

Minimal Footprint Ecotecture

Human beings do not have a biologically determined form of housing equivalent to the bee-hive, cocoon, or seashell. If anything, our housing is more analogous to the bird's nest. While the nest has some universal characteristics, it has been largely adapted to the environment and the availability of regionally determined materials. Gradually, our regionally adapted and culturally specific housing is being replaced by a regrettable monoculture that is based largely on Western "civilization" and uses durable materials (wood, stone, brick and mortar, steel, concrete, etc.) to construct what we refer to as "buildings". These have many forms and configurations, but their variations are determined not so much by the environment, but more by their function and also by the economic status and wealth of their inhabitants or "owners". Adaptability to the environment has largely been lost and forgotten.

Humans are said not to rely on instinct, but use "reason" to make decisions about their behavior. Beyond the debatable universal validity of this statement and the extent to which it represents a characteristic unique to human beings, it is clear that this situation is both fortunate and unfortunate. On the one hand, we are clearly more able to "adapt" to virtually any environment on the face of the earth. On the other hand, the technology that is necessary for this "adaptability" has never and will never ever be free of any consequences. It is quite obvious now that these consequences are, for the most part, devastating to our environment, if not the entire biosphere and, in all probability, represent a direct threat to our own survival. To that extent our "adaptability" will have to be relearned.

Perhaps this can be expressed best by saying that we need to develop a new mode of adapting to our biological environment - a new way of harmonizing with nature, a new way to co-exist with mother earth. We may regret the rise of the technologically dominated monoculture, but it is also obvious that human beings will never willingly return to any "primitive" mode of living - short of some overwhelming catastrophic turn of events (whether natural or self-inflicted). Instead, the following is an overview of a vision that attempts to demonstrate a specifically human mode of housing and adaptation to the environment that might avoid that catastrophe but also preserve the civilized manner of living we have grown accustomed to. It might not be the only reasonable alternative, but it definitely is one. This

model overlaps some ideas that have already been published, discussed, and even constructed (eco-cities, Acrosanti, etc.). I believe, however, that it goes beyond these other proposals in one respect, in that it explicitly attempts to integrate concrete regional or macro-ecological considerations into its design principles.

An architect must have a capacity that most other people lack - the ability to visualize structures in 3 dimensions. This is something they share with physical scientists. In order to bridge the gap to other people, architects often rely on visual tools such as perspective drawings or models.

Analogously, the ecotect must have the ability to visualize an ecological future that most people can simply not envision today. It is our job, as ecotects, to provide the models for these visions.

Background

When we look into our crystal ball and view the future given all that we know now, there are many possible scenarios. However, disregarding the most fanciful and wildly speculative, I believe we have essentially 4 choices:

1. Continue to drive ourselves into extinction along with most other life-forms on the planet by continuing to propagate our current "American" life-style.
2. Drastically reduce and limit the human population to the extent that such a life-style could be universal but would not have the dramatic overall environmental impact it is obviously now having.
3. Limit access to this life-style to a select few, while subjecting the rest of the human population to a life of poverty and slavery.
4. Adapt to a life-style that is ecologically viable, i.e. sustainable.

It is obvious that the first of these choices is unreasonable, although a significant number of people choose to remain in a complete state of denial and believe that we are not on a collision course with disaster. There seems to be no arguing with these people who simply refuse to even consider the overwhelming scientific evidence. The two essential pillars of the life-style referred to here are (1) the automobile (private means of transportation) and (2) "suburban sprawl". These are the flip-sides of the same core problem that is essentially aimed at the complete obliteration of nature as it existed before the domination of the human species. This problem is also enhanced by the ever increasingly centralized and monopolizing corporatization of the global economy.

The second choice has a number of difficulties. First, it is fairly unrealistic to think that it would ever be politically feasible to limit population growth - much less reduce it (although this has supposedly been in practice in China for some time). Secondly, even if it were politically acceptable, it would involve significant limitations to our liberties and impose an economic burden on younger generations until such time as the population had been stabilized to the desired level. Thirdly, short of a complete automation of most, if not all, means of production (a technical fantasy that may or may not be feasible), it is hard to imagine how the desired life-style could be maintained without the masses of laborers required to sustain it. But even if complete automation could be reached in the future, it is questionable that it would be achieved before the biosphere has been damaged beyond repair. In any

event, this "solution" would involve the imposition of a severely hierarchical and probably tyrannical political order to fulfill.

The third possibility is obviously unjust and therefore thoroughly unacceptable to anyone claiming to have even an inkling of humanitarianism. I do not, however, preclude that precisely this may, in fact, very well be the most "realistic" of all possibilities.

While it is without doubt essential to attempt to keep population growth in check and, hopefully, reduce it significantly in the long-term, it is obvious that the most reasonable and feasible of our choices is to face-up to the life-style changes we must make to survive. A significant number of people have already reached this conclusion and have embarked on a mission to change their personal behavior and support infrastructural changes that facilitate these changes - like recycling, alternative sources of energy, energy-efficient automobiles, green building materials and methods, etc. All of these noble efforts, however, are carried out within the framework of a political, economic and technological envelope that is itself not ecologically viable. Perhaps it is time to re-consider that framework.

Beyond these compelling, but somewhat ominous and negative reasons for considering the ecotectural model proposed below, there is also a positive argument for it. Not only is the life-style being proposed possibly the only one that is feasible as a just and sustainable future, but it represents - in my view - what would be a significant advance in the quality of our lives. I would argue that our current life-style is not only an ecological disaster, but that it is also empty, alienating and unworthy of the dignity of human beings (as well as other creatures). We spend much of our time imprisoned in automobiles caught in traffic driving to and from work, entertainment, events, vacation resorts, parks, etc. We spend several hours each day at home in isolation watching TV instead of spending time with friends and relatives because we are physically spaced so far apart and our communities are primarily designed for cars and commercial exploitation rather than human contact. We have been conditioned through ubiquitous advertisement to value material goods over the sanctity of life. We have come to accept environmental pollution as a given. The best we can politically hope for is "acceptable levels" of toxins in our air, food and water! Is this the best human life can be?

It is my sincere hope that the ecotectural model proposed below will not be viewed as a limitation to prosperity, but one that will enable a truly humane

alternative to the dissatisfaction that many, if not most, people already have with our current condition. It is a vision of an ecotectural environment that will encourage human community; where the efficiency of life will open new dimensions of human achievement in all forms of art; where the ease of experiencing the more-than-human world will lead to the rediscovery and daily appreciation of our own place in nature and with that the true meaning of human dignity.

Design Goals

All architectural projects have design goals, whether they are made explicit or not. The design goals of the ecotectural model proposed here must be made explicit, since they are not yet generally accepted and understood, much less taken for granted. The model described below is not limited in scope to structural design. It can be seen more as a radically new vision of land-use principals that will define parameters for both structural design as well as a network of transportation - and in the process, a restoration project for the natural environment. In line with the overall goal of reshaping our cultural life-style for sustainability, it is inevitable that we take an approach that addresses not just buildings, but the distribution, size and impact such structures have on the environment - as well as the wilderness requirements of biodiversity. Building ecotecturally sound "green" buildings is certainly more desirable than continuing to build archaic, unintelligent and usually toxic structures. But as long as this is done in the context of otherwise ecologically disastrous community and regional planning, it will never address the overall question of the ultimate sustainability of human culture.

In keeping with this guiding principle, this proposal will consider the following specific design goals:

- Structures erected for the purpose of human dwelling and other specifically human activities, should have a minimal impact on the biosphere.
- This is required for the maximization of habitat preservation for the more-than-human biological realm, in order to preserve the underlying natural environment and biodiversity that alone can allow human culture to thrive in a sustainable future.
- Minimal impact can only be achieved by minimizing the footprint required for human structures and horticulture on the surface of the earth.
- Biodiversity requires a cross-regionally contiguous and generous natural context (wilderness) that allows for the necessary long-range migratory patterns as well as sufficient area for the survival of indigenous flora.

- The materials required to support human structures as well as their design should be carefully selected to minimize the extraction of biomass from the environment.
- The need for transportation of both humans and goods should be minimized and, where necessary, made as efficient as possible while designing the infrastructure for such transportation to have a minimal impact on the environment.
- At the same time, this specifically human ecotecture must be designed in such a way as to make human culture both desirable and satisfying for all people. The design must also maximize the amount of personal satisfaction attainable within the necessary parameters. This vision cannot afford to be viewed as either Luddite or uncivilized.

The Ecopolis

At the heart of the proposal is the envisioned basic unit of human ecotecture that I will refer to as the *ecopolis*. This structure is the logical result of the principle of minimal footprint ecotecture. The basic question is: how can we minimize the land-use requirements for the maximum amount of people? However, the essential parameters of the ecopolis must also include other factors than merely spatial considerations. Bio-impact can also be reduced by the proper functional relationship of structure to activity. By attempting to bring residence, business, work space, agriculture, and recreational facilities together, the need for human and goods transportation can be kept to a minimum. The distribution and configuration of the ecopoleis also will play a key role in both the minimization of energy-intensive transportation and the contiguity of habitat for the support of biodiversity. (More on this distribution in other sections below.) Obviously, the specific design for each ecopolis will vary according to regional and geographical requirements. The following description should be viewed as an idealized (and somewhat abstract) specification.

Each ecopolis should be located at approximately the center of an area of about 10-12 sq. miles. In this case, the closest other ecopolis would be about 3 miles away, but there could be several within that approximate radius. The exact location of the structure within its allotted area would be determined by soil conditions (for maximum stability and availability of arable land) and watershed considerations (both availability and protection of the watershed itself).

The capacity and actual footprint of the structure would vary as well, but, on average, each ecopolis should probably have a population of around 1500 and not exceed 2000. This would mean (on average) that there would be up to approximately 4 acres per person of land surrounding the structure. Most of this area would be kept wild. A minimal amount of land immediately surrounding the structure would provide locally grown agricultural products and a small amount of livestock as well as some recreational facilities, like athletic fields and communal gardens. The total cultivated area immediately surrounding the ecopolis should probably not be more than about 2 sq. miles (of the 10-12 total). This should allow for enough agriculture (using ecologically efficient growing techniques like permaculture) to produce the equivalent required for the population of the associated ecopolis (even if not all of that produce was consumed by it). Again, I will emphasize that these

proposed figures are idealized and represent averages. In reality, there will obviously be a need to vary the density and distribution of the ecopoleis. However, every ecopolis must have enough open space or wilderness surrounding it to allow the free migration of wildlife in the region. This open space must also have contiguity with the open space of the surrounding ecopoleis. A general rule of thumb might be that the amount of cultivated area should never be more than half the amount of open space. This would mean that, at a minimum, an ecopolis housing 1500 people should have at least 6 sq. miles of surrounding land (2 cultivated and 4 wild). In any case, the bands of wild open space between the cultivated areas should never be less than one mile wide.

By way of comparison, Berkeley has a population of 102,000 in well less than 10 sq miles (excluding University property). Obviously, this kind of density is already extreme in relation to the model being proposed here. On the other hand, there are also other vast areas that are not populated at all - even immediately bordering the Berkeley city boundaries. Of course, given the current lack of respect for nature and the typical approach to "development" this is undoubtedly a good thing. The net result, however, is overly dense and mostly inhumane urban environments (with their ghettos and highly toxic "brown" areas), on the one hand, and very sparsely populated areas (country and wilderness), on the other, where the regulation of human activity (hunting, off-road vehicle use, deforestation, etc.) is almost non-existent and where agriculture is pursued as a mass-production service that relies on pesticides, aggravates erosion and depletion of the soil, makes poor and wasteful use of available water supplies, and then must be transported to the city. All of this results in massive transportation requirements both to get people to the areas where they can enjoy nature (wilderness areas, national parks, or even a local regional parks, etc.) and to get food and other manufactured products to the people.

This artificial separation of city, country and wilderness is then compounded by the anarchic distribution of functional locations within our cities between housing, business, work-place, entertainment facilities, etc. - all of which is sprawled out across the land with no forethought or planning. The net result of all this is the incessant need to travel which has led to the devastation of the majority of the earth's natural environment and for pollution levels that are already at a frightening level. This all could be circumvented to a large extent merely by the integrated approach to land-use being described here which I will refer to as the ecopolitan life-style.

The structure of the ecopolis itself should have some common characteristics. Obviously, we need to make use of vertical space. The base of the structure (that I call the *foot*) should be designed to accommodate commerce (including shops, restaurants, etc.), some light industry (workshops, offices, etc.), schools and entertainment facilities (theatres, etc.). At the center of the foot, would be the transportation central (bus-stop with possible light rail). The top (or "roof") of the foot would be designed to provide a large amount of open space (albeit probably concrete) where people can easily and comfortably congregate. The foot should also be terraced (probably about 3 stories high) to allow for a natural flow from the top of the foot to the surrounding area via generously proportioned steps. For a structure that is designed to accommodate approximately 1500 people the foot should probably not need to exceed an area of about 800x500 ft (or roughly the equivalent of 9 football fields). This means that the footprint of the ecopolis would be less than 10 acres. This translates to more than 150 people per acre including all of their required facilities. Now that's land-use efficiency! That's *minimal footprint*.

[figure to be provided]

Fig. 1 illustrates a possible foot design in relation to its immediate surrounding cultivated areas.

The residential portion of this structure would be contained in towers that would rise vertically from the foot. In my idealized design, I envision 6 towers each having 4-6 units across the long side of the tower on each level and rising to about 15 stories. Each unit would be appr. 2000 sq. ft. and designed to accommodate 4 people on average. To compensate for the unnatural vertical orientation, the levels should be terraced and the towers could be placed in an elliptical pattern such that they lean toward each other and thus provide the necessary structural support for the terraced towers that would rise in a tee-pee shape around the central courtyard-like surface of the top of the foot. On the outside of the terraced towers, generous patio decks would face out to the natural surroundings, providing direct access to an outdoor private area for each unit and a spectacular view!

[figure to be provided]

Fig. 2 illustrates the terraced residential towers.

To ensure a quality of life standard that is normally not provided in today's high-rise residences two additional features would be provided. First, there

would be no internal, closed-in hallways. Each unit would open onto outdoor walkways that would connect to separate elevator shafts located at the center of the foot between the towers. This way, each unit would have both a "front" door and a "back" door which would lead to open-air space to give the maximum sense of an individual dwelling. Secondly, all units will have a structural buffer zone on all sides. This buffer zone of approximately 4ft. will provide several functions. It will act as an acoustic buffer to the neighboring units. It will provide access to the utility infrastructure (plumbing, electricity, etc.) for ease of maintenance and modifications. And it will act to preserve heat in winter and provide passive cooling in summer. These individual residential units would provide nothing more than structural shells, within which the inhabitants could design their own layout and décor.

Of course, the entire ecopolis structure should also take advantage of any appropriate external surfaces for solar cells to provide electricity (e.g. around the periphery between the terraced levels and on the rooftops, as well as on a pyramid-like frame above the connected towers). Where appropriate, the structure could also have wind turbines mounted on the rooftops. Obviously the vertical design will make it easier to efficiently deal with the disposal of waste and rainwater runoff in an ecologically sound manner. The plumbing system should also be designed to separate drinking, clean and grey water feed and disposal to enable a maximum amount of reuse. And there are surely many more ecological principles that can be incorporated within this framework that are too numerous and detailed to be covered here.

Within these design parameters the architectural aesthetics, uniqueness, and character, etc. of each ecopolis will be limited only by the designer's imagination. What has been described here is mostly the specifications that must be followed to meet the design goals already listed.

Regional Distribution and Transit

As has already been indicated, an indispensable principle in this proposal is the contiguity of open (wild) space in all regions. This requirement is not only for the sake of biodiversity, but also for the insurance of an environmental quality of life that will make a harmonious relationship between humanity and the more-than-human world possible. Through proximity with the environment that sustains us, each person will have the opportunity to directly experience the process of nature both in the form of wilderness and through the horticultural process that provides them with food. It will no longer take a monumental effort to educate people about wildlife and where their eggs, tomatoes and chickens come from. They will experience these things in their immediate environment on a daily basis! The divisions between city, country and wilderness area will dissolve into a seamless unity.

The compactness of the ecopolis and the distribution rules described above are the basis for enabling a transportation system that is more advanced, more convenient and environmentally responsible than our current automobile-centered sprawl culture. The ecopoleis will represent the nodes in a network of such structures to be connected by well defined and physically restricted transit lines. These transit lines could take the form of light rail. However, it is more likely that more flexibility will be required.

I will use the word *transit-way* to refer to the connecting transit lines between the ecopoleis. This deliberately builds on the terms highway and freeway, etc. (our predominant transportation features today). However, the transit-way would have little to do with our current concept of a "road". Ideally, this would be a raised structure appr. 15 ft. above ground - especially when traversing non-cultivated areas. This would allow the uninhibited movement of wildlife underneath the structure. There would be a pathway in each direction separated with barriers much the same as the railing on bridges and overpasses. In addition, a separate "safe" path would be provided for bicycles and pedestrians, etc. These would be safe in the sense that they would be physically separate from the transit lanes, as well as raised and therefore safe from attack by any wild animals (wherever this might be a consideration, e.g. to the extent that we want to encourage the return of bears, mountain lions, wolves, etc.). Each transit direction would have at most 2 lanes or perhaps only one with occasional pull-out lanes.

Typically, each ecopolis would be connected to surrounding ecopoleis with 4 transit-ways - one for each direction. The number of transit-ways

crisscrossing the open spaces should be kept to a minimum. The areas between the transit-ways would be restricted to bike and foot paths only!

The transit-ways would be used for "buses", "trucks" and other specialty vehicles, such as ambulances and for security. There would, of course, be no automobiles. The need for transportation of both humans and goods will already have been significantly reduced by the ecopolitan architecture and regional integration itself. This need could be further reduced, of course, by additional political and economic reforms. But that is another topic altogether. Additionally, the facilitation, safety and ease of alternative modes of transport (biking, etc.) would reinforce the encouragement the ecopolitan life-style would give to using such alternatives.

The buses and trucks used on these transit-ways will undoubtedly not resemble the ones we are now familiar with very much. And they will operate very differently, as well. Both of these would probably be more of a hybrid with trains. They might have several trailer cars which would increase energy efficiency. This design would be enabled by the deliberate and careful attempt to construct the transit-ways to allow for such vehicles to operate safely. I.e. they would not be expected to go around sharp curves at high speeds and there would be a lack of dense traffic with the danger of sudden braking. Trips would be planned and scheduled. There would be no cross-traffic and frequent stops. And the transit-way vehicles will probably need to operate on some type of rail system, while maintaining their non-rail flexibility.

Note: This design allows for a high degree of compatibility with our current vehicles and therefore would ease the transition to the exclusive use of these transit-ways. We could start building ecopoleis immediately in selected regions and connect them seamlessly to existing highways, etc. Although, this would only be partially satisfactory.

Given an average speed of about 40 mph (a conservative estimate), the time needed to travel from one ecopolis to the next (~3 miles) would be $4\frac{1}{2}$ minutes or, say, about 6 minutes including stops. Assuming no transfer delays, that would mean you could travel 30 miles in one hour on a local bus with stops - which is far better than current city surface-street driving. Of course, on a regional level, it would undoubtedly be desirable to have express buses or possibly light rail systems that would be able to maintain higher speeds for longer distances. On a continental level, we might even have something like ultra-high speed levitated rail systems. We need to keep in

mind, though, that the excessive use of these transportation systems should be a lot less likely given the underlying ecotecture of the ecopoleis and their environmental distribution. It would not be necessary to drive to a local store to pick up some coffee or bread. It would, in most cases, not be necessary to drive to work and back. It would not be necessary to drive your kids to school or to a ball-park. Etc. Etc.

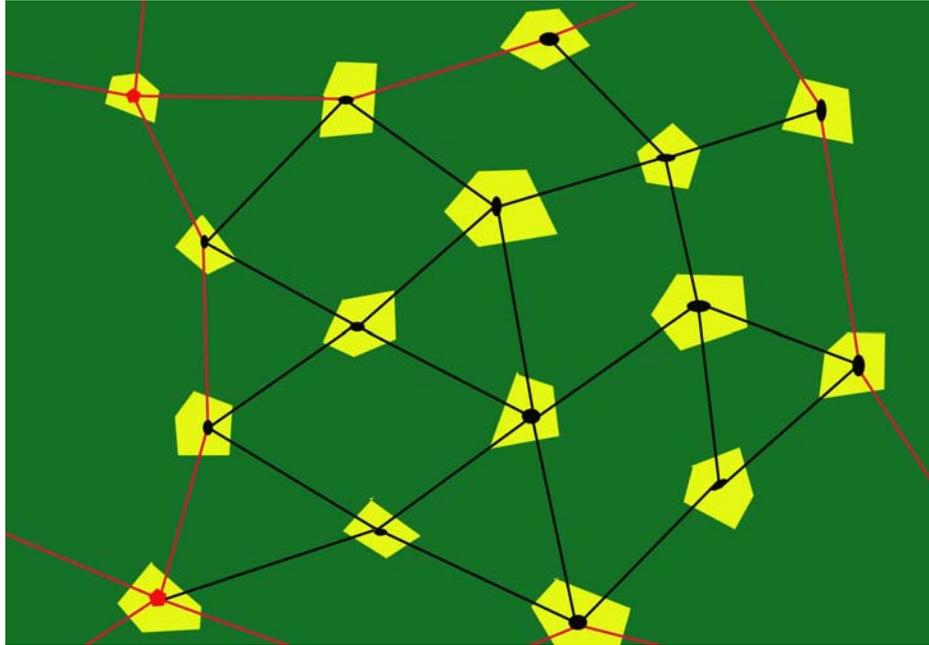


Fig. 3 shows a simplified hypothetical regional distribution of the ecopoleis with their transit connections. The red lines indicate transit-ways with express or light rail lines in addition to local transport. Yellow areas indicate the cultivated areas immediately surrounding each ecopolis. Green indicates native open space.

Aside from transportation, transit-ways would also incorporate all eventual utility lines (power, gas, water, communications, etc.). Special conduits built into the structure could protect these lines, as well as provide easy access for any required maintenance, etc. And to add to the functionality of the transit-ways, they could also be covered with solar-panels, providing additional renewable energy. This covering would also have the added effect of keeping direct sun off the transit vehicles (whether bus, truck, train or whatever) which would greatly reduce the need for cooling and increase comfort. Where appropriate, these transit-ways would also make an excellent location for the placement of additional wind-turbines, as well.

In general, the guiding principle for these transit-ways is to concentrate the technological infrastructure needs of our culture into well-defined and concentrated locations - for efficiency as well as aesthetic, practical and ecological reasons.

In Conclusion

This description of the ecopolitan model is obviously very brief. Not only does it not flush out all of the many architectural and ecological details (a task I do intend to carry out in other efforts), but it also neglects the obvious political, sociological and economic considerations that would make or break the realistic chances of such a vision ever being implemented. Some of the major stumbling blocks are glaringly obvious:

- How prepared are we to give up the cherished automobile, not to mention all of our other similar toys like off-road vehicles, etc.? But a rapidly growing number of people are recognizing that the benefits of the automobile are increasingly being negated by their consequences - leaving them with virtually no real positive purpose. And only a small minority of people is so insensitive as to not understand the destructive capacity of off-road vehicles, for example. How long can we allow this minority to dictate to us and lead us and most other species into extinction?
- Of course, many will complain that the dwelling units described here could not be adequate for their "needs". Obviously, people who now live in mansions on sprawling (and usually not ecologically preserved) acreage are not likely to view this model as an improvement - unless they understand the broader implications. For the vast majority of others, however, it would be without question an advance in their prosperity. Just ask someone living in the ghettos what they would think about this opportunity. Some may say that I am attempting to dictate a life-style to them. To this, I reply that someone is currently dictating to many of us a life-style that we neither desire nor think is sustainable by any reasonable measure. The automobile culture and its consequent sprawl has been deliberately planned and consciously imposed on us by hidden special interests.
- Some others may even accuse me of imposing an inhumane life-style on people. There are sociologists who have already "determined" for us that any building over 4 stories is unfit for humans to live in. That would indicate that these human hives I am calling ecopoleis would have a devastating psychological impact on people. But I ask: What about New York and Los Angeles? What about the ghettos and their "projects"? What about the vast toxic areas left by intense manufacturing? What about the enormous network of freeways that

slice up the environment? What about the humungous shopping malls and their endless parking lots? Do all of these things represent a humane environment? Contrast that to being able to take an elevator and a five minute walk to be in a forest! Imagine the ability to enjoy wilderness without first destroying most of it and having to drive for hours through devastated landscape to get there. Imagine having a place for children to convene in absolutely safety without excessive supervision and transportation. And the list of features goes on.

- And how would the "cost" of building these structures be covered? Given our current economic system and our obvious priorities this is indeed problematic. Will this change in time for us to adequately modify our life-styles enough to avoid completely destroying the biosphere and ourselves with it? Obviously, this question cannot be answered here. There are, however, a significant number of organizations and institutions already spending vast amounts of money on research into our current problems and, in some cases, the purchase of land for the preservation of nature.

These and many other questions and problems - both ominous and trivial - desperately need to be addressed soon. The reasoning behind the ecotectural proposal described above stands on its own for the most part. However, it can be made much more plausible when complemented with other political and economic ideas and assumptions that must be presented in their own right even though they are deeply interrelated with this model. The complementary economic model will be presented in other essays.

Eventually, and long before we have resolved all of our theoretical and academic questions, we need to venture out of the safe realm of abstract debate and into a concrete consideration of what our future might look like. This presentation of the ecopolitan model is one of my small contributions to taking that bold step. In any case, I can assert with confidence that this model does provide an ecotectural basis for the kind of ecological efficiency we will need to allow us to follow our only **reasonable** option for the future.