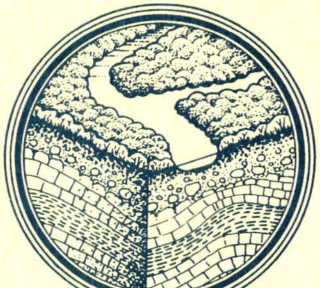
Toward A

BIOREGIONAL MODEL



Clearing Ground for Watershed Planning

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A Map Is Not A Blueprint

Support For Adaptive Tactics

Planning For Necessity And Flexibility

George Tukel

Planet Drum Foundation

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A Map Is Not A Blueprint

Presently, the planning and shape of human settlements, usually defined by market forces constrained by building codes, zoning regulations, and environmental controls, has more to do with the profits of developers and contractors and the politics of land usage than it does with individual and community well-being, human services, and the integrity of local ecosystems. The technologies which accompany such planning are projections of an industrial society which assume a life of their own. Along with the institutions that reify these technologies for their own purposes, they constitute the blueprints for modern community development. Regardless of the ongoing traumas inflicted on the biosphere as a result of this institutional and technological bias, the human themes which depend upon the natural surround remain constant, cyclical, and fundamental: how to account for an essential—food production, for example—while maintaining the base of support, that is: soil. Communities can begin to see themselves as aligning human requirements with natural ones in the course of using energy and resources. This new identity requires practical extensions, however, which can provide for the same necessities of human communities that industrial means presently meet. A map is needed to traverse this territory of human settlement so that new technological pathways may be charted as they evolve within a cultural process of reinhabitation. A bioregional model is such a map.

The guideposts provided by a bioregional model can give direction to practical concerns—water supply, waste treatment, and power generation, for example—that operate on different social levels (the household, neighborhood, or village) but which inevitably are mediated by the make-up of the locale. We may acknowledge the need for vernacular housing but industrial society is accustomed to supporting, economically and through its building technology, only standard tract housing and development. How may a native bioclimatic architecture emerge within this contradiction? This is a question that speaks to: the need for designs based on sustainable patterns of resource use, the logistics of building the house, and the requirement for an immediate political strategy.

A bioregional model helps us to navigate this terrain: not by accounting for the construction details or political climate but by describing available pathways that are technological and aesthetic in general and contoured by a specific energy and material base. These design criteria are a first step in defining political alternatives and building practices.

Accordingly, a bioregional model is a map that inhabitants can use to get a feeling for the "lay of the land" they need to cover. Except in this case, the lay of the land is the resources of the bioregion and the destination are means of provision. This stands in contrast to natural or social scientific endeavors or conclusions which have a habit of explaining themselves as being outside the realm of everyday affairs (except when supplying "input" for policy matters), while actually providing the operating instructions or blueprints for maintaining industrial society and its technocratic self-image.

Nowhere is this more apparent than in classical economic theory which is brought to bear on the human marketplace, regardless of its ecological context. According to the classical model, production and prices are determined by the economic choices of consumers and producers who inevitably act in accord with some timeless human nature: to maximize utility and profit, respectively. This description of consistent economic behavior enables theorists to justify their conclusion and prescription: that "social benefit" is maximized by the natural outcome of simplistic economic choices, notwithstanding any irreparable damage to the biosphere. This rapid translation from "what is" to "what should be" says more about the premises of industrial society (that is, maximizing consumption and profit) than it does about the reality of humankind's diverse ways of interacting within equally diverse societies and ecosystems. Exploring or rediscovering these myriad pathways of endeavor means, first of all, abandoning the "value-free" description of the human species as "rational economic animal." As a map, rather than a blueprint, a bioregional model, while retaining the devices of the scientific method, looks past its "impartial observer" status to maintaining the health and diversity of the life-place. The result is confirmation of our membership in the wider life-community. This new cultural identity as reinhabitants also mitigates against the exploitation and destruction of natural life-forms and processes wrought by their objectification.

Of what direct service can a bioregional model be to reinhabitation? A good part of that question can be answered by ensuring its proper role as a means by which we can assess a culture's melding of beliefs and material activities. The slowly evolved matrix of a bioregion includes a unique material, energy, and informational character. One way of presenting this character is to acknowledge the circular structure of the natural order and to depict it as a system whose ecological and biological elements are interrelated. What emerges is a stable setting and a distinct evolutionary style.

Two aspects are important in this attempt at describing the operations of the bioregion. The first is to portray human actions as being of one species among many by gauging its effects on the whole. Leaving aside any intentions underlying those activities, we first need to examine their ecological impact. The second aspect is the establishment of boundary conditions. These can be understood as a range of activities, based on theoretical and empirical evidence, within which the survival of the overall system—the bioregion—can be counted on by the correction of disturbances of one or several component parts.

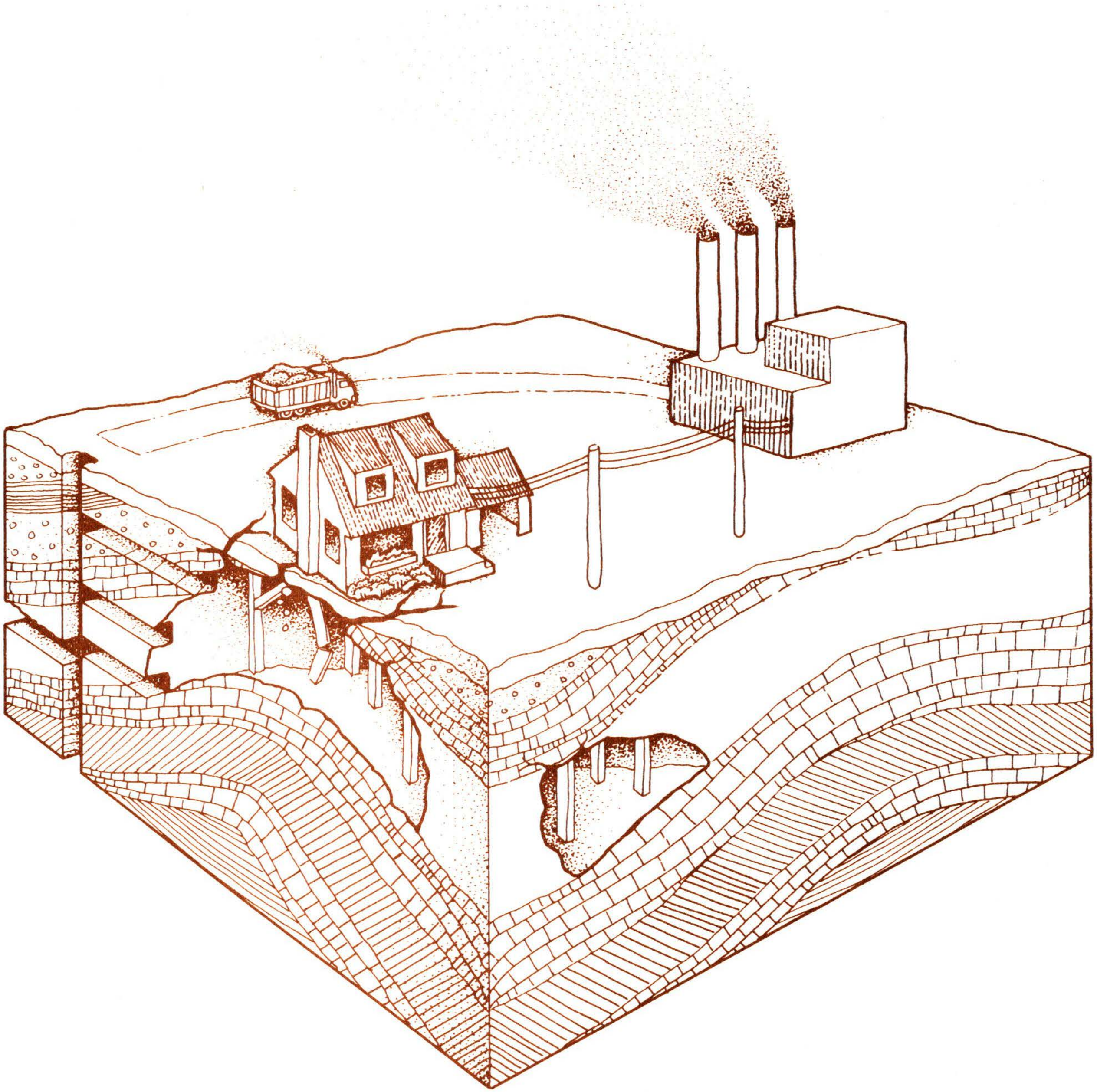
Putting this more functional picture to the side for a moment we can sense the need for and value of the cultural and social connects between individuals, groups, and society, on one hand, and the local ecosystem and watershed processes, on the other, so that both may benefit and mature. The forms by which this reciprocity can take shape among the members of the overall life-community are figures of regulation. And it is the work of reinhabitation to invent the social activities that can make up the human part of the regulatory figure while accounting for the role and proportionate influence of the human species within the matrix of watershed relations. An operative model of the bioregion fits in here, not as a blueprint for reinhabitation, but as a common reference against which an emerging culture can correct itself.

For example, the impulse while living in (or what had been) a mixed hardwood forest would be to first think of wood as the material with which to build houses and heat them. Eventually, there arises the question of whether existing woodlots can support these human purposes without depleting themselves beyond near-term recovery or recognition. A bioregional model provides information to gauge the impact and counter-intuitive effects of what could happen when this appropriate impulse is extended to larger groups of people over time. Such self-correction is vital within a cultural process which, rather than being inherited, is a reaction to an historical legacy (Late Industrial society) and which is intent on turning the corner from a critical to a constructionist pathway by restoring and maintaining life-places through new or revitalized customs, rituals, and organizations.

The goal of the bioregional model is the development of practices that have adaptive value, by informing the human side of figures of regulation. As a result, the ecological well-being of the bioregion remains intact. Judgment of a bioregional model should therefore hinge on its adaptive effectiveness and the subsequent condition of the bioregion itself rather than on its accuracy as a value-free description of that environment. And as the knowledge base of a bioregional model increasingly draws its content from the surrounding ecology, the accompanying cultural habits will grow adaptive in equal proportion. No longer an invention by the heirs to and practitioners of the scientific revolution (engineering, design, communications), cultural behavior comes to support and is supported by its native terrain. Responsiveness to the communication between human communities and the natural ecology will lessen the possibility of such a model becoming a latter-day technocracy standing in arbitrary judgment of newly-born cultural activities. The purpose of a bioregional model is not to force a culture to mimic natural processes. Rather it is to offer counsel of the type one requires before beginning a job—over the shoulder advice. In this case, though, the advice assumes the form of the logic of natural processes so that human activities may benefit from equally adaptive cultural practices.

A parallel to this selective learning process can be found in trying to learn about housing from native cultures. Transplanting the intelligence that these communities embodied in their housing forms to the contemporary built-environment doesn't necessarily mean doing what they did (though it might be worthwhile to try). Rather, it implies bringing the attributes of that intelligence to the transformation of what exists: the recognition of possibilities in what is locally available as building materials; reaction to climatic conditions in a complementary manner, through form, to achieve thermal comfort; and solidifying a culture's image of itself through its building practices.

Ultimately, the perceptions of a culture should include an aesthetic which is outside the purposes of narrow material self-interest while acting as a common social framework for distinguishing between possibility and nonsense. The understandings essential for provision of human necessities in accord with the surrounding ecology inevitably would become part of the communal perceptual character and "memory." At this point, "formal" approaches to analysis and direction, and the Late Industrial institutions which assure longevity, become less necessary. In other words, if figures of regulation were to be fully developed and internalized by a



The Natural Base of Support Can Be Eroded place-located society there would be less and less need for a bioregional model.

A current example can help illustrate this possibility. In the Northeastern woodlands, there are practitioners of traditional building techniques—timber frame and post and beam construction—who are seeking to link these techniques with insights gained from the energy "crisis." Rapidly rising fuel prices brought a good deal of attention to the question of why contemporary residential buildings were so energy inefficient. Callousness to site; regionally-imported building forms which were unresponsive to local climatic conditions; and standard wood frame construction practices based on building codes are generally recognized as being the more fundamental reasons for this inefficiency. Fossil fuel dependency prompted a re-evaluation of these assumptions. And with the rediscovery of energy efficiency and solar energy as possible solutions to home heating needs, design information and guides resulted so as to integrate these energy solutions into both new and existing housing. Questions—such as: "What is the optimal level of insulation," and "How much thermal mass for a specified glazed area" which itself has been fitted to the heating demands of the house—could now be answered given commonly understood parameters according to climatic zone.

Incorporating lessons from energy efficient housing forms, superinsulated houses, and passive solar energy applications into traditional construction methods marks the beginning of a transition from what now exists to a new set of wood frame construction practices. Seen within the appropriate energetic load of human settlements on the bioregion, this type of activity would represent a reinhabitory invention given shape by the bioregional model. An invention, however, is different than a cultural practice which is one form a figure of regulation can take. Over time, though, this evolving synthesis of old and new can deepen into a figure of regulation. In effect, the more technical orientation of the invention has translated itself into shared oral knowledge of new building practices, new identities for the designer-builders, traditions for house-raisings, and a self-evident health of the bioregion.

Support For Adaptive Tactics

Dislocation, from both place and person, is the community life with which we are most familiar. For many, it is so taken for granted, as part and parcel of a lifestyle, that it is as tangible as the car parked out on the street. For those attempting to alter this pervasive condition there is a possible paradox to further contend with: that while the deeper trauma inflicted upon the biosphere is one of an accumulated effect of many small actions—being "nickeled and dimed to death"[1]—it is the catastrophic event or accident that is paid the most attention. Many fear and respond to the possibility of a meltdown at a nearby nuclear facility but fail to perceive and react to the pollution of their water supply from various sources.

Reinforcing this set of priorities is the demand of modern styles of legal or political remedy for a clear-cut linear cause and effect relation where ecologic damage is concerned—a relation which is often difficult if not impossible to pinpoint in these terms. We are unable to perceive or predict, either intuitively or by means of systemic tools of simulation, the precise condition created by the intersection of innumerable discreet events. The accumulated effects of these actions—which include low level toxic activities—cross thresholds which demarcate qualitative changes. Yet the cause of such change is not reducible to one action. Small quantitative and material exchanges which beget structural transformation work themselves out on levels of such subtlety that it is difficult to isolate when and why the critical cross-over will take place. Most often, people react quickly only after the cross-over has occurred.

It is ironic that this built-in subtlety, which lends the natural surround its diversity, beauty, and sturdiness, is so potentially destructive when misunderstood and overpowered by the purposes of a society armed with high energy technologies. From this angle, virtually all human activities contribute to patterns of extinction and are accepted as such by those seeking to rationalize their pessimism. This same human influence, though, allows for a multiplicity of reinhabitory options once the fullness of ordinary reality is opened, and meaning is extended to what was once considered trivial and mundane. The goals of reinhabitation do not lie in grand design as much as they do in the poetics of day to day life enriched by new ways of knowing and acting.

Once provision of necessities is seen as an opportunity for reinhabitory expression, household activities may unfold in a non-industrial manner while meeting needs of energy, water, waste management, and food production. The resulting life styles of the members of the household shift to organize themselves around new activities: people spend as much time caring for their gardens as they do going to the supermarket; operate the insulating curtains or shutters as part of their home energy system along with paying their fuel bills; and change the filters on their gray water recycling units as well as keep an eye on the quality and amount of water coming through the tap. If a household is accounting for necessity in this manner, while widening the non-industrial choices for provision, recognizing that both are critical to survival, they will ask the tactical question: how to budget resources and time in meeting both of these goals.

This same question can be asked of the human population within a watershed: how is it going to maintain the bioregion through its budgeting process? Public concerns are similar to those of the household—identity, life-style, and means of provision—but they differ in scale and form. The bioregional model would assist inhabitants in their common efforts to shape the budgetary "policies" of the bioregion. Policies concerning the built environment, community technologies, and food production would be outlined with respect to their adaptive value rather than as decisions based solely on debits or credits.

What would give a tactic, operating in the public domain, adaptive value? Earlier we saw how a living system, such as a watershed or a bioregion, can be understood in terms of interlinked elements set within limits beyond which species, communities, and, possibly, the whole is threatened. Adaptation is the maintenance of these elements through response to pressures on them as well as through daily involvement with local natural processes. The ability to react to such pressures, and the restrictions within which one does so, can be called flexibility. The adaptive value of a tactic is the extent to which and how a tactic introduces flexibility—budgets of "uncommitted potential for change"[2,3]—into the varied pathways of provision. Emissions into the atmosphere and the amount and quality of water and soil are examples of variables that have to steady themselves over time and require ways to do so. Flexibility allows for the emergence of safeguards to

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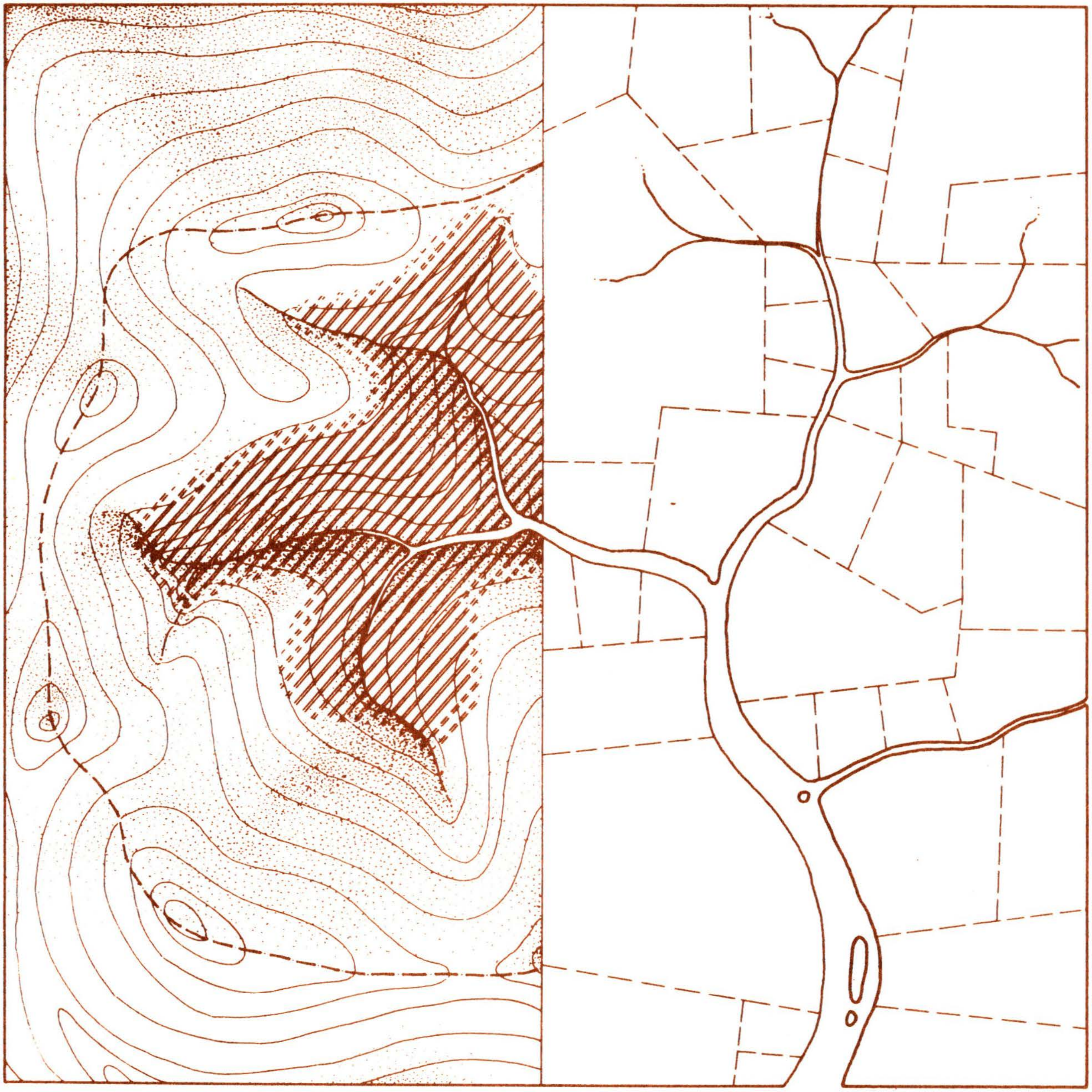
1. P. Ehrlich and A. Ehrlich, "Extinction or a Strategy of Conservation,: **Bulletin of Atomic Scientists,** June/July 1981, Chicago, Illinois

2. G. Bateson, "Ecology and Flexibility in Urban Civilization," **Steps to an Ecology of Mind,** Ballantine Books, New York, 1972

3. R. Rappaport, "Adaptive Structure and Its Disorders." **Ecology, Meaning, and Religion,** North Atlantic Books, Richmond, California, 1979



Watershed Characteristics Are Rarely Reflected by Present Political & Economic Development

Area of Greatest Biological Activity

North Slopes

Watershed Boundary

Typical Political Boundaries

keep possible fluctuations from crossing biological and ecological thresholds.

What is perceived today as "business as usual" becomes the boundaries of possibility tomorrow. A program strategy must be effective in its own right as accomplishing specific goals while not restricting the ability to change course of action. That is why opting for an energy future based on solar income is a sound adaptive tactic. It makes sense in the near term: environmentally benign, it can be aesthetic in design and economical in delivery. It works in the long term as well, because, as time goes on, more avenues of power production will emerge from local diverse sources of energy than from single centralized sources of energy supply such as fossil fuels and nuclear energy. Introducing flexibility through adaptive tactics is in the interests of evolutionary maneuverability: that is, immediate material action, the nature of which allows for alternatives to be chosen later.

The range of public concerns addressed by the bioregional model envelops two overlapping worlds. The first is the world of the built environment: both urban and agricultural. The qualities of the immediate visual and physical environment have recently been the domain of architects, designers, and industrial and agricultural engineers. A vision of dislocation has been given anchorage and credibility—"the building won't fall down"—by a self-image of professionalism that views community design and food production through the filter of industrial culture. This belief system is reflected in the machine-like characteristics of our artificial environments: their shape (institutional regularity), feel (hard vertical and horizontal lines), and workings (white noise).

The second is the world of the planner. It is a contemporary scheme of how settlement patterns are to be organized and who is to influence that organization. It usually exists in the form of a master plan as developed by the local planning board, approved by the government for which it works, and implemented through the offices responsible for zoning regulations and building code specifications. The subsequent enforcements reflect the different elements of the master plan—for example, land usage—which, in turn, are based on the planner's image of how the community should develop and look. This bias serves to assure that basic building blocks—land for housing, commerce, and industry and their proximity to each other—will remain intact. Public participation is through elected officials and by direct appeal to the offices responsible for such matters.

Support from a bioregional model can be organized in two ways to provide guidance for adaptive tactics when they intersect both of these worlds. The first is through the idea of natural succession. Some ecologists have discovered and described the tendencies for undisturbed natural systems to move through different life stages beginning in immature or pioneer stages and culminating in mature or climax states. These stages are characterized by different holistic features as they age in development, regardless of the populations which exhibit them. Species diversity; an increase in how and where energy and materials can move; and an increase in total biomass from constant inputs of energy are examples of these structural characteristics. The value of these tendencies are self-evident through the beauty, wealth, and longevity of the watershed.

Human design concepts and criteria can instill the same attributes into our built environment and means of provision. For example, approaches to growing food can exhibit the characteristics of natural systems. Through the closing of material cycles—composting—food production can increase with lower energy requirements. The health associated with species diversity, when contrasted with the results of modern agricultural practices (poor food quality, soil erosion, and a vulnerability to pests), points to the value of regional crop varieties grown in smaller scale food production systems.

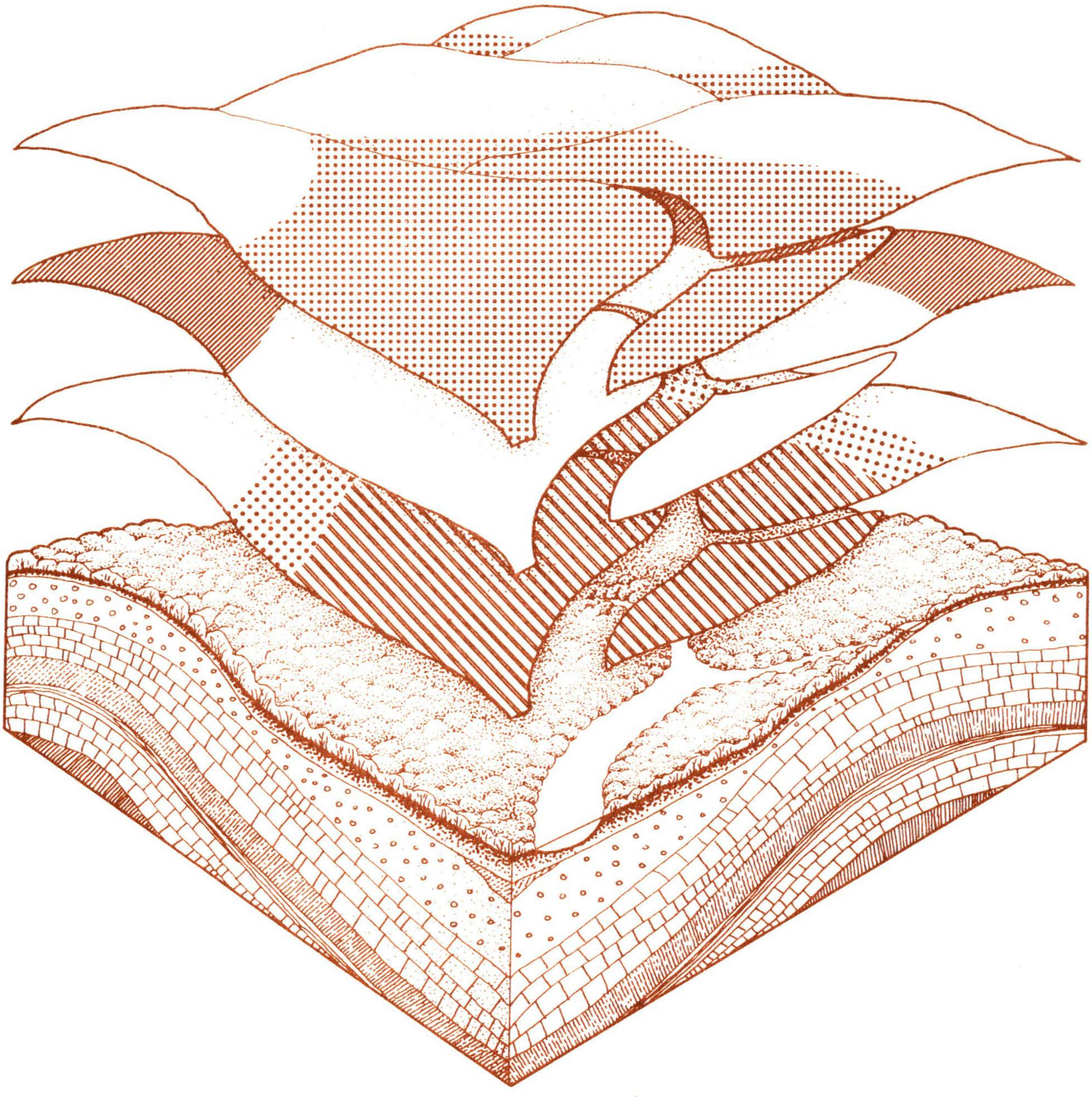
On the planning level, settlement patterns should incorporate flexibility as well as the characteristics of succession. The tendency for work to follow multiple pathways in natural systems contributes to diversity and stability while allowing for change. This principle can be translated into simple planning criteria. If we understand permanence as a pattern of change whereby specialized roles are interchangeable by design, then urban spaces can be multi-functional and renewable over the course of time. A park, for example, can be interwoven with urban food growing. Given the miniaturization possible with present technologies, residential, commercial, and industrial buildings can be transformable into one another—suitable for sustaining a variety of functions. This stands in sharp contrast to the brittle idea of conversion and change embodied in master plans. Drawn up at a fixed moment in time, they force a rigid separation among community sectors that extends far into the future.

The worlds of design and planning are immediately involved with everyday life and needs, whether the concerns are housing, food production, power generation, or other primary endeavors. Taking their cue from local successional patterns, design and planning activities should strive to accomplish discrete goals and maintain flexibility.

The short-term view, though, has to be balanced with the long-term if new practices are to unfold as essential expressions of figures of regulation. A second way to assist adaptive tactics, then, could be in the form of a long-term structural portrayal of the watershed, rising through the watershed tiers, to include the whole of the bioregion. It could be created to mirror the multiple effects of human activities within it and to be keyed directly to the natural resources that make it up, whether they be material, energetic, or informational. This could be accomplished by taking the elements of a watershed resource inventory and integrating the inventory with methods for gauging carrying capacity. A listing and description of native plants and animals, climate, soils, geology, topography, water resources, land use patterns, population densities, air quality, and surveys of sources of energy for low energy technologies are starting points for a resource inventory. Beginning with these watershed attributes, carrying capacity is a means for assessing decisions involving design, settlement patterns, and technology, as well as ecological costs and benefits to the watershed community.

Originally developed to approximate the number and types of animals that plant populations could support in a given area, carrying capacity has evolved into more sophisticated approaches which can draw relationships between human populations and levels of material supply, levels of service, and nutrition. As a method for studying the effects of changing variables within the watershed, carrying capacity can lead us to the development of plans for sustainable communities. What is the range of possible effects of agricultural practices and crop varieties on soil conditions, population levels, and nutrition? What is the level of home heating fuel that local woodlots can provide? Carrying capacity offers a framework for studying the interaction between human activities and the wider material and energy transactions of the bioregion.

This can be accomplished by applying simple and useful ecological models, based in the natural and life sciences, that reflect the impact of human actions. While impact implies a range of activity rather than a precise condition, what is important is the recognizable pattern that inheres in the watershed and connects human movement, ecological stress, and functional degradation or possible disintegration. The role of carrying capacity is not to aspire to impossible levels of data manipulation or predictive ability or to strive to replace the inhabitants' daily experience of watershed conditions with abstractions. Rather, it should act as a bridge between a people's sense of where they are and the necessary inventions of culture and technology that will have to be made in order to live there well.



Watershed Patterns Can Inform Design & Planning

Carrying Capacity
Biological Potential

Planning
Erosion prevented by preservation of natural vegetation

Design
Polyculture of perennials

Contour plowing and/or terracing

Planning For Necessity And Flexibility

The composing of a bioregional model, so that it accounts for the necessities of the public realm as addressed by adaptive tactics, is a strategic question: how to draw boundaries so that the whole can be punctuated in a way amenable to understanding, applicability, and accuracy.

One way to "score" a bioregional model would be to build ascending tiers of subject matter and vocabularies that would provide context for one another simultaneously. We begin with questions of design on the first level, move to planning on the next, and follow with carrying capacity on the last. Moving from the more local and immediate to the long-term and general allows a hierarchy to emerge which qualifies each level by means of the other in an order that is workable and mutually regulatory. For example, housing designs are informed by settlement patterns, and settlement patterns are shaped by perceptions and analysis of carrying capacity, which in turn are qualified by new housing designs. As opposed to its authoritarian form as found in social institutions, the self-correcting hierarchical ordering evident in biological and ecological systems can be considered as one paradigm and method for organizing short-term and long-term possibilities in eco-development.

The architecture of the bioregional model being developed here relates three levels of community understanding. All are concerned with the well-being of community: that is, how to mediate between short term human needs and long term adaptation and flexibility. These traits and reciprocity can be seen in the following three-part example which begins at the design level, moves to planning, and ends with the long term outlook. The common theme is power production based in community energy systems.

Given the manageable scale of the watershed, the design of community energy systems to satisfy local power requirements can move at a common sensical and pragmatic pace: to identify needs, determine how they can be met, and clarify how such means are interwoven with the continued health of the watershed.

Power generation is not an end in itself. Rather, it is a means by which needs can be met: keeping warm in the winter or having artificial light at certain times and places. A common understanding of community power requirements, tailored to reinhabitory life styles, is the first step in gauging the practicality, culturally and technically, of these requirements. In broad strokes, these requirements should be viewed within the larger picture of available solar income in the watershed. New perceptions of "supply" and "demand" will emerge from this juxtaposition and a dialogue on how to budget solar income to meet needs will follow. In addition, this would be a good time for important related questions to be asked, such as whether to use capital or labor intensive, biologically or mechanically biased technologies. This budget or outline of possibility, can serve as a reference later in the design process when technological and financial matters tend to crowd the picture with seemingly unconnected particulars. Similar in method to county "energy studies" or community "energy audits," it differs from these in its orientation: that is, how reinhabitation can take root within the watershed's solar income, rather than how to meet industrial goals with energy conservation and renewable sources of energy. With this framework in mind, a detailed analysis can be undertaken of specific sites according to two sets of criteria: net energy efficiency and a close matching of scale and energy quality of power producing technologies to community end uses.

Given choices for coordinating on-site production with medium sized back-up power production and storage, the entire system can be brought in line with commonly understood service standards. Sensible engineering would account for historical cost factors and computerized simulation would allow for optimizing operation of distributed power production. This analysis would yield a set of energy conversion technologies and end use devices for installation within the community.

These sets of choices don't tell the whole story though, as they haven't been viewed in terms of their bioregional worth—decisions which contribute to the restoration and maintenance of the bioregion. And in how it has been spoken of here, this means employing adaptive tactics: interweaving technological choices with what we understand the successional characteristics of the bioregion to be.

How can this be done? A simple and straightforward way would be to imagine a screen through which the technological choices could pass: in asking questions that reflect a shared understanding of bioregional worth the screen acts as a filtering agent. The options which emerge embody sound engineering as well as the knowledge base, particular to locale, which reinhabitants must construct in order to preserve the life-place.

The following are some questions which can be rephrased within local experience:

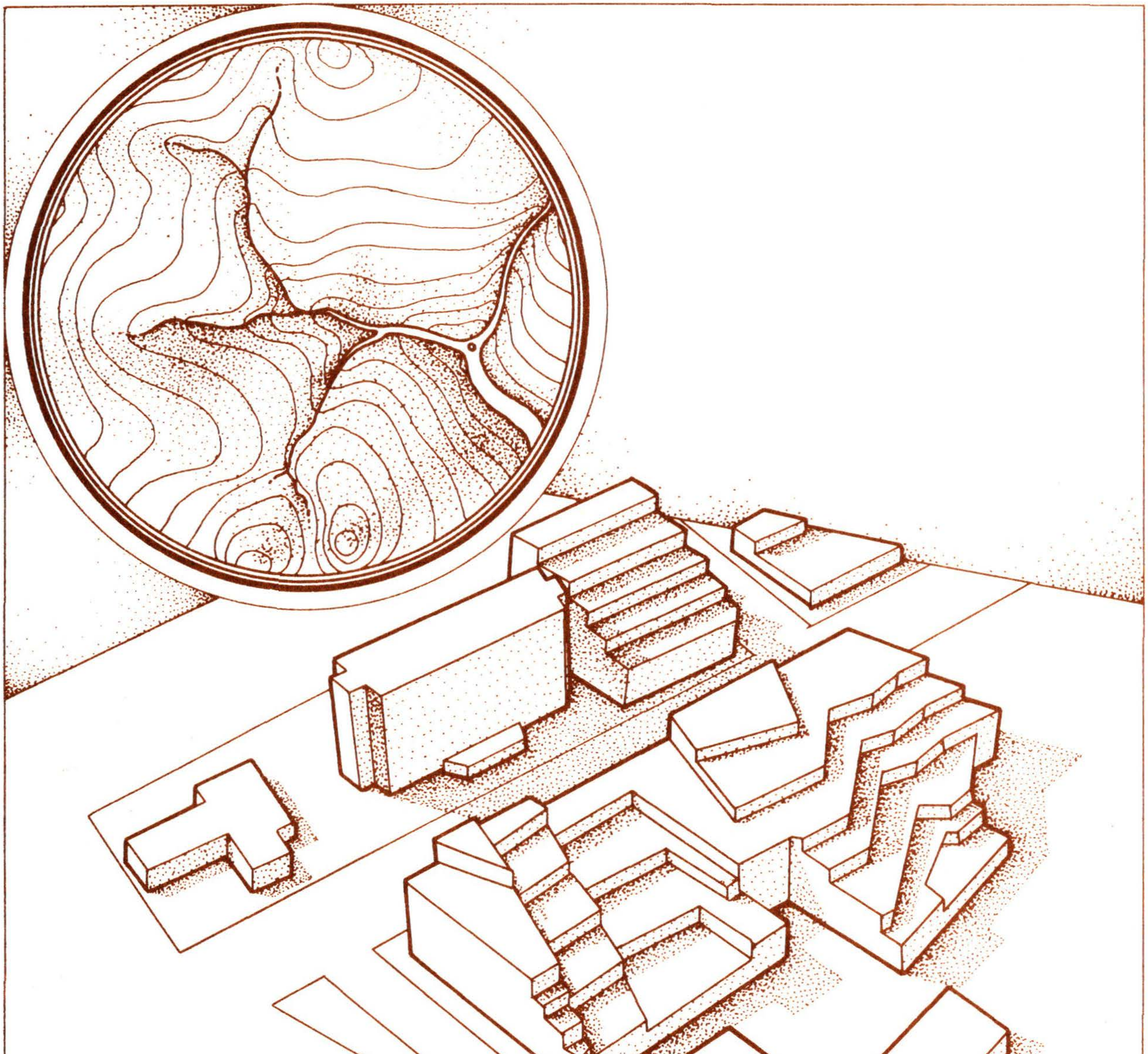
- Are material cycles being closed?
- Is the total biomass of the watershed and bioregion increasing?
- Are decentralized pathways of multiple material and energy use being nurtured?
- Are plant and species diversity increasing?
- Is energy usage per person per year changing in the interests of flexibility?
- Are energy sources becoming more interwoven with local biological processes?

Moving up a level of the hierarchy and down a step of specificity we come to the second tier within the model: planning and settlement patterns. This level may be best understood by illustrating how the planning profession currently extends its "standards" to land development, and consequently, to the built environment. We will then be better able to propose a pattern of settlement appropriate to watershed preservation.

Common sense dictates that whatever solar energy system is included in a local architecture, the first and necessary ingredient is exposure to sunlight. In more dispersed housing developments or farm communities, the only reason for not having it would be unusually restrictive zoning regulations or the blindness of the designer and builder. As we move to moderate and high density building environments, however, the guarantee of solar access becomes less likely. Many buildings in close proximity and of different sizes cast long shadows across one another, given the movement of the low winter sun. The positioning of the buildings, so that sunlight can reach their solar surfaces, becomes more complicated.

The difficulty in guaranteeing solar access may be appreciated by looking at the experience of those who have tried to undo the built-in limitations, imposed by planners, by retrofitting existing houses for various solar applications. Because of the way housing developments were and continue to be laid out (for example, medium density suburban housing in a traditional grid pattern), a southern orientation and exposure is the exception rather than the rule. This represents a large loss of longer term flexibility in our housing stock. Compensating for that loss often eliminates the option of passive solar low cost approaches and instead demands solutions which necessitate added building, design, and equipment costs. These, in turn, create economic and architectural obstacles that may act to prevent the installation altogether. The end result in such a case is no solar solution at all: the original positioning of the building has effectively removed both the passive and the high technology options.

The make-up of the bioregional model in general, and the ordering of techniques within it, can mediate against such maladaptive planning, not by dictating appropriate designs but by establishing criteria within which activities can be self-correcting. In the case at hand, we are not speaking about the need for replacing one set of restrictive zoning regulations with another. Rather, any new regulations would serve only to create the conditions necessary for a solar architecture to unfold. The research for effecting this change has already been completed.[4,5] Aimed at ecological formulations for urban development, it resulted in the concept of a "solar envelope:" "a



Human Needs Can Be Interwoven with the Natural Surround container to regulate development derived from the sun's relative motion."[6] The solar envelope—based on attributes of place—is seen as a three-dimensional space within which a building can stand without casting a shadow on adjacent buildings or land. The result is year-round solar exposure for all the buildings in the neighborhood. It is no accident that the original work in this area drew strongly off the insight of native builders of densely populated communities such as the Acoma Pueblo and Pueblo Bonito of New Mexico: that an understanding of natural cyclical forces is necessary to the design of buildings that have uniform internal temperatures.

The application of the solar envelope concept to the higher density areas of the watershed is an example of the planning level of the bioregional model. As a description of the interaction of environment and site that distinguishes one location from another, it represents the working of environmental characteristics into specifications that can inform the design of public places.

The remaining tier within the bioregional model serves to promote a longer range view of watershed health which can correct and be corrected by the formulation of design and planning alternatives. Carrying capacity provides this perspective by evolving to include the energetic basis of the bioregion while using population levels and natural resources as its base line references. If the loops between design, planning, and carrying capacity are drawn within the workable scale of the watershed and bioregion, and are kept short, direct, and timely, then there will be far less likelihood that actions taken to undo or replace industrial patterns will lead to ecological damage or collapse. Coupled with the shared understanding of the direction in which a bioregional society wishes to move—reducing material and energy imports and exports that result in local disruption, for example—the mathematical models contained in carrying capacity can yield useful assessments of actions to be taken.

One approach, potentially applicable to an evaluation of power generation alternatives within the watershed, is known as Energetics.[7,8] Grounded in natural laws of energy, it proceeds by first constructing a systems diagram of the material, informational, and energy pathways and transactions within distinct boundaries: for example, the energy flows necessary for a farm to produce food or the movement of materials and energy between country and town or city. Symbols are used to represent events within the relevant boundaries according to ecological tenets and the assumptions of the modelers. The result is an analog in the form of an energy "circuit" or "energy-flow" diagram.

For instance, we can start with the assumption that the carrying capacity of a bioregion is based in renewable and constant sources of energy and resources linked to local steady-state economies. With an energy-flow diagram derived from this solar income orientation, we could assess potential power

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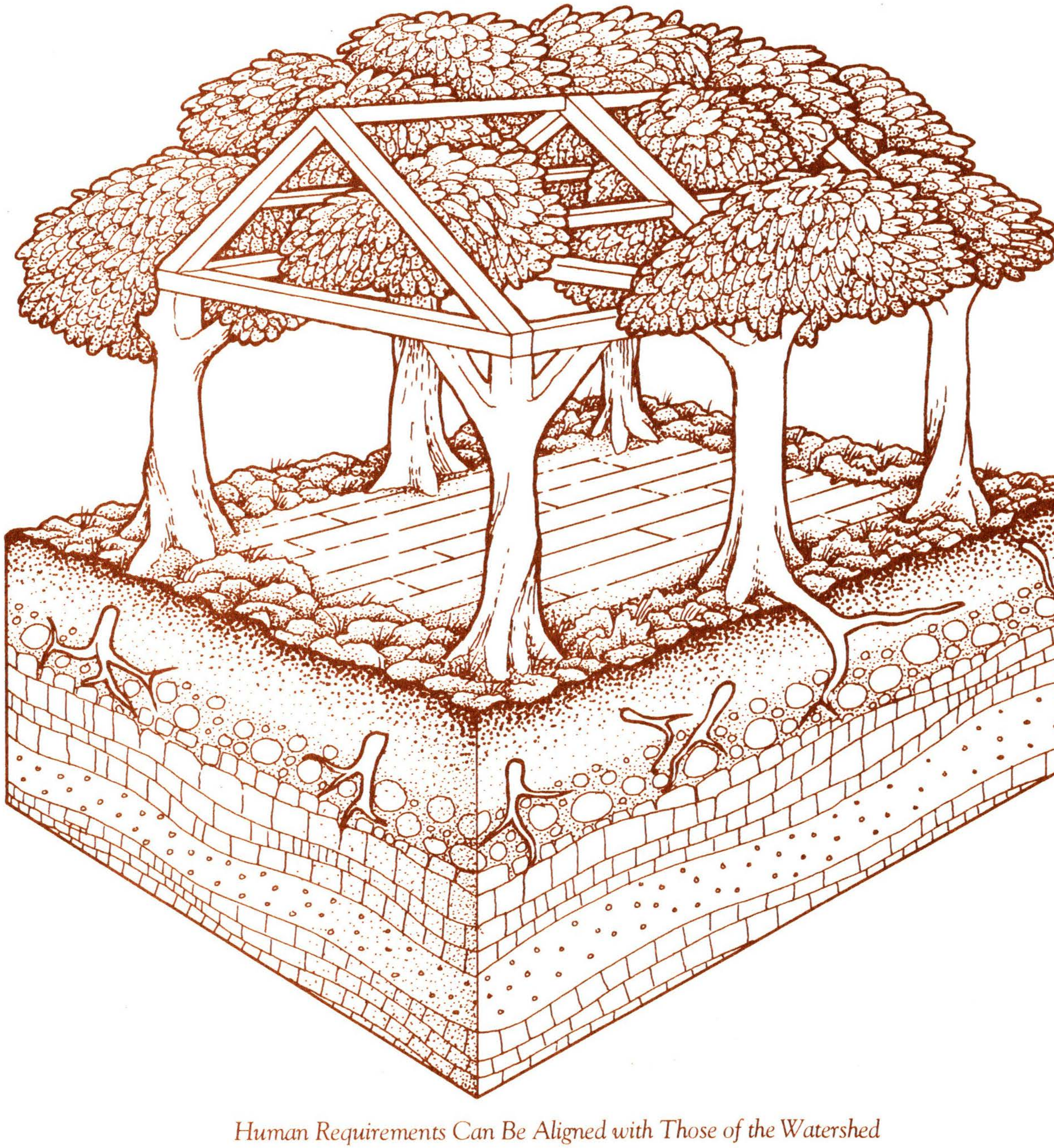
4. R. Knowles, **Energy and Form,** MIT Press, Cambridge, Mass., 1974
5. R. Knowles and R. Berry, **Solar Envelope Concepts.** Solar Energy Research Institute, Golden, Colorado, 1980
6. Ibid., p. 5
7. E. Odum, **Environment. Power, and Society,** Wiley Interscience, New York, 1971
8. H. Odum and E. Odum, **Energy Basis for Man and Nature,** McGraw-Hill, New York, 1976

generating technologies for local use. Each would be judged according to its distinct energy flows and costs, both obvious and hidden. A choice would be made based on the net efficiency in converting energy from its source into the final form in which it is used. This process results in an appreciation of the comparative strengths and weaknesses of various technologies, an understanding that will be essential to long-term recovery of the watershed. While not meant to be force-fitted to every available situation, these power production alternatives represent transition opportunities away from high energy technologies.

This composition of three levels is not a static one. Changes in one part of the picture naturally effect changes in the others. The catalyst for these exchanges can be insight, concept, and, most importantly, experience resulting from direct applications. Inherent limits to each tier of the model are compensated for by the corrective interactions between the levels and attempts at actualization. Therefore, the extent to which a bioregional model is a self-simplifying structure depends on how well community building blocks with bioregional worth are taking hold within the watershed area. And it is with this sense of lived worth and simplicity that reinhabitory cultures can begin to create means of provision through the granting of privilege to their home ground.



Human Requirements Can Be Aligned with Those of the Watershed

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