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ABSTRACT

Catastrophe theory may provide a possible model for describing and explaining the boom town phenomena at a generalized level; catastrophe models deal with phenomena in which changes in continuous independent variables lead to sudden, or abrupt, discontinuous changes in a dependent variable. Rural energy boom towns are the result of sudden, abrupt changes in rural communities and the changes can be regarded as catastrophe events. Catastrophe models can be used to explain and describe two of these events--the overall community change from a relatively stable rural community to a boom town, and the change in the integrative mechanisms in the community from informal to institutional. Used properly, with the appropriate phenomena, catastrophe models can be very beneficial in social impact assessment (SIA). Catastrophe models can bring some order and understanding to events that initially appear to be random or inexplicable by other models or theories, may force the search for independent variables that are related to the behavior observed (the catastrophe), and can point to areas or variables that need further research. The main drawback to using catastrophe models is that only a limited number of variables can be considered. (BRR)

CASTASTROPHE MODELS: SOME ILLUSTRATIONS AND POTENTIAL FOR SOCIAL IMPACT ASSESSMENT

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CATASTROPHE MODELS: SOME ILLUSTRATIONS AND POTENTIAL FOR SOCIAL IMPACT ASSESSMENT[1]

Introduction

The rural energy boomtown of the western United States has received a great deal of attention over the last several years. The work that has been done ranges from journalistic reports--the "sociological horror stories"--to detailed ethnographic investigations. But despite all that has been done the emphasis remains on the description of parti-ular instances of boom towns. No one, as far as we are able to tell, has attempted to generalize the results of this boomtown work into a formal model of boomtowns. We suggest that the recently developed catastrophe theory in mathematics and its sociological applications are particularly appropriate for use with respect to rural energy boomtowns. In addition, we will offer some ways in which catastrophe models could be useful as social impact assessment techniques. These two applications of catastrophe models are the purposes of this paper.

We shall proceed as follows: first, we will briefly discuss the rural energy boomtown and then turn our attention to the basic elements of catastrophe modeling and its applicability to these boom towns. Following this, we will present two catastatrophe models of boom towns and conclude with a discussion of the usefulness of catastrophe models as a social impacts assessment technique.

Rural Energy Boomtowns

The rural energy boom town is largely a function of the increase in energy development projects, mineral resource development and recreation expansion. It has been estimated that there are between 200 and 325 communities that have become, or could become, "energy impacted communities," (Cortese and Jones, 1977; Little, 197 ; Freudenburg, 1979; Department of Energy, 1979) within the last decade. Some of these communities have developed into boom towns and others could within the near future.

Even though what exactly is a boom town "is primarily conceptual rather than empirical," (Little, 1977:1), there have been some criteria put forward. Gilmore and Duff (1975:6), for example, state that "a five percent growth rate is about all that a small community can absorb," while Little (197 :64; 1977:4) suggests that a 10 to 15 percent annual growth rate would constitute a boom town. More general criteria have been offered by Freudenburg (1978), Cortese and Jones (1977:76), and Albrecht (1978:75). These authors consider rapid population growth, both in numbers and rates, in a very short period of time in an area that has remained stable (or perhaps even declined in population) would create a boom town.

In general, what occurs in a boom town is a sudden change from a small rural town to an entirely new kind of community, with the transformation occurring over a short period of time due to rapid population growth.

While population growth may define a boom town, the fact of population growth alone is not the most important occurrence. These communities often exhibit a high degree of ethnic, religious and cultural homogeneity prior to the developments. They have also developed stable and, for most

residents, comfortable ways of dealing with their environment. Freudenburg, et. al. (1977:4-5) have stated that

> Over the four or five generations that these towns have been inhabited, the residents have developed a fairly impressive set of informal mechanisms--or "natural systems," if you will--for performing social functions and generally taking care of one another. These mechanisms tend to be of the sort that sociologists can find nearly everywhere (to name a few noteworthy examples, they are ways of controlling deviance, socializing the young, giving people a sense of place, purpose, and personal worth, and taking care of the communities' weaker members and/or those in need or under stress).

Yet, in the boom towns,

> In what is probably the most characteristic single consequence of the large-scale impact process, these rather finely-tuned (and surprisingly delicately-balanced) arrangements are simply blown apart--scattered to the four winds by the sudden arrival of more new people than can be contained within them. The process requires no plotting, no nastiness--only numbers. The result is that a people who once took care of one another in a naturally-evolving and in fact almost automatic way--for they are often not even aware of doing so--are suddenly left with some very important machinery that's simply inoperative.

Boom towns appear to experience industrialization and urbanization in ways that have serious consequences for their ability to maintain a meaningful social fabric and a reasonable quality of life for their residents. The informal structures that have sustained area residents in the past break down. While they will eventually be replaced by new structures, the period before that occurs will be one of serious community crisis and it may never be the same for longtime residents.

Cortese and Jones (1977) describe the changes as:

> 1) The communities become more culturally diverse resulting from the immigration of new people with different backgrounds and traditions. This tends to result in such related changes as demands for an expanded school curriculum, increased recreational opportunities, a multiplication of religious denominations, new life styles, and so on.
>
> 2) Diversity leads to less provincialism and isolation.

3) Community institutions tend to become more formal and professional in their orientation. For example, a new police chief with more formal training may be hired, and so on.

4) This leads, in turn, to greater specialization and bureaucratization in these community institutions.

5) Institutional growth contributes to the belief that bigger is better. Chain operations replace local shops and grocery stores.

6) This trend, in turn, leads to greater centralization. The boom town with its new chain operations now becomes the trade center for an expanding geographic area.

7) The profit motive is sometimes strengthened as local property values skyrocket, wages increase, and increased stratification and differentiation occur.

8) Finally, people come to rely more on formal institutions. Family problems, once handled at home, are now taken to the local counseling clinic. Neighboring declines as the make-up of local neighborhoods changes, and so on.

The changes in the structure of these communities come to be reflected in the social problems they experience. The magnitude of these problems is a reflection of more than population growth alone. For example, in Rock Springs, Wyoming, the mental health case load went up 900 percent while the population was doubling (Gilmore, 1979). In Craig, Colorado, during a three-year period when the population increased by 100 percent, the local rate of crimes against property went up 220 percent, crimes against persons increased 900 percent, family disturbances rose 250 percent, child behavior problems increased 1000 percent, alcohol-related complaints rose 550 percent, and other drug-related reports increased by 1400 percent (Freudenburg, 1978; Kassinger and McKeon, 1979). Similar problems have occurred in a range of other boom-growth communities.

A possible model to describe and explain the boom town phenomena at a generalized level may be based on catastrophe theory, to which we now turn our attention.

Catastrophe Models

Catastrophe models deal with phenomena in which changes in continuous independent variables lead to sudden, or abrupt, discontinuous changes in a dependent variable (Zeeman, 1976; Isnard and Zeeman, 1976; Jiobu and Lundgren, 1978).[2] Such events are called catastrophes and as Zeeman (1976:80) has specified, "whenever a continuously changing force has an abruptly changing effect, the process must be described by a catastrophe." The change in the rural community from relative stability to a boom town is such an event and can be described by a catastrophe model.

The application of the catastrophe model to boom towns follows Fararo's (1978:311) criteria:

> Basically, it begins with a phenomena which is interpreted as exhibiting a catastrophe event or set of related catastrophe events. It then seeks the appropriate model to directly characterize that catastrophe or system of catastrophes, drawing upon the classification theorem. A certain canonical model is applied. . . . Th application usually consists in interpreting the original pnenomena as a certain type of catastrophe. . . . In catastrophe model building we move from a phenomena to a model based directly on the canonical forms of elementary catastrophes.

The appropriate canonical form to use is the cusp model.

The cusp model is preferred for two reasons. First, as Zeeman (1976:68) points out, the cusp catastrophe has been most productive and, secondly, the cusp model should be utilized before higher order models are attempted (Jiobu and Lundgren, 1978:34).

We have, so far, suggested that rural energy boom towns are the result of sudden, abrupt changes in rural communities and they can be regarded as catastrophe events. As such, catastrophe models are appropriate to describe and explain these events. Our next task is to present two catastrophe models of rural energy boom towns.

Two Catastrophe Models of Boom towns

The two catastrophe models we will present are, first, the overall community change from a relatively stable rural community to a boom town, then a model for the change in the integrative mechanisms in the community from informal to institutional.

A rural energy boom town is not the same town with more people, but a new kind of community. As Freudenburg (1976:12) has said:

> Yet an energy boom town is more than a community which is larger--it is one that is growing larger, in an abrupt, unexpected, or even traumatic fashion (emphasis in the original).

Population growth brings about a "transformation of the existing social structure into something new" (Little, 1977:11). To put the matter at its core, if perhaps with a little hyperbole, Cortese and Jones (1977:86) state that "the longtimer in a boom town wakes up one morning in his own bed but in a different town."

In Figure 1 we present the catastrophe model of the change in community social structure from a stable rural community to a boom town. The axes of the control surface are population change and community size. These two variables are the two independent variables that seem to most effect the development of a rural boom town. The behavioral surface is the community structure. Starting with an initially small community with little population change, the sudden influx of

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Figure 1 About Here

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population will disturb the stability of the community. As population change increases and community size increases, the path of the point on the behavioral surface begins to approach the fold curve; the structure

of the rural community is changing but the "old" community is still recognizable. When the point on the control surface reaches the right side of the cusp, the point on the behavioral surface makes the jump to the upper half of the behavioral surface; a catastrophe has occurred, the town has become a boom town, a new kind of town. The path back to stability must now take a different path, not just a retracing of the path to the boom condition.

Substantively, the population influx and change in community size moves the rural community away from its stability and its rural structure. New people move in, old ways of doing things become questioned by many, new roles are created, densities of acquaintanceship decline, and much of the informality of the old rural community disappears (Freudenburg, 1976, 1977, 1978a, 1978b, 1980; Cortese and Jones, 1977; Albrecht, 1978; Murdock and Leistritz, 1979). As the changes approach the cusp, the changes, which may have started off slowly, accelerate, and once past the cusp, the boom town has occurred and the changes are not only rapid but out of the control of the "old" community, which has ceased to exist. Suddenly oldtimers realize that they are living in a new community which is no longer theirs. The community is now an urban one and still growing.

However, this is only one of several possible paths that community change can take. Three possible paths across the control surface are shown in Figure 2. Path 1 is that described above, the development of the boom town. The second path represents the emergence of the boom town with the point on the control surface turning towards the back of the surface once it has passed through the cusp. On the behavioral surface this might be represented as a movement from boom town condition to

controlled growth as the population rate of increase declines, the community size becomes large enough that it is able to manage further

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Figure 2 About Here

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population increases, or the magnitude of the changes becomes less dramatic. Finally, Path 3 depicts a situation in which a boom town does not develop although there is a population increase and a change in community size. This would be the case when there is slow, gradual growth. Indeed, one strategy suggested to prevent boom towns from occurring is to control when and how much growth there is by elongating the development process (Freudenburg, 1978b).

Our second catastrophe model considers the breakdown of the community-wide informal network system that is characteristic of rural communities. What occurs is that this system is replaced by more formal relations among community residents, on the whole, while bureaucracies replace the informal helping system.

This change is frequently mentioned as one of the most important consequences of boom towns (Murdock and Leistritz, 1979; Little, 1977; Cortese and Jones, 1977), but Freudenburg (1980, 1978a, 1977), in particular, has described this change in some detail. In discussing the informal system prior to change Freudenburg (1977:4) states:

> . . . the residents have developed a fairly impressive set of informal mechanisms--or "natural systems" if you will--for performing social functions and generally taking care of each other.

Some of the functions that these informal or "natural" systems perform for the community include controlling deviance, socializing the young, and taking care of those in the community who are weak, in need, or under stress (Freudenburg, 1977:4). But under boom town conditions:

> . . . these rather finely-tuned (and rather surprisingly delicately-balanced) arrangements are simply blown apart . . . by the sudden arrival of more new people than can be contained within them. . . . The result is that a people who once took care of one another in a naturally-evolved and in fact almost automatic way . . . are suddenly left with some very important machinery that's simply inoperative (Freudenburg, 1977:4-5).

The people in the community, in short, can no longer know, and thus watch out for and take care of, others in the community to the extent before the boom town developed.

This can be easily seen as a catastrophe event and Figure 3 illustrates the event. In this model the control surface is formed by the population change and density of acquaintanceship axes. The density of acquaintanceship is the ratio of the number of existing ties between pairs of individuals to the number of theoretically possible ties (Freudenburg, 1980; Granovetter, 1976). In small rural communities the density of acquaintanceship is normally quite high; many of the theoretically possible ties are made.

Figure 3 About Here

The behavioral axis is labeled integrative mechanisms meaning the way in which a person is integrated into the community.

As the population increases the density of acquaintanceship decreases; the more people in the pool of potential ties, the fewer ties that can be actually made. Following, knowledge of others in the community becomes more limited and the informal social networks become more restricted. Helping systems also become more limited and restricted. Once the control point passes through the bifurcation set it is impossible for the informal system to operate on a community-wide basis and there is a discontinuous jump to more formal and bureaucratic systems.

That this change has profound consequences is well pointed out by Freudenburg (1980l 1978a). Control of deviance by informal controls becomes difficult, if not impossible; community-wide socialization of the young no longer takes place; and, long-time residents feel a loss of community because where at one time they were personally known by almost everyone, "each individual becomes a smaller part of a larger whole" (Cortese and Jones, 1977:82, emphasis in the original). Also, gossip can no longer wield its controlling power because not everyone knows everyone else (Lang and Lang, 1961:68-69).

The results of the breakdown of the community-wide informal mechanisms are two: first, informal mechanisms that remain, or are newly created, become "subdivisions" of the community; and, secondly, formal organizations emerge to replace the community-wide helping systems that used to operate before, with the unfortunate consequence that some of those who were aided by the informal mechanisms now must rely on bureaucratic workers and regulations, or perhaps get no help at all (Freudenburg, 1980, 1978a). Also, newcomers, who may have been easily integrated into the informal system in stable, or slow growth times, must get many of their needs met through bureaucratic means. In the aggregate, then, the community has made a sudden, abrupt change from a large informal mechanism to one based on institutional means and procedures.

Catastrophe Models As a Social Impact Assessment Technique

How useful are catastrophe models, such as those presented above, as a social impact assessment (SIA) technique? We believe that used properly, with the appropriate phenomena, catastrophe models can be very beneficial in SIA.

First, catastrophe models can bring some order and understanding to events that, at first glance, seem to be random or inexplicable by other models or theories. In addition, catastrophe modeling may force the search for independent variables that are related to the behavior observed, the catastrophe. Another benefit of catastrophe models, as with any model, is that it can point to areas or variables that need further research, and ways to research them. Once the model is constructed from the identified variables, then theoretical reasons can be given to explain why the catastrophe occurred (Jiobu and Lundgren, 1978). Another advantage with catastrophe models in SIA is that they are free from measurement problems in that the metrics of the variables involved are not important to the construction of the model. Thus, seemingly incomparable variables can be related, and in ways not thought of before. Finally, catastrophe models can explain qualitative changes in social systems that have been particularly difficult to handle in the past in SIA's.

Catastrophe models also have some important drawbacks. Perhaps the main one is that only a limited, and few at that, number of variables can be considered, particularly in the cusp models, and the higher order catastrophes are difficult to apply. A second limitation is the phenomena to which they can be applied. Forcing a phenomena into a catastrophe model not only is incorrect, but makes explanation impossible.

Overall, though, catastrophe models can be very good beginnings in approaching some very difficult problems that SIA's typically face. As with any model it is not a panacea and must be used judiciously. If used correctly, catastrophe models can make a substantial contribution to SIA methodology.

NOTES

[1]The veiws expressed in this paper are those of the authors and not necessarily those of the Bureau of Land Management.

[2]There is an important distinction between catastrophe theory and catastrophe models. The former deals with the mathematical properties and identifying the set of catastrophe points while the latter is concerned with the application of the canonical forms of the model (Fararo, 1978). As Sussman (1975:233) has pointed out, there have been few attempts at developing catastrophe theories of particular phenomena.

References

Albrecht, Stan L.
1978 "Social-Cultural Factors and Energy Resource Development in the West." Journal of Environmental Management 7:73-90.

Cortese, Charles F. and Bernie Jones
1977 "The Sociological Analysis of Boomtowns." Western Sociological Review 8:76-90.

Fararo, Thomas J.
1978 "An Introduction to Catastrophes." Behavioral Science 23:291-317.

Freudenburg, William
1980 "The Density of Acquaintanceship: Social Structure and Social Impacts in a Rocky Mountain Energy Boom town." Paper presented to the Annual Meeting of the American Sociological Association.

1978a "A Social Social Impact Analysis of a Rocky Mountain Energy Boom town." Paper presented to the Annual Meeting of the American Sociological Association.

1978b "Toward Ending the Inattention: A Report on the Social Consequences of Energy Boom town Developments." Paper presented to the National Meeting of the American Association for the Advancement of Science.

1976 "The Social Impact of Energy Development on Rural Communities: A Review of the Literature and Some Predictions." Paper presented to the Annual Meeting of the American Sociological Association.

Freudenburg, William, et. al.
1977 "Subjective Responses to an Energy Boom town Situation: A Preliminary Report on Research in Progress in Four Western Colorado Towns." Paper presented to the Annual Meeting of the American Sociological Association.

Gilmore, John S. and Mary K. Duff
1975 Boom Town Growth Management: A Case study of Rock Springs--Green River, Wyoming. Boulder, Colorado: Westview Press.

Granovetter, Mark
1976 "Network Sampling: Some First Steps" American Journal of Sociology 81:1287-1303.

Isnard, C. A. and E. C. Zeeman
1976 "Some Models from Catastrophe Theory in the Social Sciences." pp. 44-100 in Lyndhurst Collins (ed.), The Use of Models in the Social Sciences. Boulder, Colorado: Westview Press.

Jiobu, Robert M. and Terry D. Lundgren
1978 "Catastrophe Theory: A Quasi-Quantitative Methodology." Sociological Methods and Research 7:29-54.

Lang, Kurt and Gladys Engle Lang
1961 Collective Dynamics. New York: Thomas Y. Crowell.

Little, Ron
1977 "Views From Within:

1977 Some Social Consequences of Boom towns. Lake Powell Research Bulletin Number 57.

Murdock, Steve H. and F. Larry Leistritz
1979 Energy Development in the Western United States: Impact on Rural Areas. New York: Praeber.

Sussmann, Hector J.
1975 "Catastrophe Theory." Synthese 31:229-270.

U.S. Department of Energy
1979 Regional Profile Energy Impacted Communities: Region VIII. Denver, Colorado.

Zeeman, E. C.
1976 "Catastrophe Theory." Scientific American 234:65-83.

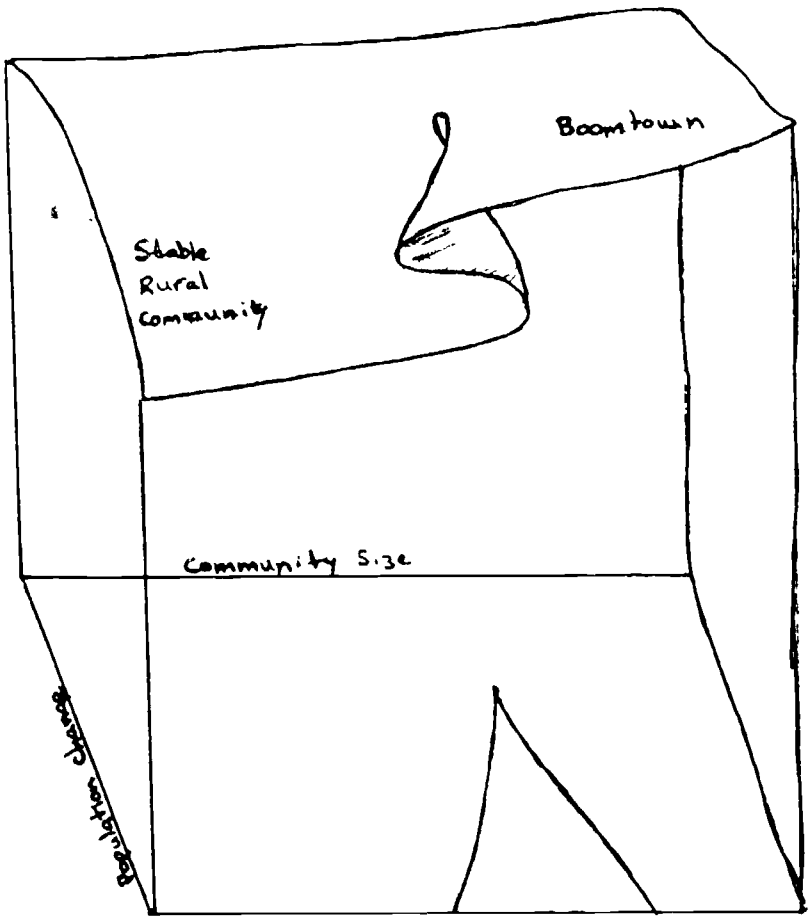

Figure 1

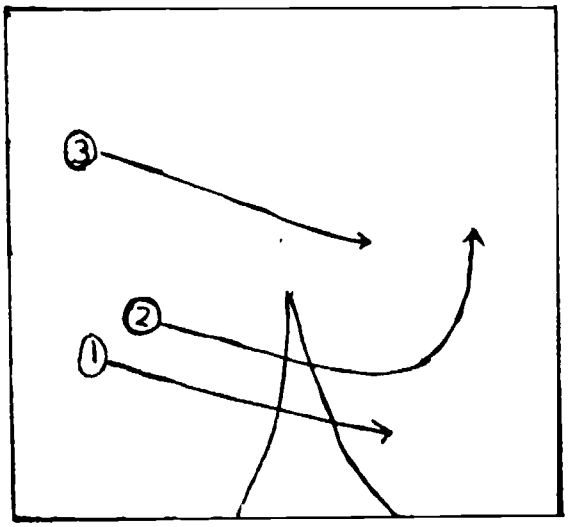

Figure 2

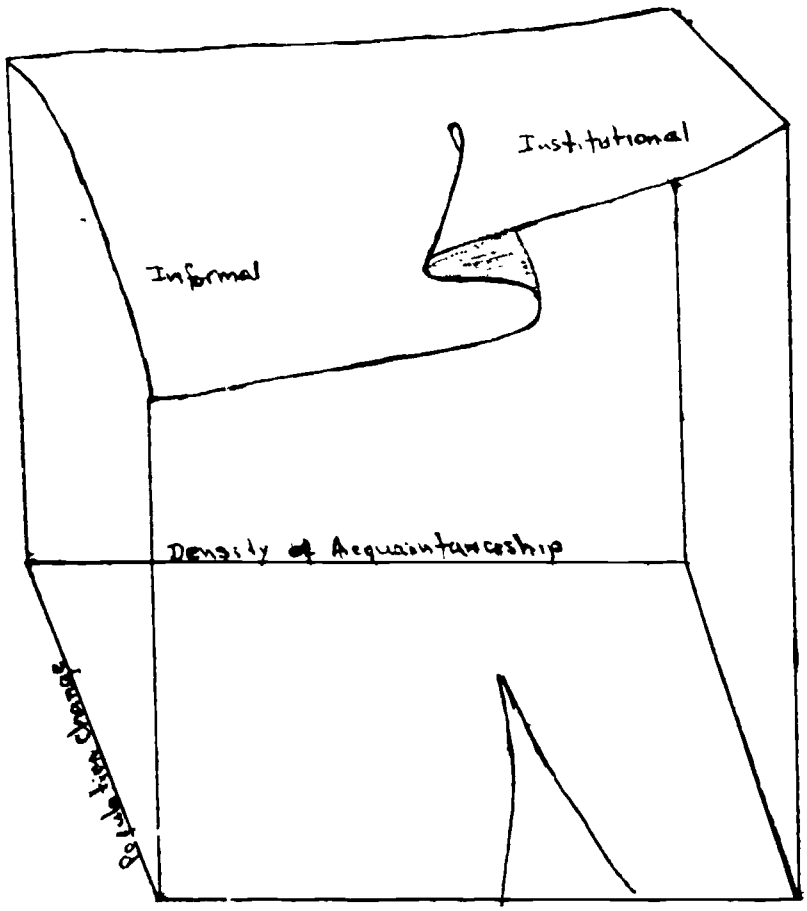

Figure 3