An Ecosystem Approach to Adaptive Decision Making Under Complexity: 
Rich Depictions, Multiple Perspectives and Savvy Stakeholders

Abstract

Complex systems, unlike simple systems, embody multiple realities that cannot be reduced to some comparable set of singularities. Then, decision making protocols under complexity must be crafted to take account of such inherent incommensurability. Planning becomes the art of constructing information-rich and meaningful depictions of the system of concern, and the development of expertise is best told as the growing of discernment, good taste, and connoisseurship, based on the application of attention over time. A sound decision is one that is generated by the application of attention to rich descriptions made from within an ecosystem approach to telling complexity.
An Ecosystem Approach to Telling Complex Systems

Complex systems are different from complicated systems, and the level of complexity is told by the quantity and quality of relationships embodied in the system of concern, rather than simply by the number of parts contained. Complex systems can only adequately be described as having a nested structure, where systems are seen to be emergent from the functional associations between their constitutive sub-system, and giving rise, in their own turn, to supra-systems shaped by system-level interactions. Each nesting is seen to be a level of organization, with the whole being arranged into a scale-hierarchic structure. [Allen & Starr, 1982, O’Neill et al., 1986; Vasishth, 2008]

Savvy societal decision making under conditions of complexity, taken as the act of choosing intelligently between genuinely alternative (and often incommensurate) potential realities, rests on the creation of rich, meaningful descriptions, and is driven by the giving of good reason. Decision making under complexity is made more tricky by the fact that complex systems embody multiple, co-occurring realities which cannot be reduced down to a singularity. In complex systems, truthfulness is multi-faceted, because there is actually more than one thing going on at the same time and in the same place. What we see, each one of us, will be contingent on our purpose in looking, and the vantage point at which we choose to situate ourselves. This confounds conventional decision making techniques, I argue, because the “facts of the case” cannot be transcribed into singular, or even comparable, forms. Not only is there more than one thing going on at the same time, but these multiply occurring realities are
distributed, often incommensurably and irreconcilably, across different levels of organization.

Therefore, there is a need for a new way of conceptualizing decision making processes under complexity. I argue that complexity should be thought of as a condition characterized using nested scale hierarchic structures, synthesizing across Rittel & Webber’s [1973] meme of “wicked problems” as open systems, within which change processes are best described using Odum’s [1969] idea of “ecosystem development,” and with the whole operating to give rise to Holling’s [1986] notion of ecological resilience and creative destruction.

A second key characteristic of an ecosystem approach to describing complex systems is scale-dependence. That is to say, the scales at which we choose to represent reality are themselves a potential confounder, in the sense that what we can and cannot see may be determined by the scales that we choose to use. Every representation is scaled in some way—where scale is taken both as sample size and sample interval. And the choice of each scale will affect what is revealed of reality and what remains hidden.

Finally, the issue of boundaries must be addressed. Specifically, under complexity, boundaries are neither innate nor natural, in the sense that we cannot reliably and agreeably read boundaries out of reality. A complex phenomenon will almost always exhibit more than one useful boundary, and each boundary will represent a different aspect of that complex reality.

These three aspects of complexity—levels of organization, scales and boundaries—come together to create an imperative for multiple depiction. Thus,
rich descriptions are depictions that capture occurrence both within and across levels of organization, use multiple scales to represent different aspects of that reality, and rely on the drawing of more than one useful set of boundaries.

Of course, the levels of organization we conceptualize to capture complexity, and the scales and boundaries that we choose in making our depictions, are neither randomly nor whimsically chosen. Instead we test the usefulness of one way of characterizing levels of organization against another way, while looking to see what one scale reveals compared to what some other scale might show, and, at the same time, while trying one particular sort of boundary against another. Gradually, over time, through attention and mindfulness, we come to know a rich description of our problem space.

In any case, no one single depiction is sufficient to capture the rich range of possibilities inherent in any complex system. No one single perspective is able to give us the full view we need to understand what it is we are looking at. And no one single purpose will provide sufficient satisfaction. And thus we are brought to the need for an authentically participatory decision making that rests on the gathering of savvy stakeholders in engaged deliberation. If this understanding of complexity is valid, then it will follow that decisions which emerge from such a deliberative process of giving good reason from multiple relevant perspectives, when fed with rich descriptions and coupled with a process of adaptive management, will prove evolutionarily more stable than decisions made from more conventional reductive methods.
In moving from decision making in conventional systems to decision making in complex systems, one of the biggest challenges is letting go of the “correct answer” meme. We are deeply acculturated to the notion that problems have right and wrong answers, and we are taught very early on the tools necessary to solve for right answers while eliminating wrong ones. Generalizing what is learned in math and science, we assume that decision making works similarly; if we do things right, then we will come to the one correct place. However, the correctness of complex decisions, by their very nature, cannot be singularly determined. As such, as Herbert Simon has argued, perhaps it is better that we act to satisfice, rather than to maximize. If we are to become effective at making decisions in complex problem spaces, we must first train ourselves to accept that there will almost always be more than one good answer (more like two or three), but also that there will almost always be some few answers that are better than all the others, and that, if we are deliberative, and rely on attention to a situation over time, and activate a model of connoisseurship, we can indeed come to know these few good answers.

**Wicked Problems As Complex Systems**

Complex systems are fundamentally different from conventional systems. Rittel and Webber [1973] capture many of the key differences between these two sorts of systems in their comparative depiction of “tame” problems and “wicked” problems. On the one hand, “tame” problems can be agreeably defined in some one singular way, irrespective of perspectival bias, and can be consistently solved to the same ultimate end point irrespective of operational variations.
These can be thought of as simple systems. Complex systems, on the other hand, cannot agreeably be singularly defined, because they inherently depict multiple realities. Nor can they be consistently solved to the same end state in every instance. Rather, each encounter with a complex system may well generate a unique outcome. At the individual level, many factors contribute to the potential lack of replication, for example, current mood, recent behavior, environmental context including the presence of others, and current task demands. At the group level, changes in economic and political factors often result in a new outcome at any given decision-point. Thus, different stakeholders may have different notions of what “the problem” is, which must all be integrated into the operational problem description. Moreover, there may be no singular point at which “the problem” can agreeably be said to have been solved. At its heart, this lays the prerequisites, perhaps the imperative, for an adaptive management approach to participatory decision making.

Because complex systems are differently structured than conventional systems, they may simultaneously embody multiple aspects of reality. Herein lies the dilemma for a general theory of planning that Rittel and Webber allude to in their now seminal article. How do we agreeably define a problem whose properties shift with perspective and with purpose? And how do we constructively engage a phenomenon in problem-solving when there is no single solution state inherent in it, and, worse, where one viably proposed solution might itself be the source of a whole other “wicked” problem?
Planning, taken as a social science, is deeply connected with ecology, which is taken as our knowledge of nature. At least in part, this is because nature is our first best operational example of evolutionary complexity in action, and so has always provided us with a ready source of models of complex systems. Of course, ecology, as a science, has itself evolved over time. What we know about nature, and about how nature happens has changed dramatically over the past century. We begin from an initial recognition in the late 1800s of the need to take an “organic” approach to understanding life, which informed the early efforts to know a systems approach grounded in a recognition of holism and of dynamism. Then we come, in the earlier parts of the previous century, to a recognition of the critical distinction that needs to be made between “closed” systems and “open” systems. Finally, we arrive, in fits and starts and in very patchy, uneven ways, to know nature as being constituted at its core by biogeochemical processes representing the exchange of matter, energy and information, arranged in nested levels of organization, and embedded in the rules of evolutionary occurrence.

This current place in the ongoing effort toward a savvy knowing of nature is informed most effectively by what has come to be called an evolutionary scale hierarchic ecosystem ecology, or a process-function ecology. In such a view, to take the world ecologically is to take it in a way that celebrates its complexity in some sophisticated cognitive way, rather than seeking to reduce it to a form more manageable by our innately quite limited perceptual apparatus. If decision making is to take complexity, as the engaged management of “wicked” problems,
in any effective way, then we must learn to apply an adaptive ecosystem approach to ecological decision making. This will allow us to deal with the thorny issues of sustainability, itself taken complexly and in regional and urban planning, in novel and ultimately more realistic ways.

As I have tried to argue, the effectiveness of decision making under complexity is significantly contingent on the descriptions we make, and which, in turn rests on the savvy telling of context and consequence, and on the pragmatic construction of strategically information-rich descriptions. Scale-hierarchic ecosystem ecology, or process-function ecology, offers a useful set of tools to help us in the creation of such descriptions in a decision making context. This work synthesizes from evolutionary ecosystem ecology to specify what it might mean, practically, to take an ecological approach to decision making. It seeks to take up the challenge of developing an operational understanding of what it might mean, in actual practice, to take up an adaptive ecosystem approach to making choices.

The Giving of Good Reason, Based on the Construction of Rich Descriptions.

How we tell a story determines what we take to be the story. Consider globalization, for instance. We can draw boundaries around the phenomenon of globalization, and choose scales at which we will make our descriptions, such that globalization appears to be beneficial to all concerned. To take the case of China and the United States, off-shoring manufacturing from the US to China can
be told as a win-win story. The Chinese gain economic development and much needed manufacturing experience, learning to make things they would never have thought to make, at scales which they would never have attained, without the US market to sell into. Americans gain a cleaner environment and cheaper goods.

But we can change the boundaries around our description such that we are able to see as well the pollution (including resource depletion and degradation) and the adverse health impacts wrought by this proto-industrial development in China, as well as the dislocation and economic sector upheaval, including loss of well-paying and secure jobs, inflicted upon the working American. Further, we can change the scale at which we make our depictions so as to capture the increased risks of cancer in Long Beach neighborhoods around the I-710 Freeway coming out of the San Pedro Port Complex, brought about by the inhalation of teeny-tiny toxic air particles wafting from the exhaust pipes of diesel trucks, trains, and ships, then move out three or four levels of organization so as to link these local cancer cases to the processes of global venture capital.

Decisions about globalization are then fundamentally different than, for instance, decisions that set prices based on supply curves and demand curves in an idealized marketplace. Likewise, decisions about the location of homes within zones with cancer-causing pollution in the City of Long Beach are different from those about the siting of goods processing logistical facilities in Southern California. Once we recognize these differences, which represent shifts across levels of organization, we can begin working on ways to resolve them.
Complexity as a special case in decision making requires special conceptual and descriptive tools, as illustrated by Rittel and Webber [1973] and by Holling and Goldberg [1971], and process-function ecosystem ecology readily presents itself as a methodology for dealing with the construction and management of instrumental depictions of such complexity. The key moves in such an ecosystem approach involve: an expansion of the well-entrenched but incomplete typological and population-community world-views into a broader process-function view; an adoption of the nested systems model of complexity, with its associated move to conceiving this complexity as being arranged into meaningfully named levels-of-organization; a recognition that, in complex systems, reality is not readily singularized in any useful way, but must instead be described from strategically multiple perspectives using multiple criteria, with some explication of purpose; and an acknowledgement of the scale-dependence properties of complex system realities, requiring the considered application of multiple spatial, temporal and organizational scales in constructing system descriptions using multiple functionally-relevant boundaries.

**Nested Levels of Organization Generate Operationally Informative Depictions**

Let us consider an example for how a solutions to a complex decision can be narrowed down using an ecosystem approach. The strong connectivity between the two adjacent Ports of Los Angeles and Long Beach make it meaningful to consider them as a single goods movement node, the San Pedro
Port Complex. This complex, due to its strong interactions with surrounding residential and industrial neighborhoods, can be seen as nested within a sub-regional system forming its own level of organization. This sub-regional system interacts strongly with a variety of logistic and warehouse sub-systems, and, as such, can be seen as nested within the Southern California regional system. In addition, this system can, in its turn, be seen as nested within a national goods receiving system that is the United States, which, in turn, can be seen as nested within a more global goods production and movement supra-system that connects across nations and continents [Figure 1].

Such a nested conception is useful to us because it allows us to move in to and out of particular levels of organization, to consider supra- and sub-systems in their structural and functional relationship as a coherent whole, and to trace the lines of influence across levels of organization as we seek to move the system in one way or another to attain particular instrumental ends, under some responsively adaptive management scheme. As O'Neill et al. [1986:55] point out: “...hierarchical descriptions help to manage complexity by isolating dynamics at a single level, while ignoring details at lower organizational levels.” Then, we can deal with parts of a complex whole, without losing sight of the wider context and without getting overwhelmed by subsystem interconnectivities.

Such an approach also allows us to fabricate a mitigation strategy that more properly allocates costs and benefits where they appropriately belong, across relevant levels of organization. The consequences of global, supra-system forces which have impacts that percolate inward two or more levels of
organization, perhaps to the regional and the local levels, can be assessed at the particular level of organization we are concerned with in any one case, without obviating impacts at other levels of organization. Then, the regional impacts of globalizing production can be dealt with at the regional level, while maintaining connectivity with the national and the local levels, and local impacts of the globalizing system can be dealt with at the local level, but without losing the contextual elements located at the national and the regional levels. In such a view, the bulk of the socio-economic advantages of the current global goods movement system belong to the level of national consumers, and in the context laid out here, the most onerous environmental health burdens are incurred at the level of the neighborhoods surrounding the San Pedro Port Complex [Figure 1].

**Nested Levels of Organization and the Reconceptualization of Goods Movement In Southern California**

Goods movement, in the form of products shipped into the United States, has become an increasingly vital component of economic activity, particularly under the steady pressures toward an increasing out-sourcing of manufacturing to the more newly developing nations of the world, such as China. The Ports of Los Angeles and Long Beach at San Pedro have accordingly moved to an increasing position of importance, and Southern California needs to take more explicit account of its goods movement infrastructure if it is to accommodate this projected and economically desirable growth. According to some planners and economists, the logistics sector has the potential to become for the Southern
California economy what defense sector-based manufacturing was to the post-
World War II generation—a steady source of blue-collar jobs with sufficient
potential upward economic mobility attached to them to promote the growth of an
economically healthy middle-class. In any event, the goods movement sector is
expected to grow significantly, and the forces of local, national, and global
consumerism will demand this growth.

A nested scale-hierarchic view of this goods movement system requires
that we see this complex global goods management structure as exhibiting
distinct levels of organization. The San Pedro Port Complex, along with the
system of residential neighborhoods and industrial facilities that support it in
social, economic and environmental ways, is most usefully seen as being nested
within the infrastructure and logistics complex that is the Southern California
region. Southern California, in turn, is nested within the economic complex of the
State of California, and the State can in its turn be usefully described as nested
within the consumer-producer complex that is North America, with the whole
being nested within the global manufacturing and production complex.

Making such a nested description of the goods movement system in
Southern California becomes useful because it allows us to move self-
consciously across levels of organization, tracing the processes and functions
ascribable to each level as they relate to its sub- and supra-levels, and to more
explicitly link effects and consequences across the diverse set of levels that,
together, make the system a viable, functioning whole. Without a recognition of
the rapidly burgeoning manufacturing and exporting activity in China, to use just
one example, and without a recognition of the pressing consumer demand for cheaper and more conveniently available consumer goods in, say, Columbus Ohio, the pressing need to expand goods movement infrastructure in Southern California loses much of its urgency outside of the immediate region.

The imperative and the magnitude of the need to expand Southern California’s port facilities, along with the roads and freeways that enable the effective and timely movement of goods, only becomes real when it is contextualized by both the consumer demand for cheap goods, and the innate pressures of the global manufacturing complex to continue to deliver goods for consumption. Absent such a nested description of the whole system, decision makers at different levels of organization would lack the information necessary to trace consequences across contexts, and to be able to properly ascribe benefits and costs across the nesting global complex. Without some systematic and equitable way to manage these benefits and costs across the various levels of organization, markets tend to become skewed by factors that could, under conventional planning descriptions, be characterized as externalities. Then the burdens of the system’s operations may fall unfairly upon some parts of the system, while the benefits may accrue elsewhere.

Consider the case of the consumer, for example, in Columbus, Ohio, and a residential neighborhood near the San Pedro Port Complex, which also has a rail and truck arterial running through its geography. The consumer in Columbus, Ohio, is capturing the quite enormous benefits of a globalizing production scheme, receiving access to goods priced far more cheaply than if they had
instead been manufactured locally within the U.S., given the difference in labor, production, and environmental costs. At the same time, this consumer is also capturing the not-insignificant benefits of an environment freed from a wide range of pollution impacts that would certainly have accrued locally, perhaps with substantial costs in terms of human health and ecological degradation. These are not trivial benefits.

Now consider the resident of the Long Beach neighborhood, two or three levels-of-organization inward of the consumer in Columbus, Ohio. This poor soul is forced to carry a conversely substantial burden in the form of traffic congestion, lost economic productivity, environmental health pollution, a degraded ecology, noise, blight and so on, all so the consumer in Columbus, Ohio, may capture the economic, community and environmental benefits of the globalizing manufacturing complex. Meanwhile, two or three levels of organization outward from the North American consumer level, the laborer involved in the production process in, say, China, captures the somewhat more questionable benefits of a modernizing manufacturing facility, and of increased economic and social opportunity, although at an increased environmental and ecological health cost.

Using Levels of Organization to Design A Regional Mitigation Scheme

At least some of the adverse impacts of the globalizing goods manufacturing complex can be mitigated, of course, to a greater or lesser extent, and if we so choose. But these mitigations must occur within the level of organization at which they are manifest. The benefits, however, may be
occurring at some entirely different level of organization. And this is where the nested scale-hierarchic conceptualization of the global manufacturing complex becomes starkly useful. For now, as systems planners operating in a cognitively holistic way, and who are free to move across and within different levels of organization, at least in our minds and our models, we can effectively mediate across the nested levels of organization to devise a sustainable mitigation scheme that can orchestrate the myriad benefits and costs of the globalizing production complex, transferring some of the benefits from one level to redress the costs at another. We can ensure, for instance and only to take one example, that consumers across North America who are benefiting in real economic terms from the globalization of goods manufacturing, help defray the mitigation costs incurred by the residents of, say, Long Beach, California, or the toiling laborers in, say, Shenzhen, China.

Sustainability is really just an explicit and thoughtful articulation of a conscious concern to consider equally the economic, ecological and ethical dimensions of any particular decision system, in some inter-generational way. So the marketization of economic decision making does not eliminate the need for planning, but rather redefines it as the conscious integration of multiple and sometimes conflicting concerns with the long-term viability (sustainability) of the decision outcome.

An adaptive mitigation management approach to administering the global production complex, based on the conceptual tools offered us by a process-function oriented, nested scale hierarchic ecosystem ecology shows us the way
to balance the diverse and often geographically and administratively disjointed manifest consequences of how the system works. The environmental and community consequences of the globally and economically pressing need for an expanding goods movement system in places such as the residential neighborhoods surrounding the San Pedro port complex can only be dealt with equitably from within some wider levels of organization that constitute the continental consumer network and the global goods manufacturing and supply chain system.

An integrated mitigation management scheme for goods movement planning would transfer some of the economic and environmental health benefits accruing to consumers across the nation in a manner that offsets the adverse environmental health and traffic congestion costs currently imposed upon residents at the neighborhood level located around such goods movement facilities. At present, such net costs show themselves as an externality, imposed upon the residents around, for instance, the I-710 Freeway leading to the San Pedro Port Complex by the somewhat amorphous forces of globalization. Some mechanism is needed, both to internalize these costs, and to spread the burden of disbenefits more equitably across broader levels of organization. For instance, some form of a fee or surcharge levied on all consumer goods brought into the country through any of its maritime and aviation ports could be levied, perhaps proportionally upon manufacturers and consumers. Such revenues could then be appropriately transferred to these port complexes and their neighboring communities with the explicit objective of funding impact mitigation projects that
seek to redress the adverse environmental, community and economic effects of the goods movement enterprise as a whole.

It should be obvious, then, that there is no one boundary inherently more “natural” than another, and no one level of organization that takes innate priority over other levels of organization in terms of consideration as the “system of concern.” As I have argued, with multiple potential boundaries, and with multiple relevant levels of organization at play, any description of the problem space would have to consider multiple alternative reality-states, depicted at multiple spatial, temporal and organizational scales. In addition, with each depiction being distinct and unique, there is simply no way to commensurably weigh alternatives other than by the application of deliberative practices. Attention, and discernment, and good judgment, applied by multiple savvy stakeholders acting on information-rich descriptions, in a reiterating reflective mode, become the tools that we rely on to make sound decisions. Moreover, there is no single optimal solution that can, even retrospectively, be deemed to be the most suitable. More than one outcome is possible, and no one of these outcomes can be reliably and agreeably be named the “best” outcome. This is the nature of complexity.

**Bringing An Ecosystem Approach to Goods Movement Planning In Southern California**

In ecology, a conventional depiction of such a hierarchically nested organization considers the constitutive relationships between cells, organs,
organisms, communities, ecosystems, and ultimately, the ecosphere [Rowe, 1961]. In planning, we might consider, for instance, specific development projects that are functionally related to each other—constituting, as one example, residential, commercial, industrial and recreational land uses—and which give rise to neighborhoods, by virtue of their functional interactions. Various functionally related neighborhoods, in their interactions and exchanges, may be said to constitute a city. Various cities, in turn and in their own relationships to each other, may be said to give rise to regions. The very act of conceiving a region in this nested manner allows us to separate out exchange processes and functional relationships by levels of organization, to then choose spatial and temporal scales suitable to capture the processes and functions thought relevant at each named level, and so trace connectivities across levels of organization.

Godschalk [2004] has argued for a conflict-based view of sustainable development, and demonstrates the need to resolve specific conflicts between particular perspectives in efforts to attain sustainability. But conflicts can be differently told as a consequence of discontinuities in flows across levels of organization as well. The approach to problem depiction advocated here shows that benefits at one level of organization may reflect as disbenefits at a proximate level of organization—showing themselves as conflicts, perhaps—and also that these discontinuities between benefits and disbenefits can be resolved by attentive and ameliorative policy interventions. The same forces that generate economic benefits at the national and regional levels, in this case, show themselves as the source of environmental and social equity disbenefits at the
local level. In some cases, at least, the apparent conflicts between economic, ecological and equity concerns may only be a reflection of changing levels of organization.

In the case of goods movement in Southern California, forces of economic globalization have moved many manufacturing activities out of the United States and into foreign countries [Robins & Strauss-Wieder, 2006]. This removal generates huge benefits for U.S. consumers on two fronts. We receive consumer goods at a fraction of the price that they would have cost us if manufacturing had continued to take place within the U.S., with its higher labor costs and economically more expensive levels of environmental regulation enforcement, as compared to some developing countries. At the same time, we benefit from reductions in manufacturing-related pollution, as the production of consumer goods is almost always associated with significant levels of resource degradation and environmental pollution. These benefits, however, come at the cost of lost employment opportunities, but the benefits and costs are incommensurate.

Describing the complex phenomena of goods movement and consumerism, and the processes that shape them, using a nested levels-of-organization scheme allows us to trace out the context and the consequences of globalization processes in a somewhat systemic way [Figure 1]. Such an approach also allows us to fabricate a reasonable mechanism for the mitigation of adverse impacts across levels of organization. A cross-level policy mechanism is needed to transfer some amount of the benefits currently accruing
to consumers, producers and corporations across the U.S., viewed as a supra-system, to the community of residents living around the Port complex and the I-710 Freeway, viewed as a sub-system. One way to mediate such an exchange of benefits, intended to mitigate the particular local environmental health and traffic congestion disbenefits, is to construct an impact management mechanism at the intermediate regional level of organization. However, this requires an integrated systems approach to regional decision making, one that can connect the functional and structural elements together in a manner that permits the effective remediation of adverse impacts across these various named levels of organization, and that can be implemented using a participatory and adaptive management approach.

**Using Urban Forestry and Smart Growth Development Strategies To Mitigate the Impacts of An Expansion of the San Pedro Goods Movement Facilities**

The single most significant concern expressed by community groups in the neighborhoods surrounding the San Pedro Port complex has to do with the present levels of truck and rail traffic through their areas. Their opposition centers around issues of adverse environmental health impacts, traffic congestion, and noise pollution. The anticipated increases in the volume of this traffic expected due to potential and proposed expansions of the port facilities quickly rise to the fore as the nub of community opposition to such expansion plans. Clearly, such impacts are complicated, and the solutions to these
concerns will be complicated as well. If, however, the matter is addressed from within an ecosystem approach which is sensitive to levels of organization and to issues of scale and boundary, then there are fairly clear and feasible actions that can be taken to accommodate community concerns within the decision making process.

In principle, the idea of buffer zones to the downwind side of freeway segments that see high concentrations of truck traffic, and hence diesel toxic emissions, has been well established. As early as 1973, Kurtzweg had identified the need to develop innovative strategies for dealing with air pollution in urban planning. It has since been observed that air pollution impacts, particularly in the case of particulate matter pollution, tend to drop rather steeply with distance from the freeway source. Zhu et al. [2002], in studying the I-710 and the I-405 freeways in Southern California, find that particulate matter concentrations decrease exponentially with distance from the freeway to the downwind side—at least until about 100 meters from the edge of the freeway, and then rather more gradually to about 300 meters [Figure 4]. Other studies, in Europe, where emission characteristics are slightly different than the US [for instance Roorda-Knape et al., 1999] and in Northern California, where background emission levels are not quite as high as in the South Coast Air Basin [Kim et al., 2004], generally agree with this basic observation.

Location matters, and a buffer zone at the downwind sides of heavily traveled freeways can be considered a reasonable mitigation for traffic-generated toxic particulate pollution, particularly in the case of roads and freeways heavily
traveled by diesel trucks, as in the case of the neighborhoods surrounding the San Pedro Port Complex [Figure 5]. The Air Quality and Land Use Handbook, prepared by the California Air Resources Board (CARB) after extensive review and public comment, establishes the “range of relative cancer risk” from freeways and high-traffic roads as being between 100 and 500 meters, and concludes that we avoid siting “sensitive receptors” (new residences, schools, day care centers, playgrounds, as well as elderly care and medical facilities) within 150 meters of a freeway [CARB 2005: 8-10].

A key problem here is the fact that most residences in the area were sited and inhabited before the I-710 freeway saw quite as much truck traffic as it currently does. In addition, if the goods movement sector is reasonably expected to grow, as it surely must under pressure of globalizing production and diversified supply chains, then what is to be done with these existing residences? How do we ensure environmental health and equity for individuals who moved to these neighborhoods before the traffic came to town, so to speak? This is the central source of contention and the primary reason Long Beach communities are so vehement in their opposition to any future expansion of port operations.

Engaging the communities in a genuinely participatory design and decision making process would be a prerequisite to any effort to rearrange neighborhoods. One of the key factors shaping resistance to property acquisition and demolition of existing buildings is likely to be the fear of displacement. But if, in conjunction with community members, a way could be found to redesign neighborhoods to give people the option of relocating within the existing urban
fabric, especially if accompanied by a genuinely generous compensation package, then perhaps some of that resistance could be calmed.

At the same time, there is a real need to improve the livability of the communities around the I-710 Freeway. Research shows that smart growth sorts of strategies (mixed land uses, higher densities, transit and pedestrian oriented transportation planning and effective urban design) can improve the quality of life of residents [Anonymous, 2000; Geller, 2003; Leyden, 2003; McAvoy et al., 2004; Portney, 2005], in cases where residents show a preference for such living arrangements. Differently, Holden [2004] has shown that households in high-density communities have a smaller ecological footprint than more dispersed urban design patterns.

Taking the basic premise of smart growth development to be true—that intelligently mixed land uses, when coupled with well-designed pedestrian and transit-friendly planning, do indeed lead to more livable and more desirable neighborhoods—it is at least possible that the urban fabric of the residential areas around the I-710 corridor may actually be improved by the creation of wooded buffer zones and densified housing.

Synthesizing across three conceptual structures: 1) an ecosystem approach evoking the nested levels of organization proposed earlier and which gives us the basis for an equitable redistribution of benefits from the national level in the form of impact fees to offset mitigation project costs at the neighborhood level, 2) an urban forestry strategy for particulate matter control, and 3) the now well-articulated principles of smart growth development
(specifically, higher density, transit oriented, mixed land use sorts of development), we may arrive at a place that allows us to propose a decision making protocol that is pragmatic in its effect—both because it effectively mitigates the local adverse impacts of global freight expansion and because it integrates an equitable financing mechanism that distributes costs on the basis of benefits.

The funding generated by the goods movement impact fees levied on consumers across the nation would then be used to offset the adverse environmental and community health effects of the necessary expansion of the goods movement system connecting the San Pedro Port Complex to the logistics and distribution networks being created further inland. (It could even be that we might advocate for a tax on all goods that arrive in the U.S. by ship or by air, with the monies so generated being used to mitigate adverse environmental impacts around port and airport neighborhoods. This would have the double advantage of reminding consumers that they are purchasing products made abroad, and that there are communities within the U.S. where people are paying a price with their health for these imports.)

Using a strongly participatory, collaborative and community stakeholder-driven decision making approach, including an educational component, it should be possible to use the funding generated to implement a comprehensive and generous relocation scheme that allows the creation of alternative residential accommodation for families currently exposed to unhealthful environmental exhaust fumes from goods movement traffic, and also those likely to be
adversely impacted by any future expansions of the road and rail goods
movement network linked to the Port Complex [Figure 5]. In addition, using
"smart growth" principles, and strategically targeting neighborhoods most at risk,
higher density, transit linked and mixed land use residential complexes can be
designed and constructed that would give impacted community members an
alternative, and hopefully preferable, choice in living accommodations within the
proposed project area [Figure 3]. Moreover, linked to a generous acquisition
package, it should be possible to clear buffer zones around the freeways in some
systematic and strategically relevant fashion. These buffer zones could then be
intensively planted with ecologically appropriate species of native trees, to
effectively mitigate the air pollution and noise impacts of the currently proposed
expansion of the I-710 freeway system, with reserve mitigation capacity built in to
the scheme to accommodate foreseeable future expansions as well.

Decision Making Protocols Under Complexity

The story of the San Pedro Port Complex is a story of globalization,
embedded within the frame of nested levels of organization, showing different
aspects of reality at different scales of description, and manifesting multiple
functionally relevant boundaries. In following processes and functions across
levels of organization, globalization shows itself to be both desirable and
undesirable, but in quite different ways. The root question is, how should change
processes be managed to generate an evolutionary stable strategy for
development?
An ecosystem approach can be used to transform the decision facing policy makers from a simple growth-no growth contest to a qualitative appraisal of how a sustainable form of development might be substituted for the more conventional model of growth-as-expansion. The generation of information-rich descriptions, focusing on the unfolding of dynamic processes and functions rather than on a static accounting of morphological events and entities, allows us to think of decision making as the adaptive management of occurrence.

Rather than choosing between competing outcomes, decision making under complexity is about choosing the spatial, temporal and organizational scales and the functionally relevant boundaries that one takes to be operationally significant for particular purposes and from specific perspectives. One makes choices and gives good reasons for making those choices, and then tests the soundness of one’s decisions in a participatory, stakeholder-driven environment.

In the case of the goods movement system attached to the San Pedro Port Complex, changes in volume of goods flowing through the system are met by modulations of ecological processes and functions generated by those flows, and by rearrangements of spatial settlement patterns. Pollution becomes a proxy for harm, and the management of that pollution is taken to be the objective of the decision protocol. Rather than choosing the “correct” answer, the objective of such a protocol is to generate meaningful alternatives; and rather than relying on simple expertise, an adaptive management-oriented ecosystem approach to decision making rests on the engagement of connoisseurship and discernment,
applied to rich, meaningful depictions drawn from multiple perspectives and for more than one purpose.
Bibliography


SCAQMD (South Coast Air Quality Management District), 2000, *Multiple Air Toxics Exposure Study in the South Coast Air Basin (MATES-II)* (SCAQMD Diamond Bar, CA) Accessed on April 12, 2006, at: <http://www.aqmd.gov/matesiidf/matestoc.htm>


Figure 1: The "system of concern" is designated to be the region around the San Pedro Port Complex, comprising the complex itself, the residential neighborhoods, the regulatory system and the freighter system. The critical relationships of concern are taken to be between the two ports and the goods movement system at the sub-system level, the residential neighborhoods and the freighter system in the system of concern level, and between U.S. retailers and consumers at the supra-system level.
Figure 2: Cancer burden estimates for the South Coast Air basin, excess cases per million population, from all sources. [SCAQMD, 2000]
Figure 3: The potential project area.
Figure 4: Pollution concentrations are sensitive to distance, and begin to decay as they move downwind of the freeway. Generally, it has been found that black carbon as well as CO will drop to about background levels by about 300 mts. downwind. [Zhu et al., 2002:4333.]
Figure 5. The freeways serving the San Pedro Port Complex