Community Ecology: A New Theory and an Illustrative Test

Frank W. Young
Department of Rural Sociology
Cornell University
Ithaca, N. Y. 14853
USA[1]

Keiko Minai
Kibi International University
8 Iga-machi, Takahashi City
Okayama, 716
JAPAN[2]

Abstract

This "structural" theory of human ecology interprets communities as problem-solving organizations that are concerned with improving the welfare of the residents. It then makes a distinction between their general (structural differentiation, pluralism and solidarity) and specific (hospitals, public health agencies, public safety, etc.) problem-solving capacity and postulates a multiplicative interaction, in the sense of mutual reinforcement, between them. The combined strength of these two types of social problem-solving enables communities to overcome the impact of most environmental threats so that population health, which is the criterion of success, is improved. Although the theory draws on the (transposed) social evolutionary model of innovative institutions, environmental selection and population increase, it diverges from the natural selection model in using "population health" as the criterion of success and, especially, by postulating the causal primacy of the three general dimensions of "problem-solving capacity." The theory is compared to other frameworks in social and cultural ecology and illustrated with findings from the 47 Japanese prefectures.

Keywords: *community ecology, population health, structure, organizations, environment*

Introduction

The structural approach to community ecology assumes that communities are units of evolutionary change. They are problem-solving organizations that are biased toward maintaining the health of their members in a changing and unpredictable social and physical environment. It further postulates that over the course of history, nested hierarchies of communities have formed that augment the response of any one level of community to "environmental threats."

The theory uses "population health" as the criterion of successful adaptation and contends that differentials in life expectancy, infant mortality, "disability days," and similar measures reflect community adaptation. The population health criterion diverges from the "reproductive superiority" that biological evolution holds up and links the theory to the emerging subfield of "social epidemiology" (Berkman and Kawachi 2000). It also avoids the distortions due to migrations and annexations of territory that can occur when size of population is the criterion.

Following Selznick (1996), communities may be defined as multifunctional groups that are concerned with the general welfare of the residents. The second criterion, welfare, simply articulates the empirical generalization that local governments and related community organizations tend to consider general welfare, including population health, in the course of their deliberations. Single function organizations usually talk about more specific goals. Thus, the welfare criterion simply specifies a class of organizations; it is not a teleological claim.

By this definition groups as small as the family and as large as the nation-state are communities, although the two ends of this continuum are usually treated separately. In between are neighborhoods, villages, towns, counties, and provinces. In modern states, the government mandates a legal basis for communities at most levels. Even so their boundaries may be fuzzy, introducing measurement error that works against precise hypothesis testing. Structural theory, which emphasizes the public, formal, and legal aspects of social organization, side-steps this problem to some extent by focusing on the component institutions of communities — schools, churches, bookstores, committees of government, factories, clinics, and the like. It avoids informal networks and aggregate behaviors except for the measures of popula-

tion and controls on composition effects that could invalidate tests.

Many community institutions deal directly with the environment — defined as everything outside the socially defined community boundary. Because their activities cross the boundary, they may be referred to as "transaction organizations" (or agencies). These fall into the conventional categories of production, commerce and medical.

In identifying a role for transaction organizations and their technologies for warfare, agriculture, industry, health, and so on, structural ecology acknowledges a family resemblance to Darwinian natural selection and functionalism. But structural theory eventually moves away from these models by allowing only a greatly reduced role for transaction organizations. This rejection is based on the judgment that they provide no guidance for identifying the institutions that make a difference in adaptation. Military innovations, for example, typically appear as complexes that include changes in leadership, government support, and troop reorganization. It is difficult to identify in advance the element that made the difference. By contemporary sociological standards, hypotheses that turn on such specific institutions, or even the complexes, are untestable.

The structural remedy for this flaw is to point out that in addition to their role in transacting with the environment, institutions fit formal dimensions of "problem-solving capacity." One such dimension is the differentiation of occupations. Other dimensions are pluralism, in terms of political contestation, and solidarity, the degree to which institutions are coordinated by core beliefs. All these dimensions are brought together in the general hypothesis that the mutual reinforcement of one or more structural dimensions with appropriate transaction agencies determines the level of population health. That is, the combination of general and specific problem-solving capacity determines population health.

Although these general strategies are referred to as "universals," the term is used in the sense of concepts that purport to apply accurately and comparatively to all communities, from family to nation-state. The term is not used in the functional sense of common problems like "making a living" or socialization that all communities must solve.

Another confusion that requires clarification is the tendency to think of differentiation and possibly other dimensions as universal paths that all communities must follow. That was the view of the classical writers, although to my knowledge, none of them claimed that communities (especially state-level societies) would continually increase their degree of pluralism and solidarity. As used here, the structural di-mensions are general problem-solving strategies. I happen to believe that increments of differentiation, pluralism, etc. appear as side-effects of social movements, but that Durkheimian's "big bang" theory (Young 1994) is beyond the scope of this essay — although it suggests the near random origin of increments. The point is that reconceptualizing the classical dimensions as general problem-solving "software" rescues them from the theory textbooks and puts them to work in a new kind of ecological explanation.

Do universal dimensions in a model undercut any claim that the theory is consistent with the natural selection format? For strict adherents of natural selection as transposed to human groups, it probably does, even though general problem-solving is still consonant with the mutation-like technologies and institutions that communities use on a daily basis.

Even this brief introduction implies a divergence from other ecological models. First, the theory claims that the appearance of language in the course of human history makes possible the maintenance of formal, universal, systemic (as contrasted with sectoral), and group-level (as contrasted with aggregated behaviors) dimensions. These may be measured at all community levels and facilitate the formulation of a priori hypotheses that contrast with the ex post facto "interpretations" of institutional evolutionary theories. It is these structural dimensions that form the backbone of this theory.

Second, these structural dimensions apply to the whole community and transform it into a unit of survival. The current debate (Sober 1993, 215ff) in biological evolution about whether "groups" evolve is beside the point because, as defined here, human communities are emergent properties and cannot be disaggregated. Population health measures are rates of the biological status of the human organisms in a community, but accepting that criterion does not undercut the claims of structural theory.

The version of ecology outlined here also diverges from the currently popular view that decries the destructive impacts of human communities on the web of physical, biological, and social interrelations. Communities certainly impact negatively on their hinterlands, but that is not the focus of this theory. Instead, it will elaborate a tripartite schema: community structure and dedicated agencies defending against potential environmental threats in an effort to improve the average health of members. All of these claims will be emphasized in the interest of communicating the new material. Moreover, all of these statements are subject to empirical tests and trimming, a process that will surely lead to theoretical revision and shifts of emphasis.

Environmental Change and Community Structure

Communities respond to events in the environment — crop failure, diseases, factory closings, etc. — by first defin-

ing them as threats and then bringing to bear specialized knowledge, policies that emerge from political debates, and on occasion, a reform movement that shifts perspectives. These three strategies may be labeled as structural differentiation, pluralism, and solidarity. Thus, structural differentiation is the degree to which specialized knowledge is "stored" in the diverse occupations and organizations of a community, while pluralism is the degree to which a community has succeeded in institutionalizing political contestation. Solidarity/mobilization, especially reform movements, is less frequent because it involves a difficult community-wide shift in orientation.

Other general strategies of problem-solving capacity exist but these three predominate. All of them — making distinctions, seeing alternative courses of action, and mobilizing behind a leader — depend on language and probably appeared with it. In contrast, the many agencies that loom so large in modern communities are a recent product and take many different forms, depending on context. Certain transaction organization complexes - market capitalism, democracy, and "social movement lobbies"[3] — are intermediate between the structural dimensions and specific agencies, but they are still derivative as compared to the primordial strategies.

It is assumed, subject to test, that superior community problem-solving capacity optimizes the biological functions of all residents, producing the energy, alertness, and rapid recovery from illness that we call health. Said differently, the human organism thrives as a problem-solving creature and communities augment this capacity. This optimizing process must be a postulate, but it is easily observed in the form of non-optimization — obesity, consumption addictions, low respiratory capacity, etc. — that are thought to be the proximate causes of poor health. The optimization process replaces the immune system that is central to the classical biomedical explanation.

Transaction Organizations

Communities with high levels of problem-solving capacity are more likely to create or borrow the dedicated agencies (and their technology) that transact with the environment. This empirical claim, which has yet to be rigorously tested, rests on general observations and some research that show correlations between big cities and new occupational specialties, between counties and states in the U.S. non-South (where one tends to find higher pluralism) and the institutions of democratic government, and the association of nationalism with the invention and acquisition of military innovations. A reasonable summary is that the level of differentiation, especially in cities, accounts for most borrowing (once an institution finds its niche, it diffuses rapidly to complex communities that offer such niches) and that the other two structural dimensions are more involved in the creation of new institutions.

How do transaction organizations relate to the structural dimensions? Classical sociological theory has always claimed that "structure" is fundamental because it is the glue that holds all of the institutions together. If we take this "embeddedness" claim seriously, then agencies should interact, in the sense of mutual reinforcement, with structure. This process may be compressed symbolically to (S*t). This formulation, which is the core proposition of this theory, differs fundamentally from the conventional view of "institutional adaptation" which may be summarized simply as: population health = (t), that is, population health depends solely on transaction organizations, especially medical.

A problem that arises when transaction agencies are used in a prediction equation is ascertaining their effectiveness. If an intervention, such as a sex abstinence campaign for young people, has no demonstrated effect in a clinical comparison, then there is no use including it in the prediction of population health. But the assessment of immediate impact is difficult at best. For now, we must assume that if the clinics, hospitals, or separate aspects of medical technology persist for a decade or more, they are probably effective in some respect. The question then is whether a new technology makes a significant difference in the prediction of population health when measures of the structural dimensions are in the equation. Evaluation of transaction organizations in this context is much more demanding. They must make a significant contribution to the prediction of population health beyond that made by the structural dimensions.

A further problem is identifying appropriate transaction agencies in the first place. In contrast to the three structural dimensions, transaction organizations and their component technologies are infinitely varied and constantly changing. Consequently, they must be handled as ad hoc institutions and their identification and inclusion in a prediction equation is ultimately a matter of trial and error. The contrasting conceptual status of these terms is represented by upper and lower case letters: population health = (S*t).

Environmental Threats

In his book, *Plagues and Peoples*, McNeill (1976) classifies environmental threats as "macroparasitism," by which he means warfare and raiding, and "microparasitism, "the mass of microorganisms that cause disease. From the perspective of human history, raids, massacres, and slavery on the one hand, and epidemics of disease on the other, are the principal environmental threats. But recent history is increasingly a matter of the impacts of economic change. Some accounts (i.e., Molnar and Molnar 2000) amend McNeill's binary classification by adding the negative impact

of regional development and urbanization on communities.

Given the constantly changing natural and economic processes, even changes that turn out to be beneficial in the long term tend to affect mortality rates in unpredictable ways. Alternatively, communities lag in finding and using appropriate defenses. Because of this unpredictability, we cannot specify in advance the potentially disruptive impact of environmental threats except to say that the theory sees the disruption as indirect: the community's problem-solving capacity is weakened and then the residents suffer higher mortality.[4]

It is possible to list a number of guidelines that facilitate the recognition of potential threats. They tend to fall into the familiar classification of physical (exhaustion of resources, natural disasters, etc.), organizational (other communities that compete or attack), and biological, especially diseases. Another distinction is between short-term and long-term threats. It seems doubtful that short-term threats are powerful enough to affect the level of death rates, although they may produce a sharp spike in the trend line. Even major epidemics, according to Watkins and Menkin (1985) have limited impacts on long-term population growth. Therefore, the search for environmental threats should look for those that are likely to last a generation or more. Murdock, Hoque, and Backman (1993) provide a potential example with their analysis of the impact of international business competition on migration trends in Texas counties. Migration, like unemployment, is a ubiquitous threat to health because it frequently disrupts problem-solving.

Significant environmental threats must be clearly visible to the residents because problem-solving can occur only if the problem is perceived. That is why regional economic shifts based on a new technology, legislated prices or subsidy shifts, new government regulations, or their analogs in the global economy are better candidates for the test equations than soil erosion or a gradual increase in the scale of manufacturing.

The interpretation of environmental threats varies with the size and level of the community. At the regional level material poverty may look like stagnation that calls for a governmental response, but at the family level it tends to take the form of constant uncertainty. Likewise, the income inequality of a unit as large as a county is often invisible to residents until it becomes associated with an excluded community, such as the African-Americans. Then it may be is recognized as a problem.

A threat like poverty is classified as an environmental threat because it is almost always a symptom of processes in the regional economy that disrupt problem-solving capacity, especially for families. Like poverty, segregation and discrimination reflect the impact of a dualized regional economy that disrupts problem-solving.

Distinguishing between internal patterns and externally imposed disruptions of local problem-solving is a long-term challenge for structural theory. "Pathologies" like police states, fundamentalist theocracies, drug cartels, or autocrats who treat communities or families as fiefdoms are ubiquitous and recurring. Calling them "low pluralism" does not do justice to their many other features. Yet treating them as "macroparasitic" does not do justice to their long term grip on the community. Some of these may someday be interpreted as problem-solving strategies under adverse conditions. Geertz (1968) has made the case for "involution" as a survival strategy under repressive colonial-type conditions and fundamentalist theocracies that may be a catch-up strategy for societies that believe they have been left behind.

Clearly, the identification of significant (enough to affect mortality rates) environmental threats is problematic. The fundamental criterion is that the threat should have the potential for disrupting problem-solving capacity. Changes like forced migration are therefore general indicators of stress.[5] Once a significant threat has been identified, it is important to attempt to trace its disruptive effect on the appropriate community: family, neighborhood, ethnic group, or province.

From the perspective of evolutionary theory the most important aspect of environmental threats is that they are only weakly selective. Businesses rise and fall and medical technologies change. Selection probably accounts for many of these changes. However, it is rare that communities become extinct — the extreme of population health. They do not have to wait around for a random gene. By virtue of their problem-solving capacity they can often create new agencies, borrow from other communities or, on occasion, call on a superordinate community for assistance. If all else fails, their leaders can "solve" the problem by denying its existence, postponing action, compromising, obfuscating, agreeing with contradictory positions, and lying. Even if most residents are physically destroyed, there is usually enough memory somewhere to begin again, perhaps in a different region or at a lower level of community.

Some Conceptual Comparisons

Several recent "ecological histories" (McNeil 1976; Diamond 1997; Flannery 2001) and interpretations (West 1985 — of Weber's sociology) show the closest conceptual affinity to the theory of community ecology presented here even though their theory is not codified. Their common strategy for explaining the rise and decline of human communities is to pinpoint decisive cultural/technological innovations, usually of a military type. Other examples, such as the customs that the Asian nomads along the Silk Road once used to protect against the marmots that carried the plague bacillus

(McNeill 1976, 155-56) are well known to medical historians. But these "variables" are usually context and epoch specific. Comparisons are limited, often to the point of non-comparability.

A paradigm that ought to have a close affinity with that presented here is Hawley's (1950) "ecological complex" (see also Namboodiri 1988 and the essays edited by Micklin and Poston 1998). But it turns out to be a remote comparison. Although both the structural and the Hawley frameworks see human communities adapting to a continually changing environment, and both accept aspects of population as the criterion of success, their theoretical cores diverge. Hawley's scheme is fundamentally materialistic ("sustenance organization"), while the structural perspective is sociological in its conceptualization of problem-solving capacity.

Both theories refer to technology, but it plays different roles. It is an independent "variable" in Hawley's model but a component of agencies in structural theory, and such agencies are assigned a secondary status. Both models refer to the environment, but structural theory focuses on publicly identified threats, not its sustenance potential. The principal contrast, of course, is that structural ecology contains a causal explanation of population health. Hawley's model points to possible links among the indicators of the four categories (Population, Organization, Technology, and Environment), but the relationships are fundamentally indeterminant.

A conceptual framework that is explicit about its non-causal approach has been proposed by Molnar and Molnar (2000). They nominate diet, disease, demography, and development as key, and proceed to elucidate the many linkages that determine human adaptation. Interestingly, they organize their exposition according to the scale and economic base of communities — hunting and gathering, agrarian, and industrial — because both the problems and the responses of such communities are different. More generally, they find a "world of linkages" which they weave together by means of "mini-explanations" that are plausible and potentially testable. The underlying principles are mostly economic but, of course, their use of four categories as a starting point undercuts any general explanatory power.

Most of these criticisms apply to Steward's (1955, 1968) "cultural ecology" even though he is oriented to both industrial and non-industrial societies and explicitly recognizes the community as a unit of survival. Steward's schema is more open to a variety of responses to environmental challenges and recognizes that subsistence activity may not be the primary determinant of community organization. As previously noted, one of his early followers, Geertz, elaborated a non-material option for Indonesia.

At first glance, theories of cultural evolution, which turn on units of meaning, appear so far removed from a structural theory like this one that they are not worth comparing. But a well-constructed cultural theory in the Darwinian tradition that addressed the blind spots of structural theories would be welcome, and a recent statement (Burns and Dietz 1992; Dietz and Burns 1992) offers just such a possibility: "Social rule systems theory" is evolutionary in terms of focusing on the variation among cultural rules, their (sometimes defective) transmission, and the selective impact of the environment. Thus, the model is inherently dynamic and, given its recognition of meta-rules and collective actors, it can address macrosociological processes.

Rule theory has the potential of making more sense of the structural account of transaction organizations. At best, structural theory can claim that the structural profile of communities influences the repertoire of agencies, either their creation or the borrowing that communities do. After that they are on their own, so to speak, in a changing social and physical environment.

Cultural rule theory (Burns and Dietz 1992, 263ff) provides a much richer account of the variability that organizations must generate. It may arise from invention, migration, and chance effects in transmission. Selection and retention forces further affect this variability. Not all innovations are retained, but those that are take the form of rules, which are central to organizations. Thus, we are presented with an embryonic explanation of the micro underpinnings of macro processes in transaction organizations.

Another point of contact is the role of social actors with respect to decision-making, independence, and creativity. This question of "agency" is especially pertinent to the rule system interpretation of the role of individuals who hold the cultural ideas and rules. Rule theory proposes four criteria for agency: effective action, intentionality, observing consequences, and reflexivity. Therefore, agents are somewhat constrained even though they have a great deal of autonomy. Rule theory also recognizes the necessity to interpret rules as they are applied, and occasionally to act on the resulting variability. It notes that actors sometimes learn or implement rules in deviant ways that nonetheless prove viable. In short, the actions of cultural actors are more open-ended than the individuals in structural theory which sees them as problem-solving units no different in principle from the communities in which they participate. Individuals apply the master strategies of specialized knowledge, mentally debate options, and occasionally manifest a dramatic personal mobilization. They also have a broad range of "transaction habits" (to use a term that sounds better at the individual level), and these are constantly created, borrowed, maintained, and renovated. They exhibit a kind of agency, but their latitude is limited by both their structural profile and the shifting social and physical environment.

The Population Health of Japanese Prefectures

It may seem odd to illustrate an ecological theory with variables from the prefectures of an industrial country. Most studies of human ecology use data from non-industrial societies in an effort to simplify the analysis. Of course, there is the precedent that Hawley and his followers have set, but Hawley's theory turns on industrialization and urbanization, so he had no choice. Structural theory claims to be applicable to all communities at all levels so the availability of appropriate data is the limiting factor. Fortunately, the information on Japanese prefectures is amazingly rich. It provides the raw material for measures of two of the structural dimensions plus medical transaction organizations and environmental threats (crowded cities and the harsh working conditions of the newly industrializing prefectures). Unfortunately, there are not enough cases for the analysis of interactions or the longitudinal dynamics that are inherent in the changing environmental forces. Therefore, the illustration falls short of the ideal.

In brief preview, this preliminary test attempts to measure the three structural dimensions and plausibly succeeds for two: differentiation and pluralism. Then it introduces what are arguably the most relevant transaction organizations: a factor score composed of physicians, nurses, clinics, and hospitals. Inasmuch as the theory interprets a wide range of transaction organizations as potentially relevant to the population health criterion, this factor is the minimum test, and much exploratory research is indicated. The same thing must be said for environmental threats. In the U.S. one would focus on the enclave situation of blacks and Native Americans. In Japan, the search produced an urban and a semi-rural source of threat, but surely there are many others. An obvious question is whether locality specific threats, such as mercury poisoning, would make a significant difference, even with smaller unit of analysis.

In short, the test format requires considerable local knowledge of changing threats and responses. Such exploratory research could easily become mindless empiricism except for the backbone relationship of the theory: the association of the general problem solving dimensions with measure of population health and their community (prefectural in this case) context. Even so, the test is limited and is included as a first attempt to render the theory operational. Given the amorphous state of terminology in sociology, some effort in this empirical direction is required.

Data and Measures

The data refer to 1990-1995 but are treated as a single cross section. The dataset derives from the Japanese census and other official sources, especially those selected for the annual Japan Statistical Yearbook (1998).

Table 1. Descriptive statistics for the measures of mortality* (n=47).

Predictor	Mean	Std Dev	Min	Max
Male mortality 1995	713	32.2	618	774
Female mortality 1995	377	20.0	323	439

* Mortality is age adjusted, per 100,000

Table 1 lists the descriptive statistics for the two criterion variables, age-adjusted death rates for men and women in 1995. The male rate is nearly double that of women.

Structural Dimensions

For concepts such as differentiation and pluralism it is almost mandatory to use a technique like factor analysis that generates single dimensions for an intercorrelated cluster of indicators. Thus, in Table 2, the first factor has high (.50 or more) loadings on the number of high schools, libraries, religious organizations, and cities. These prefectures also have high incomes per capita. Other similar indicators could have been added, but these are sufficient for deriving a stable factor score, i.e., an index that weights the constituent variables and standardizes the total scores so that they range from approximately -3 to +3.

Our measure of pluralism follows previous work (Young and Lyson 2001) and that of Putman (1993), who used voluntary associations and sports teams as indicators. Lacking data on the latter, we used the available facilities — gymnasiums, etc. — as indicators. In addition, we invoke a rationale that diverges from the Putnam emphasis on cooperation because we see the potential for political divergence and opposition even among sports groups. If the issues are important enough, all voluntary associations become politicized.

The last item in the scale, proportion of government establishments in the prefecture, reflects the services that these prefectures have acquired as part of the national community development program, but we assume that the facilities indirectly promote the free exchange that is the essence of pluralism.

Medical Facilities

The third factor shows that physicians, nurses, clinics, and hospitals per 100,000 tend to cluster. If a prefecture has one of these, it will have the others. Note that although factor analysis generates technically adequate factors, they may not match a concept. Thus the medical factor is not theoretically derived. It is simply a useful empirical index.

The R-square for the first factor reflects the fact that the urban differentiation factor explains half the variance of this

Table 2. Factor analysis of prefecture variables (n=47).

Variable	F1 Urban differentiation	F2 Structural Pluralism	F3 Medical facilities
High schools	.89		
Libraries	.87		
Big cities	.82		
Income per capita	.74		
Religious organizations	.70		
Public gyms		.85	
Sports facilities		.83	
Pct. voting 1996		.77	
Halls for meetings		.76	
Pct government agencies		.64	
Physicians			.92
Nurses			.81
Clinics			.80
Hospitals			.70
R^2	.50	.16	.10

Descriptive statistics for variables: (Mean; minimum-maximum)

Libraries: Number of libraries (46.2;13-338)
High schools: Number of high schools(114; 34-459)
Big cities: Number of cities 300,000 and larger. (4.7; 1-21)
Income per capita: Income per capita, 000's of Yen, approximately 1 to dollar 2863; 2149-4255).
Religious organizations: (4893; 473-11951)
Public gyms: Public gymnasiums per 1,000,000 (77.9; 15.3-181.7)
Sports facilities: Public sports facilities per 1,000,000. (672.3; 148.8-1266.6)
Pct voting 1996: 1996 average percent voting House of Representatives, of Councillors, and for Governor, 1996. (54.6; 40.3-73.6).
Halls for meetings: Public halls per 1,000,000 (217.2;7.8-886.2)
Pct government agencies: Percent of establishments that are owned by government (3.5; 1.2-5.4).
Physicians: Doctors per 100,000 (185.3; 108-249.7)
Nurses: Nurses per 100,000 (432; 213-600)
Clinics: Clinics per 100,000. (68; 45-94)
Hospitals: Hospitals per 1000 (.1; .04-.19)

Source: Japan Statistical Yearbook (1998) and Japan Ministry of Health and Welfare (1995).

matrix, while pluralism and medical facilities are much weaker. Yet the indicators generally load on a single factor, which improves the precision of the conceptual interpretations. Likewise, the varimax rotation (a conventional refinement) sets the intercorrelation of all the factors to zero, which helps to avoid collinearity in the subsequent regression analysis. The structural character of the factors (and most of the other variables) insures against biases that arise when using aggregated individual behaviors.

Environmental Threats

Exploratory analysis identified two environmental threats. The first is the disruption of workers' relations with their home communities and their lack of integration in the host community. The crude but effective indicator for this disruption turns on the dichotomy of the mature industrialized heartland versus the industrializing peripheries in the northeast and southwest of the country (below Osaka) during the 1950-70 period. This dichotomy is more than geographical because it reflects the post World War II industrialization phase in Japan (Kornhauser 1982; Tatsuno, 1986; Witherick 1983). A number of variables show the contrast of the two regions. The percent of change in manufacturing establishments from 1980 to 1990 was 17.6 in the recently industrialized prefectures, approximately three percentage points greater than the amount of change in the central region. The proportion of businesses that are organized as corporations is also higher in the peripheral regions. As one might expect in an industrializing economy, the peripheral population includes a higher percentage of older people, 18.3 percent versus 15.2 in the core region.

Although the industrializing prefectures are 16 percent less affluent than the heartland (Yano Tsuneta Memorial Association 1999) they are well supplied with medical personnel and facilities. The higher frequency probably reflects the need for many doctors and pharmacies to reach people in rural areas and fewer economies of scale. It is also possible that the government located medical facilities in the peripheral regions because of a perceived greater need for them there.

A second environmental threat may be labeled "hyper-urbanization" because many large cities (over 100,000) organize the seven prefectures that were so classified. These were Hokkaido, Aichi, Osaka, and four in the Tokyo region: Saitama, Chiba, Tokyo and Kanagawa. They were discovered with the help of a scattergram that showed a U-shaped curve for the association of urbanization and mortality. After attempts to model this non-linearity with a quadratic term failed, we turned to a specific indicator.

We measured hyper-urbanization by the proportion of environmental complaints that the *Japan Statistical Yearbook* classified as "vibrations" (Mean: 3.2; min-max: .6-10.4). Such noises emanate from trains, airplanes, and construction work, but the variable should not be interpreted to mean that vibrations make people sick. A more reasonable interpretation is that complaints like this reflect a generally disrupting environment, a type of stress that housebound Japanese women probably feel more than men.

The character of the seven hyper-urbanized prefectures is clarified by a comparison of means similar to those reported for the two regions. Thus, the average number of large cities in the hyper-urbanized prefectures is 15 as compared to 3 in the other prefectures. The proportion of manufacturing firms is 46 compared to 36, and the average proportion of vibration complaints is 6.2 percent as compared to 2.7.

Table 3. Regression analysis of male and female mortality.

Predictors	Men	Women
Urbanization (FS)	-.15	-.06
Structural Pluralism (FS)	-.37*	-.38*
Medical Facilities (FS)	-.01	-.33*
Industrializing areas	.50*	.35*
Urban vibration complaints	.25	.49*
Adjusted R^2	.35	.43

Numbers are standardized regression coefficients significant * at the .05 level. FS = factor score.

The Relationship of Structure to Mortality

Table 3 presents regression analyses that use as predictors the two structural factors, the measure of medical facilities and the two environmental threats. As is evident, some of the coefficients are not significant. Fortunately, we are working with the universe, where significance is less important than the size of coefficients. Also, we are aided by a theoretical framework that guides our expectations about the strength of the coefficients.

The principal result in columns 1 and 2 is that differentiation (weakly and nonsignificantly) and pluralism (moderately but significantly) predict lower mortality for both men and women. The urbanization result does not conform to theoretical expectations. Either specialized knowledge does not improve population health or the measure is flawed. What is probably needed is a factor based on a distinctive indicator of specialized knowledge.

Medical facilities lower mortality for women, but they have no effect, one way or another, on men. One of the environmental indicators, location in an industrializing region, is a strong positive predictor of mortality for men and a moderate predictor for women, while environmental complaints predict higher mortality for women. Interestingly, the prediction patterns for the two environmental variables tend to be mirror images.

How well does this test illustrate the structural approach to ecology? It uses age and sex adjusted mortality as the criterion for assessing the success of the model and it uses true structural measures for differentiation and pluralism, along with two indicators of environmental threats. The prediction equation includes measures of medical facilities, which are the transaction organizations most appropriate to the criterion variable. It lacks measures of socioeconomic status (aggregated to the prefecture level) as a control on the family level, pending adequate multilevel datasets. It also omits any further tests of alternative transaction organizations or environmental threats even though these may exist. Due to lack of cases, it does not calculate a multiplicative interaction term for a structural dimension and a health organization as the theory requires. Still, it demonstrates the way the theory guides the choice of indicators, the expected correlations, and the general feasibility of statistical tests.

Conclusion and Discussion

Structural theory claims that structural dimensions are universal, even though their strength may vary from place to place. Without some general capacity for problem solving, communities would cease to exist. In contrast, the particular agencies, as well as the environmental threats, are necessarily epoch and place specific. The structural dimensions are the novel feature of this theory that distinguish it from all other ecological explanations.

The structural dimensions that constitute the backbone of this theory are incarnations of the classical dimensions that preoccupied the 19th century sociologists. Now, instead of attempting to explain what is here called differentiation by appealing to population density and similar ecological determinants (see Lopreato 1990 for a penetrating account of Durkheim's efforts), this theory takes differentiation as an independent variable that applies to all community levels. Along with solidarity and pluralism, it interprets these dimensions as the master problem-solving strategies. That leaves unanswered the classical question of how to account for these dimensions but explanations do exist (Young 1994).

A skeptic might ask where the theory is in this formulation if most of the terms are declared non-conceptual and their indicators ad hoc. The answer is twofold. First, categories — they are not concepts — like environmental threats and medical technology can be empirically specified as well as similar terms in other ecology formats. The difference here is that their ad hoc character is explicit. But second, the interpretation of three dimensions as general strategies of problem-solving capacity introduces an explanatory core to the ecological framework that is central to the survival of human communities. These general-problem solving strategies combine with the ad hoc agencies to determine population health levels.

Are these structural dimensions plausible? The analysis of Japanese prefectures indicates that at least in principle their measurement meets the current concept-guided standard. They predict significant linkages even for large units and few cases. From the perspective of community members, they are easily recognizable and all competent adults learn to apply them in varied contexts. Residents might not call them "strategies of problem-solving," but almost everyone understands that you can solve community problems by using them.

Another kind of criticism is that the theory is community-centric, and ignores the impact of human communities on the environment. As noted in the introduction, the emphasis

is intentional. This version of ecology is oriented towards population health and interprets the environment as potentially threatening. On the other hand, almost all current environmental threats reflect the past impact of community activity. Resources may be exhausted, rivers polluted, economic dislocations increased, and new diseases activated. These problems become the second generation targets of problem-solving. Therefore, the criterion of population health indirectly monitors the wider ecology. It is difficult to attain population health unless the environment is also protected.

Some of the many paths that future research could take have been mentioned or alluded to: continued work on measuring the three strategies at all community levels; intensive scrutiny of the role of medical agencies and their relationship, if any, to other transaction agencies; and the search for measures of pervasive threats such as unemployment and the many pathologies of exclusion. More specialized problems, such as interaction terms, and methods of modeling the changes in the environment and their organizational responses, await specialized attacks.

Driving these research probes, as well as the elaboration of this version of ecological theory, is a pressing need to understand the causation of population health. Even with the addition of "social determinants" like socioeconomic status, personal affiliations, or participation in clubs and associations, the biomedical model offers only a marginal role for social factors. Meanwhile, thoughtful representatives call for an "ecological model" (Smedley and Syme 2000, 2) that rises above biological fundamentalism. The question that this theory poses is whether biomedical advocates are prepared for an explanation that departs completely from the biological and individual foundations of many public health interventions. The claim here is that population health implies structural causation located in communities that are dealing, sometimes successfully and sometimes not, with a changing and multifaceted environment.

Endnotes

1. E-mail: Fwy1@cornell.edu
2. E-mail: kei@kiui.ac.jp
3. I assume that a pattern of small but persistent social movements, mostly in the form of street protests, has become institutionalized around the world, thanks to the innovations of the "Sixties."
4. The assumption of a nested hierarchy of communities implies that subordinate communities like the family may be able to compensate for the weakness of the neighborhood or town. Indeed, the combination of the same structural dimensions and appropriate habits at the individual level is also available as a fall back.
5. For both individuals and communities, "stress" can be defined as problems for which feasible solutions are unavailable (see Stokols 1973).

Acknowledgments

The exacting comments of the three relentless reviewers are gratefully acknowledged.

References

Berkman, Lisa F. and Ichiro Kawachi. 2000. *Social Epidemiology*. New York: Oxford University Press.

Burns, Tom R. and Thomas Dietz. 1992. Cultural evolution: Social rule systems, selection and human agency. *International Sociology* 7, 259-283.

Diamond, Jared. 1997. *Guns, Germs and Steel*. N.Y.: W. W. Norton.

Dietz, Thomas and Tom R. Burns. 1992. Human agency and the evolutionary dynamics of culture. *Acta Sociologica* 35,187-200.

Flannery, Tim. 2001. *The Eternal Frontier*. New York: Atlantic Monthly Press.

Geertz, Clifford. 1968. *Agricultural Involution*. Berkeley: University of California Press.

Hawley, Amos H. 1950. *Human Ecology: A Theory of Community Structure*. New York: Ronald Press.

Japan Ministry of Health and Welfare. 1995. *Trends of National Health*. Tokyo.

Japan Statistics Bureau. 1998. *Japan Statistical Yearbook*. Tokyo.

Kornhauser D.H. 1982. *Japan, Geographic Background to Urban-Industrial Development.* New York: Longman.

Lopreato, Joseph. 1990. From social evolutionism to biocultural evolutionism. *Sociological Forum* 5: 187-212.

McNeill, William H. 1976. *Plagues and Peoples*. Garden City: Doubleday.

Micklin, Michael and Dudley L. Poston, Jr. (eds.) 1998. *Continuities in Sociological Human Ecology*. New York: Plenum Press.

Molnar, Stephen and Iva M. Molnar. 2000. *Environmental Change and Human Survival*. Upper Saddle River, NJ.: Prentice Hall.

Murdock, Steve H., Md. Nazrul Hoque and Kenneth Backman. 1993. Determinants of 1980 to 1990 net migration in Texas counties: The role of sustenance specialization and dominance in international ecosystems. *Rural Sociology* 58, 190-209.

Namboodiri, Krishnan. 1988. Ecological demography: Its place in sociology. *American Sociological Review* 53, 619-633.

Putnam, Robert D. 1993. *Making Democracy Work*. Princeton, N.J.: Princeton University Press.

Selznick, P. 1996. In search of community. In W. Vitek and W. Jackson (eds.) *Rooted in the Land* 195-203. New Haven: Yale University Press.

Smedley, Brian and Leonard Syme. 2000. *Promoting Health: Intervention Strategies from Social and Behavioral Research*. Washington, D.C.: National Academy Press.

Sober, Elliott. 1993. *The Nature of Selection Evolutionary Theory in Philosophical Focus*. Chicago, IL: University of Chicago Press.

Steward, Julian. 1955. *Theory of Cultural Change*. Urbana: University of Illinois Press.

Steward, Julian. 1968. Cultural ecology. In David L. Sills (ed.), *International Encyclopedia of the Social Sciences* 4 337-344. New York: Macmillan Co. and The Free Press.

Stokols, Daniel. 1973. A congruence analysis of human stress. In *Stress and Anxiety, Vol. 6*, 27-41. Irwin G. Sarason and Charles D. Speilberger (eds.), Washington DC: Hemisphere Publishing.

Tatsuno, S. 1986. *The Technopolis Strategy*. New York: Prentice Hall.

Watkins, S. C. and Jane Menkin. 1985. Famines in historical perspective. *Population and Development Review* 11, 647-75.

West, Patrick C. 1985. Max Weber's human ecology of historical societies. In Murvar Vatro (ed.), *Theory of Liberty, Legiitmacy and Power: New Directions in the Intellectual and Scientific Legacy of Max Weber*, 235-243. Boston: Routledge & Kegan Paul.

Witherick, M. E. 1983. Recent population changes in Japan and their spatial implications. *Geography* 68, 97-114.

Yano Tsuneta Memorial Association. 1999. *Kensei* (Prefectural Statistics). Tokyo: The Kokuseisha Corporation.

Young, Frank W. 1994. Durkheim and development theory. *Sociological Theory* 12, 73-82.

Young F. W. and Thomas A. Lyson. 2001. Structural pluralism and all-cause mortality. *American Journal of Public Health* 91, 136-138.