeastern Ohio, where, for instance, Belmont County has been extensively stripped largely by the GEM (see Figure 3).[12]

A quick scan of the map reveals several communities in the portion of Belmont County being area stripped. For example, there are 2 communities in Township 1, designated A and B.[13] Some of these communities have been entrapped by stripping while others border on areas that have been stripped. Still other communities seem unaffected in any way by stripping. This apparent continuuum provides an excellent basis for comparative community case studies of social impacts resulting from this use (or abuse) of the natural environment. But that is not all of it.

Belmont County is relatively unique because there are simultaneous strip mining and deep mining operations there. The stripping operations are in the northern, and especially northwestern, part of the county, while deep mining operations are concentrated in the southeastern section. Scanning the map from northwest to southeast, attention comes to rest on Township 16, Community A, and the boundary of Townships 8 and 12, Community A.

The irregular curve which traces the eastern boundary of Belmont County represents the Ohio River. Approaching the river from the northwest, there is a dramatic and precipitous drop of several hundred feet. Communities such as 16A are built on the Ohio River flood plain, but that is not of particular interest. What is of interest is that this and some other communities strung along the Ohio River are several hundred feet lower in elevation than are communities located on the plateau-like land characterizing the rest of the county.



SOURCE: Adapted from "Information Related to Coal Mining Activities," prepared by Skelly and Loy, Engineers & Consultants, Harrisburg, Pennsylvania, for The State of Ohio Department of Natural Resources.

Figure 3: Outline of land affected by area surface mining in County A, 1973.

The reason this is of particular interest resides in the peculiarities of coal deposits. Roughly speaking, coal seams in Belmont County range in thicknesses from eighteen inches to three or four feet. These seams are sandwiched between other strata, and there are likely to be several seams at various depths beneath any point on the ground. Thus, seams may be located at depths ranging from near the surface (at forty to sixty feet) to several hundred feet. Known coal seams are numbered in inverted order: the deeper the seam, the lower the number. Thus, coal seams 8 and 9 are area stripped in the north and northwestern portions of Belmont County, while numbers 3 and 3a can be only deep mined. Equipment manufacturers have not produced equipment which physically or economically can be used to remove several hundred feet of overburden. Over thousands of years of flow, the Ohio River has done the job now being done by men with the big shovels: the river has washed away the overburden, affording relatively easy access from river level to seams 3 and 3a. These seams are "followed" back into the side of the hill by utilizing deep mining methods.

What is found in the northwestern portion of Belmont County, then, are communities which were once strongly (if not exclusively) identified with agricultural production, but which are now surrounded by strip mined land rather than corn fields, pastures, and other agricultural features. On the other hand, river communities in the southeast were "born," and have "lived" on the deep mining of coal and their infrastructures have developed organically with its expansion. A major objective in the research is to differentiate the infrastructures characteristic of river communities from those of communities in the northwestern portion of the county, and then to explore their resiliency to social impacts. Particularly, we wish to contrast the differential impacts of strip mining and deep mining on these communities. The question which drives the research is: what are the implications for human community of the alternative methods of taking coal?

PROFILING

To explore the implications of different methods of coal extraction, we are now engaged in community profiling by use of a number of selected social indicators. Approaching community from a sociological perspective, we are attempting to determine social structural and functional characteristics which differentiate communities formerly associated with agriculture from communities associated with the deep mining of coal. Differential community infrastructure should be apparent in the kinds of goods and services delivered, by whom, and under what conditions of exchange. Specifically, differences which do in fact exist should be detectable in such items as the number of farm equipment dealers, feed mills and suppliers on the agricultural side, and the number of extraction and industrial equipment dealers on the coal mining side, as well as more subtle ones such as the number of hospital beds available per capita and the kinds of health care delivery systems.

Differential community structures and functions may also be evident in the physical settlement patterns associated with one method of extraction as against the other. Specifically, area stripping is progressive; physical location changes as the actual stripping operation proceeds. Shovels and other equipment located at one place in time may be a mile or more away from that location one month later. In the span of a year, equipment may be moved several miles, leaving a seriously altered landscape in its wake. On the other hand, a deep mine shaft or slope entrance is fixed and immovable. Every miner who enters must proceed to that orifice. Since the fixed nature of the opening makes conducive the development of settlement patterns near it, deep mining communities are found with "tight" physical settlement patterns and high population densities near long-established deep mines. Indeed, these characteristic patterns are found in communities along the Ohio River in Belmont County. Communities in the northwestern portion of Belmont County are different for two reasons: their environmental activity has been traditionally agricultural, and there has been a transitional shift from agricultural land use to area stripping.

Community profiles should express sensitivity to these changing relations between land use and human community. Following is a list of some of the many variables being assessed in generating the community profiles: population and residence patterns; age distributions; employment; employment status; occupation; education; number, type, and volume of business of wholesale and retail outlets; number, type, and production of industrial and processing plants; public services such as police, fire prevention, and education; number and types of farms, and farm production; voting patterns; crime and delinquency; alcohol abuse, and health care delivery. These variables are not so much the product of deliberate and rational choice as they are dictated by what is reported in official censuses, informal histories, and the like.

I wish now to state the following working hypotheses. Although they emerge from two years' study of the problem, they serve only as the starting point for present research.

The underground mining and the surface mining of coal have differential impacts on human community.

(a) Underground mining does not distinguishably disrupt human community.

(b) Underground mining leads to the formation of human community.

(c) Underground mining provides conditions for the differential stability and continuity of human community.

(d) Surface mining distinguishably disrupts human community.

(e) Surface mining leads to the dissolution of human community.

(f) Surface mining does not provide conditions for long-range stability and continuity of human community.

The data collection process is directed at assembling information for profiles which will facilitate diachronic comparisons of any one community or synchronic comparisons of any two communities over the period 1920-1975.[14]

EXEMPLARY DIACHRONIC AND SYNCHRONIC MEASURES

The succession of land tenure and land utilization practices in Belmont County is expressed in the following scenario. Historically, what is now Appalachian Ohio was once part of what was known as the Northwest Territory. Before 1900, a major product of Belmont County was the species of trees used for the timber and lumber for building and ship construction. As the land was cleared of its virgin timber, it was turned to agricultural production. In this transitional land use, Appalachian Ohio was part of what was at the time (1850-1920) the "breadbasket" of the United States. Grain crop production moved west into the Great Plains as the territorial expansion of the United States continued. Thus there resulted in Belmont County further transitions in agricultural land use running from pastoral to orchards and truck farming to dairying and beef production. Although deep mining has been practiced in parts of Belmont County since the turn of the century, coal operators did not begin systematic strip mining there until the decade of the 1960s.

The influence of the industrialization of agriculture in the United States generally is detectable in Belmont County, specifically in the decade of the 1950s. It was in this decade when the U.S. Department of Agriculture implemented policy designed to encourage people to leave the land. The history of the systematic industrialization of agriculture at that point made southeastern Ohio (and thus Belmont County) a prime target for a policy that did in fact result in substantial migration from rural to urban areas. The policy was an attempt to deal with the fact that it increasingly took fewer working farmers to produce the food and fiber needed for consumption in the United States. These "advances" in production efficiency are the direct results of increased mechanization and industrialization of agriculture.

With fewer farmers working less land to produce all the food and fiber needed for the rest of a growing population, it is obvious that the dynamic strictly internal to agriculture makes causal and correlational statements concerning the impacts of strip mining on human community more difficult.

In attempting to deal with this difficulty, we have acquired aerial photo index maps of Belmont County from the U.S. Department of Agriculture. These index maps display the whole county for each of the years 1938, 1950, 1960, 1966, and 1973. Because of scale, the photo index maps are not acceptable sources for aerial photo interpretation. Yet even the photo index maps provide visual display of the progression of strip mining. For instance, Egypt, Ohio was once a fledgling hub for the distribution of goods and services in the period when the Egypt Valley was being settled.[15] Egypt can be identified readily on the photo index maps of 1938, 1950, and 1960. By 1966, nearby land use changes from agriculture to strip mining are detectable. On the 1973 photo index map, Egypt is not to be found; instead there is evidence of nothing other than strip mining. The question is: what literally happened to Egypt? At this point it is not clear that Egypt declined as a result of the succession in agriculture, or as a result of strip mining.

By obtaining the contact prints from the photo index maps, we expect to be able to gain good serial visual display of communities in strip mined areas and of communities identified with deep mining. These displays will support diachronic and synchronic comparative analysis.

What this sketch makes clear is that there has been a succession of land tenure and land utilization patterns in northwestern Belmont County. We are now in the process of reconstructing the succession of land tenure and land utilization practices through the use of archival data (histories, biographies, census data, interpretation of aerial photographs, court house records, voting patterns, and more) and by interviewing identified patriarchs and matriarchs who have lived their lives there.[16]

Thus far in this section of the paper I have discussed some exemplary though general approaches to profiling. It might now be useful to turn to a more concrete example of data which has implications for profiling. Specifically, the human labor required for extracting coal by deep mining in contrast to strip mining varies in a ratio of 3:1 to 15:1. This ratio is influenced by topographical, geological, and technological factors, and the available labor force. Selected statistics from the Ohio Department of Industrial Relations establish the fact that for Ohio coal production in 1971 an equivalent ton of coal deep mined required three times as much human labor as a ton of coal strip mined. This ratio of human labor per unit production increased from 2:1 in the ten-year period 1961-1971 (see Table 1).

The following pattern emerges from exploratory work on this phase of the research: in earlier days of coal extraction (circa 1900-1930), the method was labor-intensive deep mining. In that era, many men earned their family livelihood by working in the mines. Systems of transportation available at the time were indicative of the stage of industrialization of the society generally. Thus, people lived in dense population patterns which enabled miners to walk or otherwise travel very short distances to the mines. The generalized industrialization of the society in microcosm was (and continues to be) reflected in the level of industrialization of coal extraction. Thus I anticipate finding

TABLE 1
Ohio Coal Production Employment Ratios per Unit Production for Selected Years

Year	Production Employment Ratio, Underground:Surface
1961	1.96:1
1966	2.08:1
1971	2.97:1

SOURCE: Division of Mines, Ohio Department of Industrial Relations, Division of Mines Report; 1961, 1966, and 1971.

long-term serial statistics which show an increase in production through mechanization. And I expect this increase in production to be evident in both deep mining and strip mining. More explicitly, I hypothesize direct though general relationships among production, mechanization, and employment: if one ignores consumption as a control variable, increase in employment and/or increases in the level of mechanization of the coal extraction process result in increases in coal production. What in fact seems to be the case is that dramatic increases in mechanization have been sufficient for increases in production while employment (especially in the deep mines) has decreased. The rapid mechanization of coal extraction by either deep mining or strip mining has resulted in the displacement of human labor by materialized labor, the latter in the form of machinery. Materializing labor is of course the process involved in capital formation. And the utilization of capital in coal extraction is illustrated on a grand scale in the multi-million-dollar GEMs and Muskies used in area strip mining for coal.

A detailed examination of the political economy of coal extraction remains to be done, but what this means in the context of this research is that as mechanization continues, fewer men extract increasing amounts of coal. The implication of this for human community in the coal fields is intuitively obvious. What are sought are more data which enable specific statements concerning human community impacts of the industrialization and mechanization of coal extraction.

Although no elaboration on its application is intended here, a "multiplier effect" provides the basis for much provocative inquiry into the strictly economic implications for human communities of the ten-year change in the ratio of human labor per unit coal production. That inquiry leads directly to an inquiry into the total human infrastructure of the extraction process itself, and of the human community with which it stands in systemic relation. Thus, where applicable, the number and kinds of goods and services provided in the community are expected to be explainable in terms of the extraction process employed. Explicitly, the coal extraction variables of demand for coal and technique employed are the independent variables in this investigation.

An elaboration of this set of relationships will require answers to the following questions: (1) What is the history of machinery used in deep mine and strip mine coal extraction, by whom, and how? (2) What is the history of human labor displacement in the use of such machinery? (3) How are decisions made regarding equipment design and utilization? (4) What is the human social organization of the extraction process as it relates to the kinds of machinery and equipment used? (5) What are the distinct, then comparative historical impacts on the employment of human labor from the industrialization and mechanization of deep mine and strip mine coal extraction? (6) What are the historical implications for human settlement patterns of the industrialization and mechanization of coal extraction? (7) What are the implications for human settlement patterns of the recent rapid increase in the rate at which coal is extracted?

THE MIGRATION MATRIX

The migration of people from rural to urban areas of the United States in the twentieth century has occurred in rather distinct patterns. The history of that migration has been documented, substantiated, expanded, and supported to the point that there is general consensus on what happened. It is at the point of explanation that major variances arise. Explanations most often offered include causal, or at least correlational, relationships between or among two classes of variables: (1) the great wars (World Wars I and II), immigration waves, booms, busts, breakthroughs in an otherwise steady technological advance; and (2) the migration of people to urban centers. Recognition of the history of internal migration serves to complicate analysis and explanation because of the difficulties which arise in demonstrating causal relations between events or conditions on the one hand, and migration on the other. As an example, recall the problems mentioned in differentiating the impacts of the industrialization of agriculture on migration from the impacts of strip mining.

From the beginning, foreign immigration to the United States has created attendant problems for urban centers which served as major loci for immigrants. Internal migration to metropolitan centers has created its attendant problems, both for the receiving communities and for migrants. Racial, subcultural, social structural, and personal characteristics of migrant populations have rarely been consistent with those of people for whom metropolitan existence is the way of life. The work on Appalachian migration already available makes it clear that Appalachian migrants to metropolitan areas are no exception. Cincinnati is perhaps the most compelling example of a metropolitan area faced with a substantial Appalachian subpopulation, and which has some consciousness of the problems faced by migrants to it. There are both official and unofficial programs, projects, and identity centers for Appalachian residents in Cincinnati.

Studies by James Brown, Harry Schwarzweller, and others who have done research on Appalachian migration to metropolitan areas have produced the following types of results: (1) identification of major destinations of Appalachian people e.g., Cincinnati, Detroit, Chicago, Pittsburgh; (2) identification of intrametropolitan migration centers, e.g., an area called "Over-the-Rhine" in Cincinnati; (3) delineation of metropolitan relocation adjustment problems; (4) identification of periodic and systematic return "home" to the mountains for visits, for reaffirmation of kinship and other bonds, and so on; (5) discovery of permanent return migration patterns by Appalachians who have gone back home after varying periods of residence in metropolitan areas.

The research on migration now underway in this project is related to attempts to understand and explain why, in part, Appalachian Ohioans migrate, what are their migration destinations, and what are the patterns which describe this process.

That there has been systematic migration by Appalachians from the rural and mountain or hill country of Appalachia to metropolitan areas is an established fact. The question which arises in attempting to understand and explain it has two components: are migrants "pulled" to metropolitan areas, or alternatively, are they "pushed" out of rural areas and migrate to metrocenters simply because they are forced out of their rural homes? Can explanation be couched in terms of: (1) positive sanctions attendant to the perceived attractions of opportunities in metrocenters; (2) negative sanctions attendant to trying to remain in rural contexts; or (3) some combination of these two? Are people who migrate aware of the potential psychic and social "costs" of migrating from rural areas to metrocenters, but migrate anyway?

If one takes strip mining as a concrete variable in decision-making, do people migrate partially or substantially because they are pushed off the land and out of their rural homes as a result of strip mining and its effects? These effects, of course, range from land and mineral rights acquisition tactics employed by coal companies, through the disruptions attendant to actual stripping and hauling operations, through their aftermath in mudslides, polluted water, disturbed groundwater systems, and more.

THE METROPOLITAN PROBLEM

These are the regional impacts specific to Appalachia. But rural depopulation is only one side of the migration matrix. What about the other, the "metropolitan problem"? On the most general level, the problems of the cities do not exist in isolation from the countryside. This point can be argued from its logical beginnings: the concept of "urban" has no meaning without historical or contemporary contrast with "nonurban" or "rural." Urban or "metropolitan" problems have no meaning without contrasting nonmetropolitan "nonproblems." In addition, the history of internal migration has been one which manifests a rather consistent rural to urban shift.

A sample of questions of interest to the NIMH Center for the Study of Metropolitan Problems, which recognizes this rural-urban nexus, includes: How many people migrate from rural (in this case Appalachian Ohio) areas to metrocenters? Which metrocenters? In what distributions across these metrocenters? In what population distributions (sex, age)? Do Appalachian migrants settle in identifiable residential patterns? How many stay, and how many return to rural areas? Who stays and who returns? Why? What marketable skills do these people bring to metrocenters? What necessary skills for adaptation to urban life do they lack? What are the employment and housing conditions of rural Appalachians who migrate to metrocenters? What implications do these have for individual and community well-being? What kinds of adaptations must rural migrants develop in order to be "successful" in metrocenters? What are the implications of the intrapsychic, psychosocial, social, and cultural adaptations necessary to metropolitan life for individual and community mental and physiological health? Is there incidence of psychosomatic illness? If so, what forms does it take? Can variations which may occur in incidences of types of illnesses be traced to and explained in terms of differential characteristics of migrants? Finally, there is the Pandora's Box opened by turning to an examination of welfare relief programs, their constituents, and why these people are on welfare.

One possible source of these types of problems is migration to metropolitan centers by people whose subcultural characteristics are maladapted to the demand characteristics of metropolitan life. For example, people who received primary socialization in rural Appalachia may very well not be culturally adapted to an eight-hour, five-day per week factory work schedule. If the existence of metropolitan problems which stem from ethnic subcultural characteristics is granted, it is useful to trace them to their source. Ultimately, then, a pertinent question is: is there any substantial relation between a coal extraction process called strip mining and some identifiable metropolitan problem? An answer to the question requires an examination of rural communities in terms of longevity and stability through research into their infrastructures. Thus we return to the comparison of communities identified with strip mining to communities identified with deep mining.

TECHNOLOGY ASSESSMENT REDEFINED

Ours is a technological society. We must have fuels to run it, and we have historically placed many of our fuel needs in the fossil fuels basket (natural gas, oil, coal). The history of Western technology has driven us down a one-way road—our technology is heavily, almost exclusively committed to fossil fuels engines. Given the technological evolutionary process which explains where we are now and how we arrived at our present state, we cannot realistically expect a massive and abrupt shift away from fossil fuels. Such a shift may indeed occur, and the technological society of the future may well be driven by solar, hydro, wind, nuclear, and/or geothermal power. But for there to be evolutionary continuity from the fossil fuels-driven technological society of today to the technological society of the future, it seems that coal will admirably serve transitional needs. There is a lot of coal there, and in addition it theoretically appears to be quite mutable: it can be burned as coal, or it can be liquefied and used as a synthetic gas. Nazi Germany ran its war machine on liquefaction, and that was 30 to 35 years ago. Interim developments in science and technology should in principle make these conversions more feasible today, both in terms of efficiency and effectiveness.

However, these conversions relate to only one aspect of technology assessment and research into national needs. The obvious point is that there is no technological society without the people who constitute it. Therefore, technology assessment cannot be totally meaningful devoid of what I have come to refer to as the "people factor." People develop technology, and in turn are affected by it. Any given technology developed is not necessarily compatible with human needs. To the degree that it is incompatible with such needs, to that degree it is destructive of human potential. Technology assessment has rather blatantly ignored the people factor up to this point by concentrating almost entirely on scientific, technological, and strictly economic variables under the conditions dictated by the world view and value system dominant in our society. I do not argue that these variables are irrelevant or unimportant. I do argue that there are other variables which are systematically ignored in technology assessment, and I have mentioned their locus and general variety earlier in this statement.

If ours is to be a sensible society, one where the application of human intelligence reigns, then we must immediately begin to include in our calculations more than matters of technological and economic feasibility. There are crises all about us which have their source in the manner in which we have manipulated our environment. Certainly, we can only speculate on the nature of society, environments, and technology had we systematically included the people factor in previous decision-making regarding technological development. My personal and professional concern is that we may fail to broaden our definitions of ecology, environment, and technology assessment to include the human factor. If we fail to do so soon, such a decision (or nondecision) may have cataclysmic results.

NOTES

1. Underground mining is subclassified as either shaft, slope, or drift mining; surface mining is subclassified as contour, area, or auger mining. The differences among most of these subclasses of methods of coal extraction are not of particular interest in this paper.

2. In the vernacular, underground mining is called deep mining while surface mining is characterized as strip mining. All the negative connotations associated with the word "strip" are intended, for there is general distaste among affected populations for this method of extracting coal.

3. I use the word "social" in its sociological sense. In doing so, I include all implications for human populations of activity in environments. These include the social implications of scientific activity, and their manifestation in technology. SIA subsumes technology assessment and also the assessment of impacts on individuals as well as collectivities such as human settlements. These impacts are presumed detectable in modifications of societal institutions and culture.

4. There is controversy within the ranks of interested sociologists over the definition of environmental sociology. Generally, the division is between those who view environmental sociology as an examination of the ecosystemic relations between man and environments and those who view it as an assessment of man's activity and impact on environments. Although they will not be dealt with here, these differences are significant both philosophically and practically.

5. With reference to Note 1 (above), the research involves comparative analysis of deep mining in general, and a particular type of strip mining—that of area stripping. Therefore, differences among shaft, slope, and drift mining as types of deep mining operations are ignored. Also of no consequence in this research are differences among contour, area, and auger strip mining. The relevant variables are deep mining on the one hand, and area stripping on the other.

6. In the research proposal which serves as the funding basis for this research project, I identified and discussed eight different conceptualizations of "community." Although differences in definition are important, discussion of the problem of conceptualization will be foregone here.

7. A native West Virginian friend has nightmares of future generations of strip mining equipment which would be built on massive stilts straddling several mountains. The actual stripping machine would move about on a system of trolleys as it proceeded to devour the mountains by area stripping. The image is of a spider-like system with a central machine which stands poised in a position resembling that of a spider about to strike its prey. Were this science-fiction image to become a reality, technological man would literally level the mountains of Appalachia, and in doing so would aiso change a way of human life if indeed human life would be possible under such physical conditions.

8. To explain topographical differences between southeastern Ohio and West Virginia would require entry into a geological discussion of glacial periods, glacial scouring, and the related succession of flora and fauna. Such discussion is beyond the scope of this paper.

9. The GEM of Egypt is the name given to a massive power shovel owned and operated by the Central Division of Consolidation Coal Company, a subsidiary of Continental Oil, one of the largest energy conglomerates in the world. GEM is the acronym for Giant Earth Mover, a machine so large it had to be hauled in on a railroad train and assembled on site. The GEM was initially deployed in the once agriculturally productive Egypt Valley of Belmont County, Ohio. Thus the name, GEM of Egypt. Following are some revealing statistics on the GEM: (1) one of the largest self-powered mobile land vehicles ever built—as wide as an 8-lane superhighway; (2) stands nearly 200 feet high—about the height of the Astrodome in Houston, Texas; (3) weighs over 14,000,000 pounds—more than 100 big jet airlines; (4) machinery "house" is as big as a 3-story 6-family apartment building; (5) while operating, consumes as much electricity as a city of 12,000 people; and (6) shipment of the machine's components from Milwaukee, Wisconsin to the Egypt Valley required 250 railroad cars. The "Big Muskie" is a dragline operated by Central Ohio Coal, a subsidiary of Ohio Power, in turn a subsidiary of American Electric Power. AEP is the most powerful, and perhaps most voracious, electric power-generating corporation in the United States. The AEP power grid extends from Michigan southeast into North Carolina, and is growing. The Big Muskie derives its name from the Ohio County where it got its start—Muskingum County. To provide an impression of the size of the Big Muskie, only one comparative statistic need be cited: the bucket capacity of the Big Muskie is 220 cubic yards while the bucket capacity of the GEM is *only* 130 cubic yards. In case capacity in cubic yards is not very meaningful, imagine instead a bucket which very comfortably holds two school buses with ample room to spare. The Muskie's bucket has that capacity.

10. Overburden is often loosened by drilling, setting charges, then detonating so that subsurface formations of subsoils, sandstone, rock, limestone, shales, and pyritic

materials are shattered. This enables easy removal by the shovels, draglines, and bulldozers. Some characteristics of these subsurface formations allow for groundwater systems which are the source of supply for springs, ponds, lakes, and wells. Once shattered, geological formations called aquifers no longer function in their usual way; the blasting disrupts or literally destroys the groundwater systems. Removal of overburden results in what might be compared to scrambling an egg: various rock and other formations get mixed in a way making their segregation impossible (imagine unscrambling an egg). Once disturbed, these unwanted scrambled materials are referred to collectively and properly as "spoil"—hence the terms "spoil pile" and "spoil bank" in discussions of strip mining.

11. Economics explains why Consolidation Coal, Central Division, still employs machines of the generation immediately preceding the GEM. These include such lesser shovels as the "Tiger" and the "Mountaineer," the latter having about one-third the capacity of the GEM. Although smaller by comparison, their earth-moving capacity is impressive, as are their environmental impacts.

12. The Big Muskie works the area of the four adjoining counties of Muskingum, Morgan, Noble, and Guernsey, all in Ohio. Research on the social impact of this operation parallels the research underway in Belmont, Harrison, and Jefferson Counties. Unfortunately, the substance of this parallel research project must be ignored in this paper.

13. Counties, townships, and communities are coded in order to compare communities strictly on the basis of profiles while preserving their anonymity.

14. Selection of this time period is dictated by availability of data, largely of an archival sort. Although strip mining has been practiced for a longer time, coal operators did not begin intensive stripping until the 1950s. The GEM was not deployed in Belmont County until 1967. By establishing early base-line data for affected areas, one finds a more convincing analysis of effects at least theoretically plausible.

15. Anecdotal history recently acquired informs us that the Egypt Valley, of which the small community of Egypt was a settlement center, was named because of its natural fertility. Although crop rotation practices were known, the land was reputed to be so fertile that crop rotation was not necessary. In its name, obvious reference is to the Nile River Valley of Egypt.

16. In addition to decennial population census data, we are using several other official censuses. These include the Census of Agriculture (recently taken every five years ending on four and nine, e.g., 1954, 1959, 1964, 1969, 1974); the Census of Business (recently taken in 1948, 1954, 1958, 1963, 1967); the Census of Manufactures (recently taken in 1947, 1954, 1958, 1963, 1967); and the Census of Mineral Industries (recently taken in 1954, 1958, 1963, 1967). A major unresolved problem is that of correlating the information from these and other sources. For comparative purposes the most desirable series of community profiles is for the years 1920, 1930, 1935, 1940, 1950, 1960, 1965, 1970, 1975.