SENSE AND RESPONSE:
A BIOCLIMATIC DIALOGUE OF PLACE

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ABSTRACT

Preindustrial societies had a intimate connection to their environments in part because survival was dependent on a constructive understanding. This resulted in fantastic forms of settlement that maintained a stable and sustainable relationship. Increasing use of energy and technical prowess allowed societies to loosen this relationship, at times becoming abstract and capricious. Our current increasing awareness of our ecological dependence has resulted in a renaissance of understanding of how we should inhabit the earth. A new sensing of our place in the world has engendered a bioclimatic relationship, resulting in new forms of settlement which respond to place.

1. INTRODUCTION

Historically as humans tread on the earth they needed to be careful where they placed their feet. The transition from a hunter-gatherer to an agrarian existence is often portrayed as a moment when humans lost a degree of awareness of the earths interconnected systems, and began the progressive exploitation that has resulted in today's ecological degradation.

Much awareness of the natural world was lost as life became more comfortable and stable. It can also be seen as the moment when stewardship of the earth became a possibility, with management of resources entering the lexicon of endeavors. Clearly a new set of skills came into development, and may also be interpreted as the time that a partnership was brokered between humans and the land. No longer were impacts left behind, but now were experienced as a consequence of our actions.
The idea of embracing and enhancing the utility of available resources resulted in numerous forms, from the land use patterns of ancient Hawaiians, to the traditions around bird houses, and the landscape designs in the new world.

Fig. 1: A tunnel built of live willow

Ecosystem services were optimized. Working the land is an investment, an effort that brings bounty after effort. It takes time, and physical area to grow and harvest, and these essential limits encourage consideration of the lands capacity. The agrarian condition rewards an engaged relationship with the land, stewardship in which the essential wildness of nature is moderated and put in service of productivity. In providing for human needs, stewards are

vested in insuring that the abundance of the land is not compromised. At it's best; our relationship with land is symbiosis.

Landscapes have been deeply altered by human activities, and clearly not always for the better. There are also many examples of human settlements that epitomize sustainable approaches and have dramatically increased the ecological productivity of the land. It is worth examining some of these, and noting what is significant.

2. TRADITIONAL RESPONSES

2.1 Balinese rice paddies

Food is at the base of Maslow's pyramid of human needs, and as such has engendered many engineered landscape forms. Rice is the world's most important crop, and is the staple food for half of the world's population. Of the most spectacular forms are the terraces used for growing rice in tropical mountain regions. Humans engaged the opportunities provided by the mountainside to create an engineered landscape that develops existing water flows and utilizes gravity to equitably distribute water and optimize the growth of rice.

Rice is grown in flooded terraces, where water is used in a carefully regulated pattern to optimize the conditions for growth. Fields are flooded when plowed, after the rice is grown and harvested the fields are drained and burned, and then re flooded so that the old rice stalks slowly decompose under the water.. This method of irrigation goes back at least 1,000 years, and the time to grow traditional Balinese rice (210 days) is the length of the Balinese year.

Fig. 2: Balinese rice terraces

Control of irrigation, which is water coming from a higher source and directed into the many terraced rice paddies, is critical to the life of the population. It requires the rice farmers to co-operate with each other in social units. The farmers set the cropping patterns and irrigation to optimize water sharing and, through coordinated fallow periods, reduce pests. There is a trade-off between these two constraints, water sharing and pest control.

Rice paddies do not just produce rice but also protein. They are full, complex working ecosystems, with eels, frogs fish, and dragonflies. After the harvest, rice farmers bring a flock of ducks, which spend the day clearing up old pieces of grain and eating insects that would destroy the next rice crop if left alone. Humans and the biological world coordinate for mutual benefit.

2.2 The Ahupua'a

The ahupua'a, Hawaii's traditional land planning system is an archetypal example of land planning for environmental stewardship and sustainability. Communities managed pie shaped wedges of land that extended from the mountain ridges to the ocean reef. This land division followed the

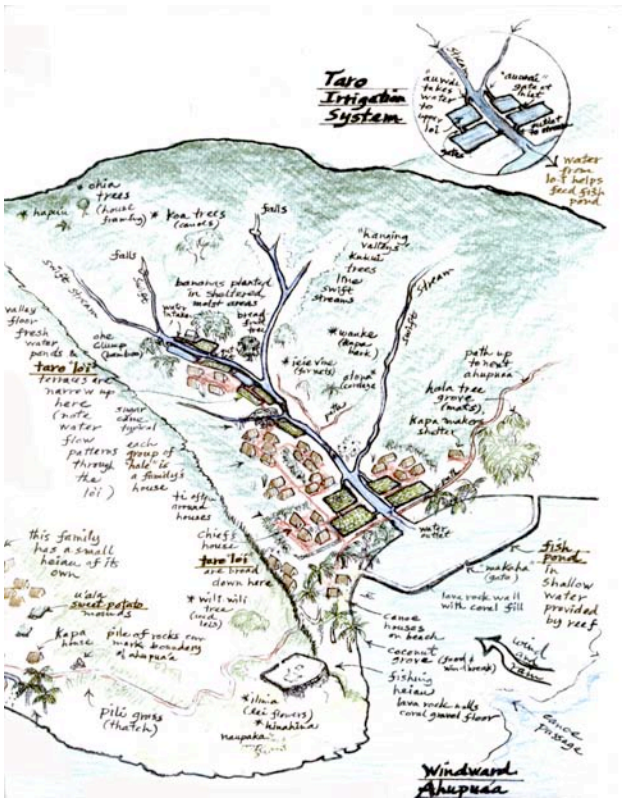

Fig. 3: The ahupua'a, and its interconnected optimized ecological systems (after Gillmar).

watersheds, and thereby insured a shared vested interest in protecting the land and water resources. Common use of the ahupua'a resources demanded that boundaries be drawn to include sufficient land for residence and cultivation, freshwater sources, shoreline and open ocean access. The political subdivisions of land enhanced natures form and resources. Each micro environmental system was optimized for a specific use, recognizing the hydrological and climate resource. "As the native Hawaiians used the resources within their 'ahupua'a, they practiced aloha (respect), laulima (cooperation), and malama (stewardship) which resulted in a desirable pono (balance). This is sound resource management where the interconnectedness of the clouds, the forests, the streams, the fishponds, the sea, and the people is clearly recognized. i"

2.3 Aviaries

Humans have lived with numerous animal species with mutual benefit of cultivation and cooperation. The fishponds of the aapuaha provided optimal food and shelter for fish, and replenished populations, and sustained and nurtured life. Patterns of grazing animals have changed landforms, and when thoughtfully done can enrich and cultivate the landscape. The tradition of birdhouses and other animal husbandry extends deep into prehistory and continues today. Often integrated directly into individual residences aviaries also have urban and community agricultural benefits. Pigeons and other birds are valued for their insect eating, as well as for their droppings, which are collected and used as fertilizer.

Fig. 4: A traditional Hungarian Sekey gate, providing birdhouses in a gate for people and carriages

2.4 The "Emerald Necklace"

As agrarian habitations became more densely populated the patterns of land use changed. From small buildings in a large landscape, villages began to aggregate around roads and circulation networks, forming patterns that provided small frontage, with long narrow lots that allowed for agrarian land connection. Higher densities begat towns ad cities absent of land, and parks and greenbelts took their place, providing some modicum of ecological merit. Fredrick law Olmsted designed the park system around the greater Boston area in concert with several critical environmental issues. What most persons perceive as a pleasant corridor of parks is also an elegant resolution of storm water drainage and water filtration, while also providing wildlife corridors and refuges. It remains as testimony to the vision of integrating the ecological benefits of nature into urban environments.

Fig. 5: Olmsted's ring of parks and waterways provide ecosystem services in the urban context

3. CONTEMPORARY RESPONSES TO OUR BIOLOGICAL ENVIRONMENT

3.1 Changing context

The industrial and agrarian revolutions have released us from much of our biological requirements to be connected to place. Few people working land can provide food for many, energy allows us to transport materials and goods easily, and live in proximity to economic rather than ecological opportunity. Cities are ecological deserts; yet provide for millions, our biological interdependence with the planet is more of an abstraction than a daily reality.

We sense the planet differently today, business sets our schedules rather than seasons, our actions are not dependent of the weather, newspapers and science form our impressions, and we see impacts far beyond our immediate selves. Climate change is a global effect, the sum of billions of individual interactions. Historically human actions that did not have immediate localized effects were considered marginal in importance and dismissed. While this continues to be the predominant worldview, we now are beginning to see global issues being internalized, personalized, and directly addressed at a decentralized local level, engendering a reemergence of a climatic dialogue of place.

We are beginning to understand what we are doing to the planet, and we are making changes to our lifestyles, architecture and town settlements to adjust to our understanding of what are happening to the planet at the global level. Often theses are market-based responses, as companies see economic benefit in acknowledging their stake hold in environmental issues; it can be as simple as saving money on energy. The insistent subtext remains the ethical concerns, however, and these are starting to trump economics.

This localized response to a global problem is different from previous environmental responses, and is happening on a grander scale than before. As people act, the evident answer to many significant global impacts is to develop an architecture that reflects a regionalism, that works with the climate to reduce the loads on buildings, that works with the biology, the hydrology, and the local conditions to optimize the interactions between the built environment and the natural environment to minimize the negative environmental impacts. This is form giving design information. Rather than the traditionally romantic aesthetic, climatic change is creating a regionalism that is performance based. There are morphological aspects (orientation, shading, daylighting, etc) yet many of the elements are invisible technical fixes to enhance performance.

As deserts transition to the moisture-laden plains, and rivers cut valleys, leaving alpine forests behind, each climate begets an engaged ecosystem and a wealth of climatic building design responses. Settlements in hot climates value shade and breezes. When diurnal temperature swings are significant, massive building materials show their merit moderating thermal energies. Daylight apertures are restrained and shaded, water venerated, dew collected, a sense of earth and significance of leaf celebrated. Brazen sun can be collected and stored, and oasis created through the climatic engagement with place. This path of sensing place and responding to its cues results in a new type of stewardship, valuing ecological productivity and restoration, rather than local production of required sustenance.

3.2 The Desert Living Center

The Desert Living Center in Las Vegas is an example of such a place that visibly uses climatic information to inform a design response. As a visitors center, it teaches through the demonstration of efficient regional architecture. Evaporative cooling towers, rainwater catchment, massive construction elegantly provides both high performance design and a pleasant habitat. The resulting light footprint on the earth directly addresses our current understanding of building affects on climate change, and anticipates a future when ecological efficiency in design is not a choice.

Fig. 6: Downdraft evaporative cooling towers flank rainwater catchment, cascade and cistern at the Desert Living Center in Las Vegas

3.3 Endless Consumption

The denial of our biological interdependence is evident all around us. We act as if our actions have no consequences. We can build and consume eternally, and if we dislike the consequences of our actions we can move on and the issue appears to be gone. Global environmental impacts appear as a distant liability and therefore the prudent action is to internalize any benefits, (continue to drive my own car) and protect owned assets. For most people there is no profit in addressing global issues, they only have negative economic and social consequences. What is the benefit to reducing your own emissions?

Fig. 7: And the poor inherit the degraded environments

Our striving for prosperity compels us to consume desirable resources until they are gone, and then move on, leaving degraded environments behind for those less fortunate. If people can move, they do move. We act in our own self-

interest, spend money on things that benefit ourselves. This is the antithesis of community, and ascribes to the view of disposable place, and unlimited resource. Places that had been considered to be desirable may become less desirable.

Fig. 8: We create ecological deserts, and assume that our clean air and water will still be available

This attitude results in missed opportunities, for example our network of highways are designed as if they have no other purpose or effect other than moving traffic. Yet they are enormous civic infrastructure, that could be designed to engage hydrology, create microclimates or cultivate ecosystem services. Instead we have inherited a system that often causes enormous negative consequence that we some how manage to deny. This externalization of consequence is our lens of experience, a disassociative way of life.

In the last few years the Town of Grand Lake, which has been a popular vacation spot in the Colorado Rocky Mountains for over a hundred years has seen a disastrous infestation of pine beetles killing off over 50% of the conifers, and it is likely that in the next few years the landscape surrounding the town will be virtually 100% devastated. This has caused people who previously found Grand Lake a great place to vacation and invest now find it less desirable; frankly they don't want to be in a place that does not have trees. Real estate values are declining, along with a flight of people to more arboreal reaches.

This is a predictable result of ecological exploitation on place; people internalize the benefits and externalize any cost associated with global warming by moving away from damaged areas and towards more desirable areas. Fluid capital affects the social and economic definition of place.

The pine beetle example illuminates many of the conundrums of how climate change is affecting inhabitation now, particularly the manner in which people are connected to their environments, and the degree to which they adapt to a perceived changed future. Environmental impacts are rarely direct, and the elusive paths they take provide ample reason to doubt their complicity. Attitudes towards the

Fig. 9: Residents in Grand Lake Colorado have been shocked by the deforested moonscape created by the by the epidemic of the Pine forest beetle in the past two years.

beetle kill favor opinions, such as that that the park service has mismanaged the forest resource and created the problem through fire suppression, inadequate logging and preservation of road less areas. Beetle kill has happened before, and many believe perhaps that the current devastation is nothing more than nature's cyclical events, and not our concern. These ideas have merit, and these causes likely do contribute to the problem. Conveniently, they also share a satisfying release of responsibility, with uncertainty as the sword severing accountability.

Looking beyond Colorado we see the pine beetle issue aflame in Arizona, and steadily marching across the vast untouched Canadian forests. Mismanagement is moot as an issue at this scale, and several studies show a high degree of correlation between temperature rise and pine beetle infestation. Earlier pine beetle outbreaks have collapsed after weeks-long cold spells with temperatures less than 20 degrees below zero, but without these long, deep chills that kill off large amounts of the beetles the outbreak continues. For most people, it is difficult to connect automobile traffic in Los Angles with the decline of the Lodge pole pine in North America.

Paradoxically the effect of disengagement from the issue of climate change could engender a renaissance in those areas that are experiencing the evident, direct physical impacts of climate change. Those places that are experiencing erosion, draught, or decline of the biotic environment that may be valued as places that have enormous potential for

restoration, much as brown fields are often considered undervalued and good investments today. This may drive the influence of regionalism further, as the economic benefits of restoration are seen as increasing.

4. SENSING THE FUTURE: DESIGNING A RESPONSE TO OUR ECOLOGICAL INTERDEPENDENCE

4.1 Changing context

Buildings are inevitably considered negative impacts on the environment. This is how they are envisioned and therefore this is how they are made. We can also consider them in other ways. When we look closely at rocks in a natural environment, we often see them acting as frameworks for many types of ecological life—plants, lichens, birds, and other organisms all use the rocks for the utility the provide. Minerals leach out, plants latch on, and habitats are created and modified by the interactions of sun, wind, and water. The rock becomes an essential part of the environment.

A healthy, mature ecosystem has innumerable connections of this sort. Food webs, flows of materials and energy, decay and rebirth, and other synergistic relationships are all available for us to connect our buildings. Envisioned from this perspective buildings can be functionally integrated into the local ecosystem, taking up waste and producing resources, and providing frameworks for more ecosystems to grow and connect to. The intervention of a building can potentially increase the diversity and complexity of an ecosystem, and increase the productivity of a site through provision of ecosystem services.

Both the critical nature of climate change issues and the emergence of credible metrics to understand building performance has given rise to a striving for eliminating the negative ecological impacts of buildings. It is possible to go yet beyond this and develop buildings which are restorative, creating positive environmental impacts, for example by taking degraded pieces of land and improving them, providing habitat for species, reclaiming desert to arable land and other such things. There is precedent for this historically, and in a modern world we can imagine how we could begin to value our environment so much that we develop settlements that increase the ecosystem services that are available within a region.

Rene Dubos, the noted ecologist, stated that the restoration of degraded ecosystems is one of the most urgent tasks of our time. The general recognition that the earth has a finite carrying capacity that has been exceeded in various dimensions is now embodied in language; the phrase carbon footprint or ecological footprint implies recognition of our dependence on the earth's ecological services.

While ecosystem services are a multidimensional metric involving a spectrum of human needs, there are ecological stresses that require our consideration. The significant services may vary by location, while some issues are regional and others are global. We produce carbon dioxide more quickly and in quantities that have exceeded the earth's capacity to sequester such emissions, with resulting climatic impacts. Fiber and fish are harvested more rapidly than they are regenerated, water sullied more quickly than the environment cleanses it.

We can measure these impacts and use them as the basis for regional metrics; we measure the built environments impacts in a given area by measuring the resources available and consumed. One example of this would be an arid climate such as the southwest United States, where water sets the limits for biological capacity. Applying this capacity analysis to architecture requires sustainable design to work within the available resources.

Understanding regional resources is literacy, and the character of places is enriched by the results of careful resource management. Our inventiveness as designers allows us to unleash a place's latent potential: developments may increase the ecological productivity of an area, engage in the development of local watershed and subsurface hydrology, and so forth. Design that senses place can create abundance. This intimate connection is one side of our modern sense of place.

At a visionary level we can truly constructively engage our environment. Humans have created and inherited a vast amount of devastated land and polluted rivers; we have deforested mountains, and paved wetlands. We must conserve and protect the remaining ecological resources from careless exploitation. Our devastated areas constitute a great resource and are ideal for ecological restoration. We can create ecological "power plants"—buildings that act as factories for the production of ecosystem services in areas that require extensive remediation. Frameworks could be created to cleanse water, rebuild soils, sequester carbon dioxide, and other benefits forming a distributed network, fitting into ecological niches, evolving with our needs. We could use society's wastes as raw material and produce ecosystem resources in return.

The green building industry has been busy designing purposeful buildings with reduced environmental impacts. Each building does, however, continue to have significant environmental impacts—each building uses a few more

resources and contributes a little more to our growing environmental crisis.
If we turn the issue upside down we can describe an architecture designed primarily to repair, restore, and rebuild the environment, and secondarily to provide typical architectural program needs. If we were to consider these "ecological utilities," what would they look like? What services would they provide and how might they do it?

We are now the managers of a vast amount of distressed environment: stripped, eroded land, toxic dumps, contaminated waterways. These discarded results of our plunder should now be considered assets. Their desecrated nature makes them prime candidates to rejuvenate with the qualities of nature that we desire. Fortunately, we are beginning to recognize that these "unnatural resources" are potentially very profitable. Solid waste dumps in the United States are nowadays mined for the resources (mostly metals) they contain—it is less expensive and therefore more profitable than mining virgin ore. The most inefficient buildings can be considered the conservationist's equivalent of a gold mine; when retrofitted with efficient lighting and other basic measures they often consume one-fourth of the energy they previously used. The net cost savings and net increase in available energy is the greatest for the worst offenders.

Fig. 10: A Biological wastewater treatment facility

Often the benefits of recycling of degraded environments are not found in individual profit—the market for Superfund sites and land sterilized by arsenic-laced mine tailings is pretty small. The incentive to clean up a stream, or revive stripped land, is found in the benefits we can share as a community.

Because our destroyed environments are often considered to have little value, when they are restored to a healthy state their values increase In urban areas this can be a significant incentive; at a municipal level investment in local ecology can have enormous impacts on a tax base. Globally, there are obvious benefits to increasing ecological capacity through increasing available ecosystem services; locally benefits may be harvested as well.

As we decide to rebuild deteriorated ecosystems, we should consider ecological problems our prime opportunities. By identifying these "keystone" issues in ecosystem degradation, we can target our efforts for maximum impact. Plants are net primary producers, meaning they harvest sunlight and produce biomass and energy that is then transformed throughout the environment. Our buildings right now are more like heterotrophs, which live off autotrophs (the primary producers). We need the elements of our built environment to be primary producers as well.

4.2 Living Machines

Through decades of innovation, John Todd realized "green machines" in his biological wastewater treatment plants. Using various sources of pollution as nutrient sources, Todd developed an elegant series of water remediation systems that can be applied at the building scale, as well as at the community and urban scale. Producing clean air and water, creating marketable biomass and absorbing carbon dioxide, these living machines epitomize the goal of turning an ecological liability into an asset.

We can use the goal of regenerating ecosystems to give architecture form at both the urban scale and the individual building scale. Rather than be a liability, architecture can increase ecological productivity of an area. While some ecosystem services are limited by non-biotic elements such as temperature or water, more often it is the lack of biological elements that limits ecosystem services. Ecosystems are context driven: the available ecological niches and opportunities create the form and shape.

Our opportunities are the deteriorated environments that surround us. Where there were once vast tall grass prairies, there are now acres of parking lots. Riparian ecosystems teeming with aquatic life are now the cooling systems for petroleum distilleries. Can these devastated areas become opportunities to rebuild and restore ecosystems? The

following illustrations show some visionary possibilities for allowing ecosystems to become formal building and urban elements.

4.3 CO2 Absorbers

The generation of carbon dioxide is a critical environmental issue, with all the attendant consequences. Attaching biological material to building exhausts, and providing lush greenbelts around cities, can help balance the generation of carbon dioxide with absorption. Especially high carbon dioxide generation areas could be fitted with frameworks for fast growing vegetation that could be harvested when the peak sequestration was reached and utilized as biomass.

Fig.11: Urban carbon dioxide absorbing biomass.

4.4 Soil Regeneration through compost factories

Creating urban-scale compost factories—which utilizing solar heat, air, and moisture to promote the aerobic decomposition of biomass could generate amazing urban forms. Locating such systems near the generation of waste would minimize the distances we haul trashDucting for ventilation and glazing for passive solar gain can also serve as architectural sculpture in park-like settings. The compost generated would create a significant ecological foundation for rebuilding topsoil in depleted areas.

5.0 ENVOI

For too long we have been created architecture to serve humans, with little regard to the social and ecological consequences. Like Narcissus, we are in danger of drowning in the consequences of our self-adoration. Turning our inventiveness outside ourselves, we can apply our creativity to solve foundational issues in our culture, take responsibility for our actions, and connect ourselves to the ecosystem on which we depend and the services it provides. Factories that spew smoke can now clean air. Acres of asphalt can sprout shade trees and recharge groundwater. Designing to provide ecosystem services first can generate exciting architecture, which may also be habitable. Expanding the definitions of architecture and machines opens the door to a new relationship with nature.

As we develop an architecture that shows this regionalism (some of which is visible and some of which is invisible)

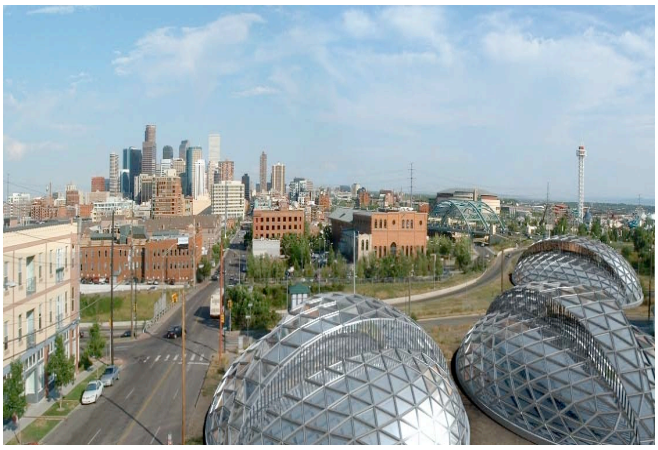

Fig 12: "King Clivus," the urban compost factory

we may return to some core values of architecture. The way that we see places, and experience environments influences how we act. Place that are warm in cold weather, and places that are naturally cool in hot weather, are places that we linger. The moderation of climate, the development of biology and habitat makes places valuable, interesting, more desirable and resilient to the consequences of climate change. Persons that experience such places may be influenced to further this progression of an architecture that truly meets the needs of the people, and the consequences of addressing externalized costs may seen to result in increased local benefits. Addressing climate change at the local level is instructive and by increasing individual awareness may influence change at the level of a global community. Our sensing of place may be the inspiration for response.

6.0 REFERENCE:

i Carol Silva, Archaeological Investigation of Hule'ia National Wildlife Refuge Ha'iku, Niumalu, Kaua'