Creating a Sustainable Economy and Future On Our Planet

The San Diego/Tijuana Region
A Case Study

By

Jim Bell

Suggested Donation: $5.00

Creating a Sustainable Economy and Future On Our Planet

The San Diego/Tijuana Region
A Case Study
By
Jim Bell

www.jimbell.com, jimbellelsi@cox.net, jimbellob@hotmail.com
(619) 758-9020

If our scientists are correct, the human family has been around for some 150,000 generations, assuming each generation is 33 years.

Let our generation lay the groundwork to ensure that the next 150,000 generations have a healthy planetary life support system to sustain them in their time.

The Way I See It

If the human family is to prosper in the future, we've got to stop hurting each other and our planet's life support system. Anyone paying attention knows that the human family is hurting itself and is seriously disrupting, if not destroying, its own planetary life support system.

What should we do? What I'm doing is learning as much as I can about how our planet's life support system works and how we can work together to develop a sustainable economy and way of life for ourselves, our children and future generations.

My goal is to use this knowledge to raise the general level of consciousness, happiness and sustainability where I live and ultimately, planet-wide. If enough of us do the same, the world will be a happy place for everyone, now and for future generations. Ultimately, it's all about consciousness. If enough of us become conscious enough, soon enough, all good is possible.

Permission to Reproduce this Book

Dear Reader,

This book is FREE to anyone in the world to read on line and print out if they have a printer. To read or print out FREE copies go to www.jimbell.com, then click "Jim's New Book" then on "print whole book." The book prints out as 50 pages including cover. For dial up,

To print the book out in sections, go to www.jimbell.com and click on "Jim's New Book" then on the books title. The book is broken up into 8 sections which can be printed separately by clicking on the section you want in the Table of Contents. Please forward these offers to anyone you feel would be interested.

I encourage people to mass-produce this book as written or as a translation, I'll be happy to work with you to produce, translate or adapt the book to make it more relevant to non-western cultures. If you produce the book in mass to sell, please keep the price as low as possible and still cover your costs.

My vision is that once any region or country develops a life-support sustaining economy or seriously moves forward to create one, the result will be so attractive economically, environmentally and in other ways, the whole world will want to develop their own regional and national life-support sustaining economies.

Peace and love, Jim

This publication is a project of the Ecological Life Systems Institute (ELSI). If you would like to support this work and other ELSI Projects, please call Jim at 619 758-9020 or contact Jim at jimbellelsi@cox.net or jimbellob@hotmail.com.

The hard copy of this book is printed on 50% pre-consumer and 15% post-consumer content paper. The ink is soy based and the published version has the union "bug".

TABLE OF CONTENTS

2. The Way I See It
2. Permission to Reproduce
3. Table of Contents and Acknowledgments

4. Synopsis

4. Part One: Vulnerability by Design?

7. Part Two: Developing a Plan

7. Where is it appropriate to do what on the land?

8. How do we do the what once the correct location for it is determined?

24. Part Three: The San Diego/Tijuana Region, A Vision of a Sustainable Future

27. Conclusion
28. After word
29. Footnotes
46. About the Author
47. Dear Reader

Graphics

10. Energy Self-sufficiency in the San Diego/Tijuana Region – Land Area Perspective
17. Investor Profit/Payback on Investment Cycle
42. Mapping for Sustainability in the San Diego/Tijuana Region

Acknowledgments

Thanks to Derek and Nancy Casady for their valuable suggestions and comments during the process of writing this document and especially Derek Casady and Jean Costa for their meticulous help in editing. A special thanks to Heather Honea, Alan Gin, Melanie McCutchain and Ryon Layser for their work on developing the spreadsheet and graph, and to Rosalyn Stevenson for the book's hard copy layout and Chris Kline for the book's web version. Thanks also to Michael Gelfand, Cassia Rodrigues, Sandra Wawrytko, Rebecca Margolis, Lester and Leone Hayes, Matt Stadsklev, Sicco Rood, John Atkinson, Robert Ocegueda, Peter MacLaggan, Patrick Abbot, Ann Marie Harmony, Nadia Amer, Bill Rolley, Skip Fralick, Michael Williams, Jose Maldonado, Mary Clark, Jodie Beebe, Sicco Rood, Bonny Hough, Kevin Falconer, Brian Weintraub and Allied Sun Technologies, Charles Wei-hsun Fu Foundation, Lenny Cooper Foundation, Heather and Rick Redman, Judy Seid, Bill Powers, Rebecca Neary, Janet and Jake Umlauf, Barbara Rosenbaum, the International Brotherhood of Electrical Workers, the bands Psydecar, Able Minded Poets, Kuumba Dawa, Vegitation, the B-Side Players, and Winston's Night Club.

Creating A Sustainable Economy and Future On Our Planet Beginning with the San Diego/Tijuana Region

Note: Although the analysis presented here focuses on the San Diego/Tijuana region, the principles it is based on can be applied to any region or country on our planet.

Synopsis

Part one describes how the region and its economy are vulnerable. The threats discussed range from intentional attacks on key infrastructure elements like aqueducts, electric transmission lines, natural gas and oil pipelines, power plants, freeway overpasses and railroad trestles, to naturally caused infrastructure damage due to earthquakes, floods and severe weather. Additionally, Part One examines how infrastructure attacks and natural phenomena would impact the flow of basic resources like energy, water and food into the region. Also discussed is how the region is vulnerable economically, from a purely business-as-usual perspective, even if the threats to its security, just discussed, never happen.

Part two introduces a comprehensive plan designed to strengthen the region's economy while making it and the communities that it comprises less vulnerable to the threats described in part one. For example, if floodplains, which are vulnerable to flood and earthquake damage, are not developed, the public at large won't have to bear the economic burden of floodplain clean-ups, lawsuits, etc, when floods and earthquakes occur. Similarly, if the region becomes energy self-sufficient through efficiency improvements and renewable energy development, it would not be economically vulnerable to the cost and supply uncertainties associated with continuing its dependence on imported energy. Currently the San Diego/Tijuana region imports 98 percent of its energy and exports $6 billion a year to pay for it. Add water and food, we export $20 billion a year out of our regional economy.

Part Three is an exploration of the future. It answers the question: If the San Diego/Tijuana region were well on its way to becoming a sustainable economy, what would living in the region be like?

<u>The goal of creating a life-support sustaining economy and way of life is to improve the common good now and for future generations</u>. With this in mind and heart, I submit the following:

Part One: Vulnerability by Design?

Even if it had been planned intentionally, it would be difficult to create a regional economy that is less sustainable and more vulnerable than **<u>ours</u>**. * As it is currently configured, the region's infrastructure could be seriously damaged by a small group of people or even an individual. Power lines, oil pipelines, natural gas pipelines, freeway overpasses, railroad trestles, aqueducts, and dams are all vulnerable to simple explosives that can be homemade or stolen from mining or construction projects. (1)

Water stored in open reservoirs can be easily contaminated by dropping something into them from a plane or boat or by contaminating upstream watersheds. Power lines can be knocked out with hunting rifles.

*** "Ours" – Since I live in the San Diego/Tijuana region I will use phrases like "our region" or "our economy" to make my points more efficiently**.

If a terrorist attack were well orchestrated, the region's infrastructure could be damaged so severely that the flow of energy, water and food to the region, for all practical purposes, would be cut off. The loss of key freeway overpasses and rail lines would also make it difficult for people to leave the region to obtain these necessities.

The region's dependence on imported oil makes it vulnerable to political changes, terrorism and war in the countries from which it imports oil. Just the fear of reduced oil imports can affect the regional economy by causing oil and other energy prices to rise. Whenever there is conflict in an oil-producing nation oil prices rise. During the 1991 Gulf War, oil prices on the world market almost doubled and energy costs in general went up even though there was never any real oil shortage. With the current Middle East war and political unrest in countries like Nigeria and Venezuela, similar energy price dynamics are coming into play. If shortages were to become real, the impact on our regional economy would be doubly traumatic. Present moves to increase our region's dependency on imported natural gas will carry similar liabilities.

Another threat is criminal activity to manipulate the supply and price of imported energy. During the recent California energy crisis, the average San Diego County household and business was robbed to the tune of $500 per household and $4,000 per average business above what the energy would have cost if supply manipulation had not occurred. (2)

The Mexican part of the region is slightly less vulnerable to events in other countries that affect the supply and price of oil in the world market. Unlike the U.S., Mexico currently pumps enough oil out of the ground to meet its domestic demand. Nevertheless, Mexico's economic wellbeing is affected by the supply and price of oil on the world market.

Beyond the threat of intentional human acts, the region's key infrastructural elements are also vulnerable to earthquakes. Geologists estimated in the 1960s that there was a high probability that the Tijuana/San Diego region would experience a serious earthquake sometime in the next 30 years. Based on this data the region is overdue for a quake. (3)

Additionally, the region's vulnerability to earthquake damage has been aggravated because of extensive development on valley floors that overlay alluvial deposits. Structures built on alluvial deposits are more vulnerable to earthquake damage than structures built on most other geological formations. Alluvial deposits are composed of sand and groundwater that tend to liquefy if shaken. This well-known phenomenon is called liquefaction. Since areas subject to liquefaction usually lie in floodplains, these areas are also vulnerable to flooding from excessive rainfall or the loss of upstream dams during earthquakes.

Obviously, if any of the possibilities discussed above occurred singly or in concert, the region's economy would be seriously damaged. The cleanup and repair costs associated with a serious earthquake or flood, or both, where valley floors have been developed, could be a billion dollars or more. Even if damages are insured, the economic impact would be devastating. Insurance never covers everything, and when faced with catastrophic losses, insurance companies have gone broke. To avoid going under, insurance companies would almost certainly raise rates in general. (4) To the degree these losses were not covered by insurance, the taxes we pay, federal, state, and local would be tapped. Whatever the case, we end up footing the bills.

Even if we could be guaranteed that earthquakes, floods, terrorism, price manipulation or restrictions or cutoffs of essentials like energy, water and food would never occur, the region's economy is still quite vulnerable from a purely business-as-usual perspective.

There are three principal ways that dollars come into our region – from **exports**, from **federal and state governments** and from **tourism and new residents and businesses moving to the region**. All three of these sources are shaky on both sides of the border,

Exports: Although the region's economy has a substantial export sector, it has historically run a trade (cash-flow) deficit. This is because what people around the world pay for its exports is less than what we pay for what we import.

The region's nearly total dependence on imported necessities like water, food and energy aggravates our region's trade deficit. Currently we export $20 billion a year to pay for the importation of 98 percent of our energy and 90 percent of our water and food. (5)

Even in good times, this $20 billion annual trade or cash flow deficit represents a strain on our region's economic health. During tough economic times the strain can be quite serious. This is because when economic times are tight, it's easier for people living outside our region to cut back on purchasing the things that we produce and export than it is for us to curtail our purchase of imported necessities like water, food and energy.

In other words, during broad national and global economic slowdowns, the rate that money flows into our region slows down faster than the flow of dollars leaving it. The longer this continues, the more cash starved the local economy becomes. As dollars become scarce, local business suffers, and economic activity is stifled in general.

The more energy, water and food self-sufficient we become, the more the $20 billion we now export each year can be kept in our regional economy. If all $20 billion were kept, economic activity in our region could potentially double, benefiting everyone's bottom line. **Plus, and let me stress this: <u>We would greatly increase our security by taking control of our energy, water and food future</u>**.

Federal and State Funding: Changes in policy by the central governments on both sides of the border can severely reduce the amount of cash coming into the region. As federal and state deficits grow, there will be even more pressure to reduce the flow of federal and state dollars to counties and cities. Currently, San Diego County and its cities are scrambling to maintain public services in the face of their own mounting deficits and serious state and federal cutbacks. In general, central and state governments in both countries are in serious debt and looking hard for ways to cut costs. This will be true for some time even under the most optimistic scenario.

Tourism, new residents and new businesses: Tourists spend money when they visit and new residents and new businesses bring assets with them. Like trade, the amount of dollars brought into the region by these sources is vulnerable to broad national and global economic slowdowns. Since we now import most of our energy, water and food, most of what tourists, residents and businesses pay for these necessities leaves our local economy too. (6)

Plus, there are many who live in our region who feel that we already have more than enough residents and that promoting tourism only encourages more people to move here.

The economy is also vulnerable ecologically.

In addition to being almost totally dependent on the use of imported, nonrenewable energy, water and food resources, it uses renewable resources in ways that make them nonrenewable or difficult to renew. The region's rapidly filling landfills are graphic testimony to this fact. To replace what we bury, our region and planet are being scoured for a rapidly shrinking supply of virgin resources largely being exploited in non-sustainable ways. Similarly, the region's agricultural and forest soils are being used in ways that cause them to erode more rapidly than they can be renewed. These soils are also being used up by urban sprawl. Nationally, at least one million acres of prime agricultural soil are being converted into shopping malls, housing projects and roads each year. (7) Practices in our region continue to reflect this trend. Focusing on the car, for every 5 cars added to the U.S. fleet, an area the size of a football field is covered with asphalt. (8) More often than not, cropland is paved because it is flat and well drained. Flat land is easier and cheaper to develop and with development come roads and parking.

Regional groundwater, an important element in a more water-secure future, is being contaminated with pesticides and other domestic and industrial poisons. Additionally, ill advised development and other non-sustainable uses of our region's forests, grasslands and valleys are reducing groundwater recharge rates. Unhealthy watersheds absorb less rainfall. Buildings, asphalt and concrete absorb none.

In short, our region's economic practices are undercutting the ecological resource foundation that makes the creation of a sustainable future possible. As our ecological resource base shrinks, the region's sustainable economic options shrink with it.

Obviously, the picture just painted is not very pretty, but is the current state of increasing regional vulnerability inevitable? **Absolutely not!** In fact we already have all the technologies and strategies necessary to preserve and strengthen our planet's life support system – and to create a strong, vibrant, sustainable economy and future at home and abroad.

Part Two: Developing A Plan

If our goal is to create a sustainable economy in any region or country on our planet, there are two fundamental questions that need to be answered.

1. ***Where is it appropriate to do what on the land?***
2. **How do we do the "what" once we've determined the "where"?**

Expanding on the "Where is it appropriate to do what on the land?" question first: **What areas, like floodplains and along earthquake faults should not be developed?** Floodplains flood and are subject to liquefaction during earthquakes. On average, the closer development is to an earthquake fault, the more severe the damage will be when an earthquake occurs. In both cases, development in these areas endangers public safety and constitutes a tax revenue black hole for every taxpayer.

What land should be set aside for wildlife habitat? Healthy wildlife habitats and their connecting corridors are essential to watershed health and groundwater recharge. Healthy watersheds reduce flooding, protect against soil erosion and maximize the absorption of rainwater runoff by soils and thus the recharge of our region's groundwater storage basins.

What land should be set aside for growing food? Given that global population is still growing and agricultural soils are declining, it's only prudent that we set aside our most fertile soils for growing food. Having sufficient agricultural soils in use for farming or in reserve gives us insurance against the reduced flow or cutoff of imported food. Fortunately, the San Diego/Tijuana region is rich in agricultural soils.

Where are the best places to locate intense human activities? Broadly speaking, intense centers of human activity like cities and towns should be located on land not in floodplains, vital habitats or on our best agricultural soils.

For a more detailed look at how answering the above questions correctly would look and function, see: **Mapping for Sustainability –** pp. 42-45.

How Do We Do The "What"?

Now that we've answered, at least in a general sense, the **"WHERE TO DO WHAT?"** question, let's focus on the **"HOW DO WE DO THE WHAT?"** question.

How do we ensure ourselves a secure, plentiful and affordable energy supply? Our region's only secure energy supply is solar energy in its various forms, (direct solar, solar electric, wind, biomass, ocean currents, etc.) Therefore any energy security solution for the region has to be based on renewable energy. In the shaky world of today, any energy future based on importing nonrenewable resources only serves to maintain our region's current energy vulnerability.

Fortunately, our region is so rich in renewable energy resources it can easily supply all its energy needs and could even be a large energy exporter. Eighteen percent coverage of our existing roofs and parking lots with solar panels would produce enough energy to make San Diego County completely energy self-sufficient, keeping the $6 billion we now export to pay for the energy we now import, in our County's economy. Covering thirty-six percent of these surfaces would make us a large energy exporter, adding another $6 billion to our local economy each year.

How do we ensure ourselves a secure, plentiful and affordable supply of water? Unlike renewable energy resources and agricultural soils, both plentiful in our study region, freshwater resources are not. Nevertheless, our study region can become water self-sufficient if an integrated water collection, storage, use and reuse strategy is developed. Plus, with our abundant renewable energy resources, seawater can be converted to freshwater to make up shortfalls. All the freshwater (600,000 acre ft.) now used in San Diego County each year can be supplied by using the electricity produced by 8.3 square miles of solar electric panels to power large scale reverse osmosis system pumps to convert seawater into freshwater.

How do we ensure that our region has a plentiful, affordable and sustainable supply of food? Currently, we import 90 percent of our food. Given the unstable world we live in, the fact that world population is still growing and the amount and fertility of our soils are declining, this is not a secure position in which to be. Especially considering that groundwater, worldwide, is being polluted and extracted much faster than natural recharge rates.

The only way we can ensure that we will always have sufficient food for everyone is to grow it here in our own communities. **Our region is blessed with abundant and fertile soils.** This is true, even though we've already developed or otherwise damaged some of our region's best soils. So step one toward food security in our region, is to preserve the soils that have not yet been developed or otherwise misused and reclaim soils misused in the past wherever possible. Step two is to use organic agricultural practices that increase soil fertility, use local freshwater resources sustainably, and to not pollute our air, water and soil in any way.

How do we design and build our communities, buildings, transportation systems, vehicles, roads, parking lots, etc. in ways that enhance sustainability? Although building our communities and their supporting infrastructures in appropriate locations is vital to sustainability, it is also essential that they be designed to be:

- Energy and water efficient
- Made with nontoxic, recycled and sustainably harvested and mined materials
- Designed to be easily recycled at the end of their useful life.

The following will answer these **"How to do the what"** questions in more detail beginning with:

Becoming Renewable Energy Self-sufficient

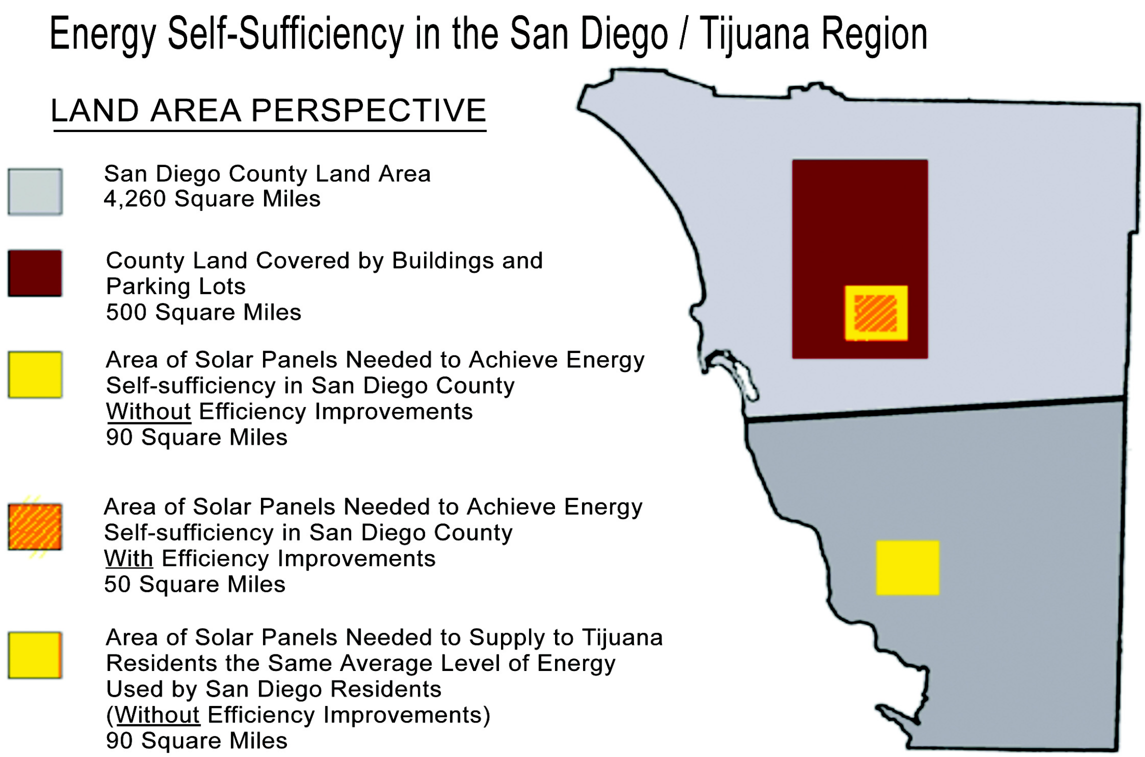
Key questions:

1. Does our county and region have sufficient renewable energy resources and efficiency improvement opportunities to make the residents of the San Diego/Tijuana Region, completely energy self-sufficient?

YES, AND THEN SOME!!!!

Our region is so rich in renewable energy resources that we could easily become energy self-sufficient even without energy-use efficiency improvements. For example, even with zero efficiency improvements, San Diego County could be net metered out electrically if only 7.1 percent (35.4 square miles) (9) of the 500 square miles currently covered by buildings and parking lots in the county were covered by photovoltaic (PV) panels. (10)

Covering 18 percent of our county's roofs and parking lots with PV panels would produce enough electricity to replace all the imported energy (electricity, natural gas, gasoline, diesel and propane) currently used in San Diego County. (11) If we cover 36 percent of the county's roofs and parking lots, we would earn $6 billion each year from the electricity we would sell into the western states grid. (12) Plus, if we aggressively pursue cost-effective, efficient energy-use improvements as we develop our region's renewable energy resources, San Diego County could supply all its energy needs with as little as 10 percent coverage of our region's 500 square miles of roofs and parking lots. (13)



2. What economic benefits can we gain by becoming energy self-sufficient?

+ Economically, the more our region becomes energy self-sufficient, the more money we will have circulating in our local economy. If we were energy self-sufficient today there would be $6 billion more money in our wallets or bank accounts than is there now. According to economic multiplier theory, adding $6 billion to our local economy each year would increase local yearly economic activity by $12 billion. If we chose it, we could easily install enough additional solar electricity capacity to bring another $6 billion into our regional economy as a large exporter of solar (PV) generated electricity. (14) According to economic multiplier theory, adding $12 billion to our county's economy would generate $24 billion of new economic activity in San Diego County each year. If the Mexico part of our region pursued a parallel path of increasing energy-use efficiency and renewable energy development our total regional economic multiplier benefit would be more than $36 billon each year.

(As a teaser, if energy, water and food self-sufficiency were achieved in San Diego County, the $20 billion we currently export per year to pay for the energy, water and food we import would be kept here as well – boosting our County's economic activity by $40 billion each year. If the Mexico part of the region followed suit, regional economic activity would be increased by at least $60 billion annually.(The economic benefits of becoming water and food self-sufficient will be detailed later.)

+ Becoming energy self-sufficient will save us money. This is because becoming energy self-sufficient costs less than continuing our dependence on imported, nonrenewable energy resources. Since nonrenewable energy resources are running out, their cost, on average, will continue to rise. Recent experience shows us that energy costs are also subject to criminal and/or immoral supply and price manipulations designed to take even more money out of our pockets.

Since solar energy is free, once we have the capacity to convert enough solar energy into electricity to satisfy all our energy needs and wants, our only cost will be local grid and system maintenance. Because solar PV panels are performance warranted for 25 years, there would be very little system maintenance required. Plus, as we get better at designing, manufacturing and installing renewable energy collection capacity and efficiency measures, the cost per kilowatt hour produced or saved will go down and performance warranties will get longer, perhaps as long as 50 years.

+ Becoming energy self-sufficient will save money in other ways as well

- Lower health costs. Becoming energy self-sufficient through efficiency improvements and renewable energy development will reduce pollution, especially air pollution, on all fronts. Just one example, reduced air pollution means fewer emergency room incidents related to severe respiratory attacks. If all the health costs associated with our current dependence on nonrenewable energy resources were added to the cost we pay for them, the cost of energy would probably double. (15)

- Lower property maintenance costs. The pollution caused when nonrenewable energy resources are used attacks paint, metal, roofing, clothing, landscaping, public art, etc. Solar energy development and efficiency improvements are virtually non-polluting by comparison.

- Lower per capita costs for crime prevention and social services. Becoming energy self-sufficient will create well paid full employment and greatly expand profitable business opportunities across the board. The more legitimate opportunities there are to make a decent living, the less crime and fewer social problems there will be.

- Increased community spirit. Becoming energy self-sufficient is about getting paid a livable wage while working on ensuring that our youth and future generations have a world where the air, water and food and the other necessities are pollution-free, plentiful and produced in ways that strengthen economic and public health and are completely life-support sustaining. In our time and place in history there is no work more important and fulfilling than insuring that our youth and future generations have a healthy, abundant, prosperous and secure world to live in during their lives. Additionally, When people feel that their work is contributing to the common good, and they get paid enough money for their work to pay their bills, afford a decent health plan, set aside something for retirement and have plenty of fun along the way – crime, violence and family frictions will be greatly reduced.

- Add to unemployment insurance funds, while increasing social security reserves. With full employment, unemployment funds and social security reserves will grow rapidly.

- Eliminate economic losses associated with staying with the status quo. These losses include:

Lost economic multiplier benefits. Exporting $6 billion each year to pay for imported energy means there is no economic multiplier benefit gained locally in spending this money.

Lost tax revenues. Once the dollars we export to pay for imported energy leave our local economy, no local tax revenues can be generated from them.

Increased tax revenues. Keeping $6 billion a year in our local economy will increase local jobs and business opportunities on all fronts. Since the people earning this money live locally, their local spending will bring new tax dollars into municipal coffers. This means we will have fewer economic and social problems and more tax revenues to take care of the economic and social problems that increased employment and new business activity don't solve. We will also have more money available to rebuild our infrastructure, create new libraries, parks, sports venues, and to support the arts and cultural expression.

3. How will energy self-sufficiency increase energy security and regional security in general?

+ The more we reduce our dependence on imported energy, the more secure we will be. As we have seen, we have little control over the price or supply of the energy vital to every aspect of our lives. Therefore, the more energy self-sufficient we become the more local control we will have over both energy price and supply. In this age of uncertainty, achieving energy self-sufficiency is vital to our personal security and the security of our families and communities.

+ Reduced threat of energy flow restrictions due to terrorism, accidents and severe weather here and abroad. A dispersed solar panel system installed on roofs and over parking lots would be much less vulnerable to large scale damage from acts of nature like earthquakes and severe weather and to human-caused accidents or damage caused by people bent on hurtful and destructive actions.

Current natural gas, oil, coal-fired and nuclear power plants are sitting ducks and the loss of any one of them to an attack will cause considerable local harm and systemic problems as well. On top of this, a successful attack on a nuclear power plant would render thousands of square miles of land unsafe to inhabit for tens if not hundreds or even thousands of years.

I won't talk specifics because I don't want to give anyone ideas, but a solar electric system dispersed over 50 to 100 square miles of roofs and parking lots would be much more difficult to damage in any major way than are centralized power plants. Plus, even if centralized plants are not attacked directly, the cut-off of their fossil fuel or enriched uranium fuels would serve the same purpose. Since free solar energy comes directly to us, it cannot be interrupted.

+ Reducing the creation of greenhouse gases. I take my cues on this issue from the Global Reinsurance Industry. These are mega insurance companies that insure the insurance companies we buy policies from. Here's a quote from a recent world conference of Reinsurance Industry Leaders, "… climate change could cost the world more than $300 billion each year" and "only urgent efforts to curb emissions of CO2 and other gases linked with the greenhouse effect, can avert this outcome." (16)

The more we increase renewable energy development and install efficient energy-use measures, the fewer CO2 and methane gas emissions to the atmosphere there will be. Carbon dioxide and methane gas are two major contributors to global warming.

Probably the most important economic issue is that once a community has installed sufficient renewable energy collection capacity to meet all its local energy needs, NO ONE LIVING OR WORKING IN THAT COMMUNITY WOULD EVER LOSE THEIR HOME, BUSINESS, JOB OR WAY OF LIFE DUE TO OUT-OF-CONTROL ENERGY COSTS OR UNCERTAIN SUPPLIES.

4. What are the health and environmental benefits of becoming energy self-sufficient?

+ Many of the economic benefits that becoming energy self-sufficient will bring, will reduce pollution and therefore help improve human health and the health of our planet's life support system. I estimate that just using off-the-shelf technologies, becoming energy self-sufficient through efficiency improvements and renewable energy development, will reduce our current energy-use-related pollution by 90 percent.

Additionally, as we get more skilled at saving energy and developing our renewable energy resources, we'll eliminate energy-supply-related pollution completely. In other words, if we do it right, we can have a secure abundance of energy with no pollution and no health or life support system liabilities.

Obviously, our cities, county and region can benefit greatly by becoming energy self-sufficient. This given, what should we do to benefit from this opportunity economically and to get control of our energy future?

Here's my plan:

Both San Diego City and County residences and businesses pay enough for energy each year to swing the deal I'm proposing. Even smaller municipalities, like the residents of Chula Vista, pay enough for energy to swing the deal as well.

But the best deal for investors, manufacturers, installers and for the public at large, would be for San Diego County and all its Cities and the Cities of Tijuana, Tecate, Rosarito and Ensenada to partner in issuing a Request For Proposals (RFP) to make our region energy self-sufficient by 2030 or as soon as possible.

This RFP would be issued to the large solar panel manufacturers and energy service companies to come up with a cost-effective plan including financing to make our region renewable energy self-sufficient by 2030 or sooner if possible. To maximize local job and business opportunities, the RFP would include the provision that at least 90 percent of the products used to develop our solar resources and increase efficient energy use, would be manufactured and installed by people living in our region earning at least prevailing wages.

How Do We Pay For It?

SURPRISE!!!!!!!!! We are already paying more money for energy than we will pay if we become energy self-sufficient. Plus, while we are saving money on energy, our energy payments will transform us from being energy supply renters to being the owners of our own renewable energy supply system.

Now we rent energy, just like renting a place to live. In either case, no matter how much we pay or how long we pay, we never gain equity in the place we rent or in the system that supplies us the imported energy upon which we now depend. With my plan, investors will finance the development of sufficient solar energy and efficient energy use improvements to make us energy self-sufficient.

For our part, we will pay off the investors including their profit by paying our energy bills just as we do now, except our cost per unit of energy will gradually go down as local efficiency improvements and renewable energy systems are installed. Plus, as the process unfolds, we will transform ourselves from being energy supply renters into energy system owners of our own local solar electric energy supply system. Additionally, as discussed previously, solar energy is free.

Another benefit, and arguably the most important, is that becoming energy self-sufficient locally is the best energy supply and price security insurance policy we can own and we get it for no additional cost.

Imagine what the payments would be on an insurance policy that would guarantee that there would be no economic losses in our region due to energy supply uncertainties and upward price volatility, given our current almost complete dependency on imported energy that more often than not is coming from distant politically unstable sources. This is an insurance policy that even Lloyd's of London would not underwrite.

Bottom line: as we invest in becoming energy self-sufficient we are also investing in affordable energy price and supply security. If we continue our nonrenewable energy dependence, we will become increasingly vulnerable to energy supply shortages and rising energy costs.

At today's costs, on average, each man, woman and child consumes approximately $6 worth of imported electricity, natural gas, gasoline and diesel energy each day or $2,200 each year. Even if we assume that energy costs remain static, at the end of 10 years the average household of 2.8 people will be out $61,320 in payments for energy with nothing to show for it but increasing energy costs and supply uncertainty. (17) With my plan, we will save money and along the way we will become shareholders in our own energy supply system.

What's in it for investors and companies?

The incentives for investors and companies to provide financing and submit proposals are threefold:

+ If our region committed itself to becoming energy self-sufficient by 2030, we would create the largest solar development and efficiency improvement project in the world, at least 10 times larger than anything that has been implemented before on our planet. This is a market that investors and manufacturing companies would be happy to win.

+ Once the successful bidders finish making our region energy self-sufficient, they will own the world market in manufacturing solar panels and efficient energy use products. With the economy of scale production required to meet our local energy needs by 2030, these companies will be producing and marketing the most cost-competitive, solar electric PV panels and efficiency products in the world. With such an advantage, our local companies will take over the world market in solar electric panels and efficient energy-use products and their installation.

In fact, the only way for other solar panel and efficiency products manufacturers to compete will be to increase their scale of production to match the production scale of our local plants. This will reduce the cost of converting solar energy into electricity and saving energy through efficiency improvements even more.

+ From an investor perspective, financing energy self-sufficiency is one of the most secure investments in the world. Who is not going to pay their energy bills? Especially considering all the economic, health and environmental benefits that becoming energy self-sufficient will bring and all the problems that being dependent on imported non-renewable energy resources portends. Energy security is essential.

Without energy we wouldn't have light, refrigeration, heating, TV, radio, computers, transportation etc. Without energy, we can't even pump water or deliver food. Plus, with the economy-of-scale production that making our region energy self-sufficient will require, investors can look forward to investing in a multi-trillion dollar global market aimed at replacing all non-renewable energy sources by various forms of solar energy over the next 50 to 60 years.

On another level, investors, manufacturers, installers, municipalities, ratepayers, and really all of us will benefit in emotional and spiritual ways not quantifiable in dollars. In addition to securing our own energy future, we will be ensuring that our children and future generations have an abundance of clean renewable energy. Abundant clean energy is an essential precursor to the creation of a strong sustainable economy and insuring that future generations have an abundance of clean and healthy air, water and food to sustain them during their lives.

The Economics of Becoming Renewable Energy Self-sufficient

The purpose of the following spreadsheet and corresponding graph is to show the positive economic benefits of aggressively pursuing renewable energy self-sufficiency. Unfortunately, the level of aggressive investment used in the spreadsheet calculations is probably not achievable unless there is an all-out region wide Apollo Project like effort to get the job done. Such an all-out effort would include:

+ Extensive public education as to the economic and security advantages of becoming renewable energy self-sufficient as soon as possible.

+ Greatly increasing the local manufacturing capacity to supply the efficiency improving and renewable energy collection products necessary to meet the 27-year renewable energy self-sufficiency target shown by the graph.

+ A 10 fold expansion of existing training programs to insure that there is a large enough skilled labor force to manufacture and install the necessary efficiency improving and renewable energy collecting equipment to get the job done in 27 years.

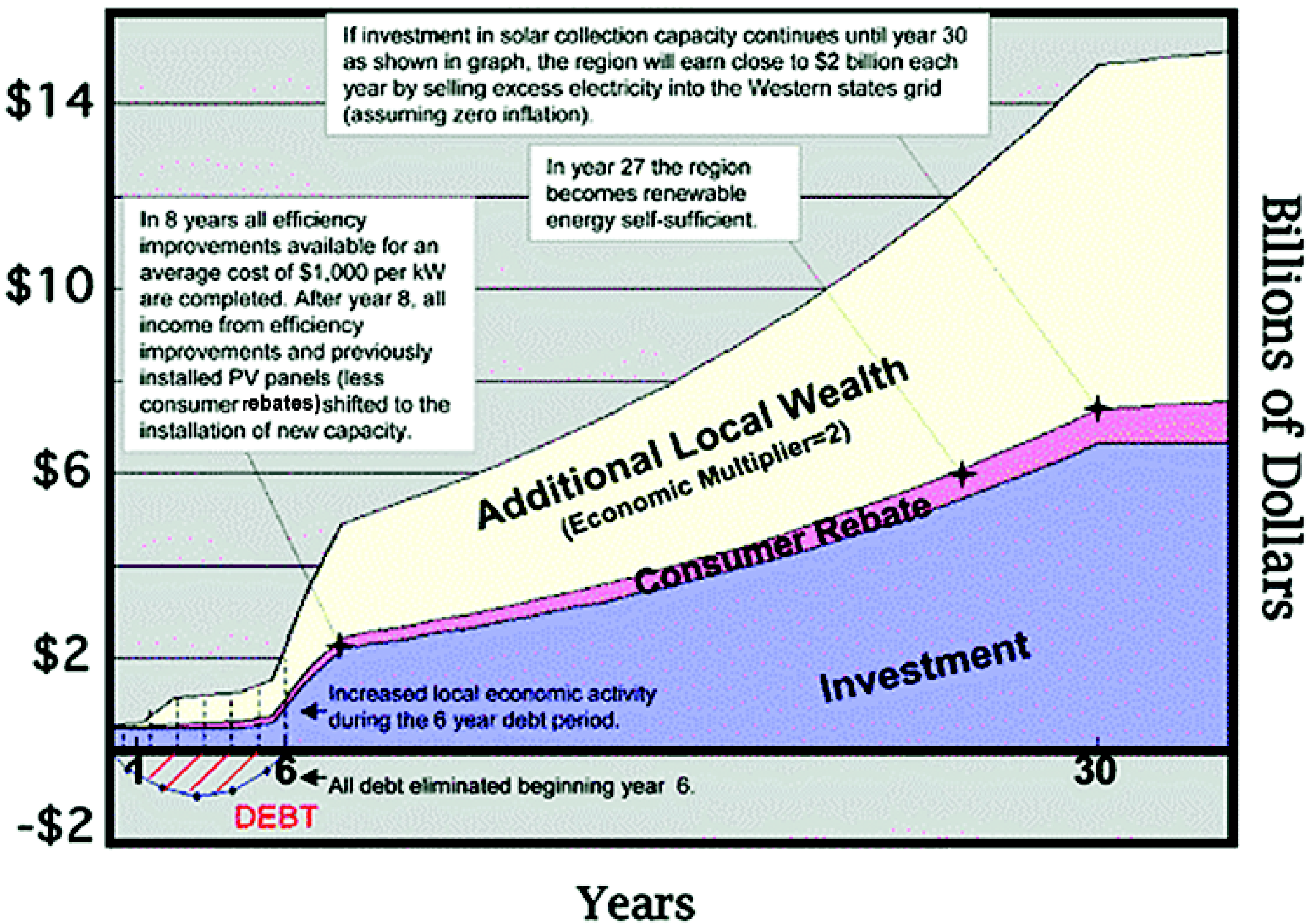
The beauty of the spreadsheet however is that as long as the working capital per year is sufficient to create the economy of scale production benefits projected by the spreadsheet, whatever debt was incurred would still be paid off in 6 years. For example, a yearly working capital of $100 million each year would still provide the same economy of scale production and installation benefits that a working capital of $500 million per year would create. The difference would be that starting with a working capital of $100 million each year, it would take 46 years instead of the 27 years shown in the graph to make the region renewable energy self-sufficient.

The case made in this book is that staying with the energy status quo is increasing our danger of experiencing a regional economic and security meltdown; and that our best hope to avoid such a meltdown is to become renewable energy self-sufficient as soon as possible. This implies that we should set our initial working capital level as high as we have the labor and manufacturing capabilities to spend the money efficiently. As newly trained labor and manufacturing capacity expands, working capital levels can be increased accordingly.

Economic Benefits of Becoming Energy Self-Sufficient (Monetary values are in millions of dollars)											
Date	**Year**	**Cum. Bond Debt**	**Working Capital**	**Invested Capital**	**Interest Debt**	**Surplus Capital**	**Income From PV**	**Income from Energy Efficiency**	**Gross Income**	**Total Income less interest payback**	**Net Income less consumer rebate**
2005	1	$500	$500	$500	$75	$0	$0	$0	$0	$0	#0
2006	2	$828	$500	$500	$124	$0	$1	$266	$267	$191	$172
2007	3	$960	$500	$500	$144	$0	$2	$531	$533	$409	$368
2008	4	$871	$500	$500	$131	$0	$2	$797	$799	$655	$590
2009	5	$529	$500	$500	$79	$0	$3	$1,062	$1,065	$935	$841
2010	6	$0	$598	$598	$0	$0	$4	$1,328	$1,332	$1,252	$1,127
2011	7	$0	$1,485	$1,485	$0	$0	$5	$1,645	$1,650	$1,650	$1,485
2012	8	$0	$2,197	$2,197	$0	$0	$8	$2,434	$2,442	$2,442	$2,197
2013	9	$0	$2,306	$2,306	$0	$0	$128	$2,434	$2,562	$2,562	$2,306
2014	10	$0	$2,419	$2,419	$0	$0	$254	$2,434	$2,688	$2,688	$2,419
2015	11	$0	$2,539	$2,539	$0	$0	$387	$2,434	$2,821	$2,821	$2,539
2016	12	$0	$2,664	$2,664	$0	$0	$526	$2,434	$2,960	$2,960	$2,664
2017	13	$0	$2,795	$2,795	$0	$0	$671	$2,434	$3,105	$3,105	$2,795
2018	14	$0	$2,933	$2,933	$0	$0	$824	$2,434	$3,258	$3,258	$2,933
2019	15	$0	$3,077	$3,077	$0	$0	$985	$2,434	$3,419	$3,419	$3,077
2020	16	$0	$3,229	$3,229	$0	$0	$1,153	$2,434	$3,588	$3,588	$3,229
2021	17	$0	$3,388	$3,388	$0	$0	$1,330	$2,434	$3,764	$3,764	$3,388
2022	18	$0	$3,555	$3,555	$0	$0	$1,516	$2,434	$3,950	$3,950	$3,555
2023	19	$0	$3,730	$3,730	$0	$0	$1,710	$2,434	$4,144	$4,144	$3,730
2024	20	$0	$3,914	$3,914	$0	$0	$1,915	$2,434	$4,349	$4,349	$3,914
2025	21	$0	$4,107	$4,107	$0	$0	$2,129	$2,434	$4,563	$4,563	$4,107
2026	22	$0	$4,309	$4,309	$0	$0	$2,354	$2,434	$4,788	$4,788	$4,309
2027	23	$0	$4,521	$4,521	$0	$0	$2,590	$2,434	$5,024	$5,024	$4,521
2028	24	$0	$4,744	$4,744	$0	$0	$2,837	$2,434	$5,271	$5,271	$4,744
2029	25	$0	$4,978	$4,978	$0	$0	$3,097	$2,434	$5,531	$5,531	$4,978
2030	26	$0	$5,223	$5,223	$0	$0	$3,369	$2,434	$5,803	$5,803	$5,223
2031	27	$0	$5,481	$5,481	$0	$0	$3,655	$2,434	$6,089	$6,089	$5,481
2032	28	$0	$5,751	$5,751	$0	$0	$3,955	$2,434	$6,390	$6,390	$5,751
2033	29	$0	$6,034	$6,034	$0	$0	$4,270	$2,434	$6,704	$6,704	$6,034
2034	30	$0	$6,331	$6,331	$0	$0	$4,601	$2,434	$7,035	$7,035	$6,331
2035	31	$0	$6,643	$0	$0	$6,643	$4,947	$2,434	$7,381	$7,381	$6,643
2036	32	$0	$6,643	$0	$0	$6,643	$4,947	$2,434	$7,381	$7,381	$6,643
2037	33	$0	$6,643	$0	$0	$6,643	$4,947	$2,434	$7,381	$7,381	$6,643
2038	34	$0	$6,643	$0	$0	$6,643	$4,947	$2,434	$7,381	$7,381	$6,643
2039	35	$0	$6,643	$0	$0	$6,643	$4,947	$2,434	$7,381	$7,381	$6,643
2040	36	$0	$6,643	$0	$0	$6,643	$4,947	$2,434	$7,381	$7,381	$6,643

Note: To be extra conservative this spreadsheet assumes zero income from efficiency measures and renewable energy installations during the year they are installed.

Economic Benefits of Becoming Energy Self-Sufficient Over 35 Years



Definitions

		Minimum	Maximum
Yearly Investment	Capital ($)	$500,000,000	$6,600,000,000
Debt Interest Rate+ Annual Return on Investment	Rate (%)	15	
Percent of Annual Investment Going to PV Installation [Note 1]	Investment (%)	3	100
Percent of Annual Investment Going Toward Energy Efficiency [Note1]	Investment (%)	97	
Cost of Installation (assumed economies of scale at 500 MW per year plant output [Note 2]	PV Cost/KW capacity ($)	$5,000	
Average Sunlight for San Diego per day		5	
Retail Price per KWH (includes components, distribution etc.) [Note 3]	Cost ($)	$0.15	
Average cost per KW saved in all sectors [Note 4]	Cost ($)	$1,000	
Average Residential, Commercial, and Industrial Building Use per day	Hours	10	
Economic Multiplier Factor		2	
Consumer Rebate	% of Income	10	
Bond Debt Payoff	% of Income	90	
Energy Efficiency Income Achievable available at $1,000/kW Saved			$2,434,108,590
PV Income Achievable at $5,000 per KW of Installed Capacity			$9,000,000,000

Definitions Footnotes

1. At the investment level assumed in this graph, all efficiency improvements at anaverage cost of $1,000 per kW saved would be installed by year 8. At this point all the income from efficiency improvements and already installed PV panels, less the 10 percent consumer rebate, would be shifted to the installation of new PV capacity.

2. Detailed studies funded by British Petroleum and Green Peace Netherlands have shown that large scale PV panel manufacturing plants designed to produce a minimum of 500 MW of PV panels each year would bring the cost of producing PV panels down to around $2.00 per peak Watt. Currently, (1/05) large installers are paying $3.15 to $3.50 per peak Watt in a market place where the world demand for panels is exceeding supplies and the production of PV grade silicon to make them is not keeping up with demand. If we assume the current $3.50 per watt panel cost then add $1.50 per watt for installation and $.80 for taxes equals $5.80 per installed watt. At $2 per watt the total is $4.30 per watt of capacity. The spreadsheet number of $5.00 per watt falls in the middle range between $5.80 and $4.30 per watt. Yes a profit margin would be added on, but with mass production and installation, this can be low and still attractive to investors and the industry.

3. Common experience shows us that the cost of a kWh of electricity is volatile and more likely to go up on average than go down. In this light, $.15 per kWh is probably a little on the conservative side as the future unfolds. The more that energy costs rise, the faster the payback on investing in efficiency improvements and renewable energy development.

4. This was a hard number to come up with since most research in this area is focused on reducing peak demand instead of reducing total consumption. After discussing this with numerous experts in the field, the general consensus was that up to 50 percent of the energy currently consumed to light, heat and cool buildings and to run equipment and machinery in them could be saved for an average cost of $1,000 per kW saved for 10 hours per day. This10 hours per day estimate is probably a little high for the residential sector because many people are at work and school during the day and therefore residential energy use is low during those hours. But 10 hours per day in commercial and industrial buildings and the work done in them is probably low. Most businesses and industries are operating at least 12 hours per-day and many operate 24/7. To be conservative, the spreadsheet calculations assume that only 40 percent of the energy currently used in the region could be saved for an average of $1,000 per kW saved instead of the consensus figure of 50 percent.

With regard to efficiency improvements in vehicles, a number of recent studies using varying assumptions have arrived at widely differing estimates on how much it costs at the factory to improve the mpg of various vehicle types. Meanwhile in the real world, the 2004 five passenger 55 mpg *Toyota Prius* has already exceeded even the most optimistic projections of these studies. Additionally, the Prius has very low emission and has not increased in price. Plus, according to the Wall Street Journal, the Prius has been the fastest selling car since it came out in 2003. Compared with its Big 3 competitors the Prius is 30 to 50 percent more fuel-efficient. In short, the Prius demonstrates that with good design, the fuel efficiency of passenger cars can be greatly improved with little or no increase in price or $0 per kW saved. Even if it costs $2,000 in changes per car to improve its efficiency from 35 mpg to 55 mpg assuming 15,000 miles per year (42 miles per day average) equals around $400 per kW saved, well below the $1,000 per kW saved budgeted in the analysis.

Large (18 wheelers) and median sized trucks show similar promises of cost-effective fuel efficiency gains. (For details read Lovins, Amory B., E. Kyle Datta, et al. Winning the Oil Endgame. Rocky Mountain Inst., 2004. For Prius details - pp. 29-30, General discussion - pp. 44-78 and figure 11 - p. 51, figure 21 - p. 66 for study comparisons and pp. 73-78 for large trucks.

Note: The cost of system maintenance is not included in the graph because it is assumed to be low or less than maintenance on existing systems. This is because PV panels are performance warranted for 25 years and efficiency improvements like extra insulation, double paned windows and skylights require no energy related maintenance since they will last the life of the building in which they are installed. Improvements like replacing old lighting with more efficient systems will actually save on maintenance costs. New efficient lighting systems last up to 10 times longer than the systems they replace. Longer periods of time between replacements translate into reduced maintenance costs. Although energy efficient electric motors used in industry and appliances may last longer than the less efficient electric motors they replace, even if they don't, no additional maintenance will be required.

Achieving Water Security by Becoming Water Self-sufficient

Although our region is rich in renewable energy resources and agricultural soils (agricultural soils will be discussed later), this is not the case for freshwater. If recent lower than historic rain/snow falls continue, freshwater resources will be even more limited in the future. But, even if recent less than historic rain/snow falls continue, our region can be water self-sufficient, with few or no lifestyle changes, if an efficient, integrated, sustainable watershed, water collection, storage, use, and reuse-for-irrigation strategy is adopted. Additionally, we have an abundance of renewable energy to convert seawater into freshwater to make up for any water supply deficits.

What we need to do to achieve water self-sufficiency

<u>Protect and improve watershed health to maximize groundwater recharge and surface water collection</u>. Healthy watersheds are rich in life. Plants provide food and oxygen for animals (humans included) and animals provide nutrient-rich wastes and carbon dioxide for plants. Healthy plant communities protect against soil erosion by blunting the force of even the heaviest rain. By protecting the soil from eroding, plants keep surface runoff clean and easier to collect. Soil animals like earthworms create a nearly infinite number of tiny tunnels, which provide pathways for water to be absorbed by the soil to nourish both plants and animals and maximize soil and groundwater recharge, whatever the rainfall total is in a particular year. In other words, the healthier watersheds are, the more groundwater the people living in them will be able to use sustainably, whether rainfall is below average or above it.

<u>Develop a more efficient, durable and secure local water collection system</u>. On the water collection front, water would be extracted from groundwater reservoirs or taken from streams and rivers. In some cases, surface water collection would require the construction of small reservoirs along stream or river channels. Unlike the typical reservoir of today, which completely blocks the flow of a waterway, these reservoirs would be small, usually less than 10 feet high, and designed to divert no more than 50 percent of the water flow into pumping reservoirs. Pumping reservoirs would be sited at valley perimeters out of floodplains. As the water rose in these reservoirs, float activated pumps would deliver water to underground storage tanks primarily located on mesas and hills but never in floodplains.

<u>Develop a more secure water storage system to protect stored water from contamination and evaporation</u>. Thus far, my research shows that underground tank storage is the most secure and cost-effective storage system for our region with one or more tanks located in each community depending on the size of the community. The land above each tank would be used for parks, basketball and tennis courts, soccer, baseball and football fields, community gardens, wildlife habitats, etc., depending on the size and location of the tank and community preference. The benefits of the underground tank storage over other options include:

+ No loss of water or water quality to evaporation. In our region, open reservoirs, depending on location, lose 4 to 8 feet of water from their surfaces each year to evaporation. This is 4 to 8 times more than our average rainfall. (18) Not only is water lost, the salts and other minerals that were dissolved in it become more concentrated in the water left in storage.

+. Providing a secure water supply where water will be most needed if aqueducts and delivery pipes fail due to earthquakes, severe weather, or accidental or intentional human disruption. (19)

+ Protecting water from air or water-borne pollution. (20)

+ Making stored water more difficult to purposely or accidentally contaminate. (21)

+. Being less vulnerable to earthquakes than are dams. (22)

+ Fewer land-use liabilities. Unlike dams, underground tanks do not flood farmland or wildlife habitat. (23)

+ Eliminating the threat of deaths, injury and damage to property that dam failures cause. (24)

+ The potential to design underground storage tanks that can collect water from humid air even if precipitation is absent. (25)

+ Having a world-class underground tank builder based in our region. (26)

Use water more efficiently by getting more water-use benefit using less water.

Residential, commercial, industrial and agricultural water use can be substantially reduced in cost-effective ways without reducing water-use benefits. Residential water use can be reduced by 70 percent without life style changes through a combination of low-flow shower heads, low-flow toilets, water-efficient appliances, climate-appropriate landscaping, and the use of bath and sink water (graywater) for irrigation where appropriate. (27)

Commercial and industrial water use can be reduced by using the residential measures listed above where appropriate. Other improvements can be made depending on the nature of the commercial or industrial operations involved. One example, of several discussed in footnote 28, is the “Armco Steel Mill in Kansas City, Missouri. This plant, which manufactures steel bars from recycled ferrous scrap, uses water 10 to 20 times more efficiently than a normal plant and uses the water it takes in 16 times before the water is discharged into a river. (28)

To maximize water security, it is important to use water efficiently in every way we can. But more efficient water use in agriculture could save more water than all other efficiency measures combined. Worldwide, the amount of water used in agriculture “accounts for some 70% of global water use,” greatly exceeding the quantity of water used for domestic and commercial purposes. In countries like the U.S., with well-developed irrigation infrastructures, up to eighty-five percent of all water used is consumed by agriculture. The remaining 15 percent accounts for all other uses. (29)

One of the most troubling aspects of this water use in agriculture is how rapidly it is depleting groundwater supplies. In 1986, the U.S. Department of Agriculture reported “that one-fourth of the 21 million hectares (52 million acres) of U.S. irrigated cropland was being watered by pulling down water tables anywhere from six inches to four feet per year.” (30) Groundwater depletion is an accelerating problem worldwide. (31)

Whether in the United States or abroad, much of the water used by agriculture can be saved through the use of efficient irrigation practices and by growing climate-appropriate crops. (32) Fortunately for us, our region’s farmers are already some of the most water-efficient farmers in the world. (33)

Water Recycling

Water recycling is another way to improve water-use efficiency. Water recycling can occur on several levels. Home gray water systems (bath and sink water) may be as simple as draining bath and wash water into one's yard. Depending on the particular situation, more sophisticated systems may involve filtering, pumps, and disinfection. Gray water includes bath, sink, and water from washing clothing. It excludes toilet wastes. Food scraps and many soaps and shampoos present in gray water are not usually a problem since they can be broken down by soil organisms into nutrients that are used by plants. Whether it be human bathing or general cleaning products, it is best if they biodegrade rapidly. (34)

Community-scale water recycling is another way to get twice the benefit from the same amount of water. In dense urban areas where many residences do not have yards, community-scale sewage recycling systems can be used. As with backyard systems, it is important to keep toxic and caustic materials out of all wastewater collection and recycling processes. If this is done there are a number of processes that can be used to clean up wastewater so that the water can be used for irrigation and the solids composted into fertilizer. In general, such recycling systems use both biological and mechanical methods to clean wastewater.

One cost-effective approach has been developed in Tijuana, Mexico. The treatment plant in Tijuana is called Ecoparque. I was involved in the design of this system, directed its construction and was co-project director during its construction. Ecoparque is designed to transform sewage into irrigation water and fertilizer. It's particularly suited to our semi-arid climate because very little water is lost to evaporation during treatment. (35)

Designed to combine biological and mechanical methods to process wastewater, Ecoparque also minimizes the amount of land needed for treatment. The treatment process involves mechanical screens, biological filters, clarification (slowing the flow of water so solids can settle out) and disinfection. Basically, Ecoparque recycles all the water and nutrients that pass through it. The recycled water is being used for irrigation and the nutrient rich solids are composted through a vermiculture (earthworm) composting system, then used as an organic fertilizer rich in plant nutrients and food for soil organisms. (36) On a more prosaic level, Ecoparque converts sewage waste and pollution into irrigation water and soil nutrients. Using these reclaimed resources on site has transformed a former dump and health hazard into a 32 acre park and wildlife refuge where families' picnic and couples get married. As a bonus, land values around the site have increased substantially and developers use advertising slogans like "Live Next to Ecoparque" to attract home buyers.

Use our abundant renewable energy resources to convert seawater into fresh water through reverse osmosis, distillation and other strategies.

Today, most systems designed to convert seawater into freshwater, are powered, directly or indirectly, by fossil fuels, but direct solar or solar generated electricity can be used. Simple, single-stage direct solar stills in Southern California will produce, on average, one gallon of fresh water from seawater each day per 10 square feet of glazing. Multistage solar stills can double this production. Combining waste industrial heat with solar distillation can increase freshwater production many-fold depending on how much waste heat is available.

Currently, the most efficient way to convert seawater to freshwater is through reverse osmosis that can be powered by renewably generated electricity. Reverse osmosis uses high-pressure pumps to force seawater through a membrane that lets water through but blocks dissolved minerals like salt. Large-scale reverse osmosis systems (5 million gallons per day and larger) will produce 50 gallons of freshwater from seawater per kWh of electricity consumed. At this rate, 8.3 square miles of PV panels installed on rooftops and over parking lots will produce, on average, 180 gallons of freshwater from seawater per capita per day for 3 million people. (37) The amount of water used per capita per day in our county for all uses (residential, industrial, commercial and agriculture) in 2001 was 180 gallons. Wave power and tidal power can also be used to convert seawater into freshwater. Float Inc., a local company, has proposed building a floating airport to replace Lindbergh Field. I've researched their technology, and was quite impressed with it in general and its' potential to use wave power to make freshwater from seawater. (38)

Collecting Water From the Land, Our Region's Potential

Given the goal of achieving water self-sufficiency, how much water can be sustainably collected from the region's coastal watersheds each year and what do we need to do to convert sea water into freshwater to make up for any deficits?

Historically, average rainfall, including snow, has run at around 18 inches per year, 9.9 inches on the coast to 40 inches on the western slopes of the Laguna Mountain Crest. If this historic average held up over the long run, the assumptions and conclusions in the following footnote are more or less accurate. (39) Unfortunately, average rainfall totals have been declining. As rainfall totals go down, the percent of runoff and groundwater recharge goes down even more steeply. In other words, the lower the average rainfall, the smaller the percentage of it that will run off or recharge groundwater supplies. When rainfall is low there is little runoff because most of it is soaked up by the first few inches or feet of soil where it is used up by plants or evaporates over time. Similarly, very little groundwater recharge occurs until there is sufficient rainfall to fully saturate surface soils. (40)

Taking the above into consideration and assuming a coastal watershed average rainfall of 12 inches (6 inches along the coast and 24 inches above 4,500 feet in elevation) instead of the historic average of 18 inches, how much water could we collect?

Basically there are 3 land sources of water available to us: general runoff from the region's coastal watersheds, runoff from impervious surfaces like roofs and parking lots, and groundwater.

+ <u>General Runoff</u>. Assuming a Tijuana/San Diego region coastal watershed area of 6,220 square miles or 3,980,800 acres (1,612,224 hectares) and that only 6 percent of the rain that falls runs off and that only half of this 6 percent can be collected (3 percent of 12 inches) without causing ecological sustainability problems - the amount of water that can be collected equals 17 gallons per capita per day for 6,000,000 people. (41)

+ <u>Impervious surfaces</u>. Assuming that there are 600 square miles of impervious surfaces (roofs and parking lots), in the San Diego/Tijuana region and that 6 inches of precipitation can be collected from these surfaces on average per year, the amount of water that can be captured per capita for 6 million people is 28.5 gallons per day. Note: with road surfaces included, there may be as many as 750 square miles of impervious surfaces in the San Diego/Tijuana region. Also, given the assumption of an average coastal rainfall total of 6 inches, six inches of collectible water is probably conservative considering that 6 inches of rainfall on the coast would be 8 inches west of I-15, around 10 inches in El Cajon, La Mesa and Escondido and 12 inches or more in communities like Alpine and Valley Center. (42)

+ Groundwater. If current lower than historic rainfall continues, we should assume a sustainable yield of no more than 5 gallons per capita per day for 6 million people from our region's groundwater storage basins. (43)

Adding these totals together, we get 17 gallons + 28.5 gallons + 5 gallons = 50 gallons per capita per day sustainable water supply from precipitation in our coastal watersheds. If we recycle 80 percent of this water after use for irrigation it gives us an average water budget of 90 gallons per day per capita for all water uses.

Currently, the average use of water in the San Diego part of the region, for all uses, (residents, commercial, industrial and for agriculture) is around 180 gallons per day per capita. (44) This is based on dividing the total amount of water used in San Diego County in 2001 by the total county population in the same year.

My research has convinced me that through the use of currently available know-how and technology, it is possible to actually improve our individual water-service benefits while using no more than 60 gallons of water per capita per day.

Since 90 gallons per capita per day for a 6 million regional population is available given the assumptions already discussed, we can more than meet our water needs if an integrated collection, storage, efficient use, and water recycling system is developed.

Plus, as discussed above, even if rainfall averages continue to fall, 8.3 square miles of solar cell coverage on each side of the border (16.6 square miles total), will generate enough electricity to produce 180 gallons of freshwater from seawater per capita per day for 6 million people using large scale reverse osmosis systems. (45) Additionally, wave and tidal energy can be used to power large scale reverse osmosis systems. (46)

Maximizing Food Security in the San Diego/Tijuana Region

On the food front, the San Diego/Tijuana Region is very rich in agricultural soils. From the most productive to the least, there are 8 agricultural soil classifications, number “1” being the most versatile for growing crops. The land areas covered in our region’s coastal watersheds by the 4 best soil classifications are as follows:

Number 1 soil – 153 square miles (396 square kilometers.)
Number 2 soil – 145 square miles. (375 square kilometers.)
Number 3 soil – 670 square miles. (1,735 square kilometers.)
Number 4 soil – 1,221 square miles. (3,162 square kilometers.) (47)

Although there are ample soils to feed many more than 6 million people, regional food production is limited by the availability of water. If historic average rainfall totals return our water budget would be sufficient to grow enough food to feed our current population indefinitely. If it doesn't, reduced precipitation can be replaced by using solar generated electricity to convert seawater into freshwater. Fortunately, we have an abundance of renewable energy to accomplish this task. Plus, wave and tidal power can be used to convert seawater into freshwater as well. Efficient water use in growing food can be increased many-fold if crops are grown in greenhouses designed to collect the water that condenses on the underside of greenhouse glass for reuse.

We Have Many Options But For How Long

As I hope I've shown, we have many options. My fear is that if we don't take them up soon, world events will preclude this opportunity.

The most important thing we need to remember is that becoming energy, water and food self-sufficient is the economic engine that will both solve our budget problems and give us the money to build libraries, swimming pools, recreation centers, parks, and do public benefit projects in general. And, we can do this simply by keeping the money we now spend on imports of energy, water and food in our local economy. This is around $20 billion each year.

In our favor, it turns out we can supply ourselves with all the energy, water and food we want and produce them cheaper and better locally than if we continue to import them. Plus, we'll be doing it in ways that protect human health, environmental health and strengthens our economy.

Additionally, every time we pay for energy, water and food, we will gain equity, ownership and income from the systems that make us energy, water and food self-sufficient. In addition to the economic benefits, being energy, water and food self-sufficient locally is the best insurance money can buy to insure that these essential resources will be available to everyone living in our region, no matter how unstable the greater world becomes.

Part three: The San Diego/Tijuana Region, A Vision Of A Sustainable Future

If our region's economy were well on its way to becoming completely sustainable, what would it be like to live here?

Actually, at least on the surface, life would be much the same as it is today, except that the region would be much more park-like in appearance and there would be little if any pollution. If they chose to, people would still have cars and would be able to drive them as far and often as they do now. The difference would be that they would be driving much more efficient vehicles powered by renewable energy produced locally.

Rapid charge electric cars and trucks would charge up their batteries by using solar (photovoltaic) cells to convert the solar energy that falls on rooftops and parking lots into electricity. Hybrid drive and fuel cell vehicles would be powered by liquid fuels like bio-diesel, ethanol, methanol, etc., produced locally from food wastes, kitchen grease from restaurants, grass clippings, bush and tree trimmings, kelp, eucalyptus, chaparral and other biomass materials. Natural gas derived from the anaerobic digestion of food wastes, sewage and kelp residues can also be used to fuel hybrid-drive and fuel-cell powered vehicles.

To maximize the efficiency of converting biomass into liquid or gaseous fuels, solar generated electricity would be used to supply the conversion energy. If wood and other biomass materials are converted into methanol, half the energy in the biomass would be used up in the conversion process.

Converting a primary energy source into a more usable energy form always uses up significant amounts of energy. If solar generated electricity is used to supply the conversion energy, all the energy in the biomass can be converted into methanol and ethanol. In addition to producing more bio-fuels like methanol and ethanol, the extra fuel produced constitutes the storage of the solar generated electricity that is stored in extra bio-fuels produced because none were consumed in the conversion process.

Even though plenty of energy for powering cars and trucks would be available, people probably wouldn't drive nearly as much as they do today. This is because communities they live in would be designed to maximize the balance between the availability of homes and apartments, with opportunities for work, shopping, education, and recreation. Some people would still commute to jobs and travel to other communities, but the opportunity to work and play in one's own community would be optimized. To make communities more people friendly, balanced communities would include an internal transportation system consisting of various pathways designed for pedestrians and human powered vehicles. Electric carts and vans would be used to move cargo and people needing transportation assistance in and around community centers. The expanded use of telecommunications would also reduce the need to commute by making it possible for more people to work or be educated at home or at satellite locations in their own communities.

To facilitate transportation between communities, each community's internal transportation system would be linked to a local transportation hub. This hub, in turn, would be linked to the hubs of all the other communities in the region. Whether by bus, trolley, or train, this would make all mass transit between communities, express. In large, densely populated areas, cars and delivery vehicles would be brought in on underground roads to underground parking and loading docks. In smaller communities they would be kept to the outskirts of smaller community centers.

Buildings would look more or less the same as they do today but would be much better insulated and very resource efficient in all their operations. Some low-cost ($40-$45 per square foot in 1980) buildings in Canada are as much as 10 time more energy efficient than are most buildings in our region today. Even though winter temperatures may drop to as low as minus 60 degrees Fahrenheit, some 2,000-square-foot homes in Canada have heating bills less than $60 per year. (48) Of course the cost of natural gas and other fossil fuels have risen since the 1980's, but the money saving benefit of increased efficiency continues to pay big returns.

In addition to being more insulated, most buildings in the region would get 85 percent of their light during the day from daylight sources. Windows, skylights, electric lighting, wall coloring, etc., would be coordinated to maximize the benefits of natural light to increase the comfort, health and productivity of each individual while saving energy.

Electric lighting fixtures would be very efficient and fixture placement would focus on delivering light to where tasks are performed. Light systems would also be controlled by automated motion/heat sensors so that electric lights would turn on when someone entered a room and turn off automatically when the last person left. Light intensity sensors would also dim or turn electric lights off according to the amount of daylight available. Potentially, the range of light levels in a room would be infinitely adjustable by its occupants.

Buildings would also be designed or remodeled to avoid external and internal heat gain. This would be accomplished through the thoughtful placement and choice of windows, and by using the most energy efficient machinery and office equipment available. Commercially available openable windows have 7 times the insulation value as do the single pane windows widely used today. More advanced window designs can double and perhaps even triple the efficiency of the commercially available windows used now. Some computers and monitors use a fraction of the energy to do the same work as do others and therefore greatly reduce heat gain from these sources.

Although buildings with features like those just described would require very little cooling, any cooling needed would be provided by installing heat-absorbent pipes horizontally below the ground. When cooling is required, air collected in naturally cool places like in the shade of a tree, would be drawn by a fan through the buried pipes. As it passes through the pipes the air would be further cooled by the earth before it was discharged to cool the building. The air temperature a few feet below the surface of the earth is usually around 55 degrees Fahrenheit.

In most situations, this system alone would be sufficient to cool thoughtfully designed buildings. Where air conditioning cannot be avoided, earth-cooled air would save energy and money by reducing the amount of cooling that air conditioners would have to provide.

If all costs are considered, direct solar energy is the most cost-effective energy source available in our region for heating space and water, and for producing steam and drying heat needed for many industrial processes. Selective surface* flat plate collectors can produce steam even when it is overcast. Concentrating tracking collectors can deliver steam at 600 degrees centigrade (1,112 degrees Fahrenheit) or more on clear sunny days. Back-up energy for these processes will be provided by solar generated electricity—primarily from solar PV panels mounted on roofs, parking areas, and other areas where shade is desirable.

(*Selective surfaces are special surfaces that are very good at absorbing and converting light energy into heat energy while not letting heat energy escape once it's absorbed.)

Industries, their machinery, and the electric motors that power them would also be much more efficient than today. Most of this technology is already available, and in most cases, its installation will pay for itself just in energy savings in 5 years or less. (49)

Whether industrial, commercial, or residential, new buildings would not be built in areas that are subject to flooding or earthquake damage due to liquefaction. As buildings already located in these areas wore out, they would be dismantled, recycled and rebuilt in safer locations as needed.

Efficient Water Use

Although water consumption per capita cannot be reduced as much as energy, good, efficient water-use strategies can cut water consumption substantially without changing water-use benefits or lifestyles. In other words, people could shower, bathe, flush toilets and use washers for clothing and dishes just as now, but all the toilets, showerheads and appliances would be designed to maximize efficient water use.

Landscaping, to the casual observer would appear to be much the same as today with perhaps a bit less grass. Vegetation used in landscaping would be drawn from a large palette of luxuriant, drought-tolerant native and introduced plants. Drought-tolerant plants that produce useful material and food would also be an important consideration in selecting trees, shrubs and groundcovers. Where irrigation is desired, it would be supplied by water-efficient irrigation technologies like drip irrigation controlled automatically by soil moisture sensors installed in the soil. These sensors, called tensiometers, ensure that irrigation water is only applied when there is a real need. (50)

Water Reuse

In addition to efficient water use, water resources would be stretched through water reuse. Homes with yards would be equipped with gray water systems that would filter and disinfect bath, washing machine and sink water so it can be used for irrigation. Sewage water, unpolluted by harmful industrial or domestic chemicals and heavy metals, would be recycled and disinfected. Then it would be used to irrigate farms and landscaping. Sewage solids would be composted and used for fertilizer. During rainy periods, recycled water would be stored in separate, non-potable underground tanks and used for irrigation when rainfall is insufficient.

Water Collection and Storage

Fresh water would be collected from general rainwater runoff and from impervious surfaces and from groundwater. Using renewable energy to convert seawater into fresh water would also augment supplies that can be sustainably collected from the land. Water collected from all available potable sources would be stored in underground tanks as discussed in Part 2.

Food

In a sustainable economy future, most of the food consumed in the region would be grown and processed locally. Water is scarce, but the more we move agricultural production into water recycling greenhouses, the more food we can grow, even if rainfall averages in our region continue to decline. See Food Security in Part II for more details.

Conclusion

Clearly, maximizing regional self-sufficiency and sustainability has many economic and security benefits. This is especially true as it relates to fundamental necessities like energy, water and food.

Making our regional economy more self-sufficient and sustainable will increase business and well paying job opportunities. It will also make the world a happier and more secure place, locally and planet-wide.

From a local government perspective, new business and employment would add sales and property tax revenue to municipal coffers. It would also reduce municipal costs by reducing crime and social problems. Additionally, unemployment insurance and Social Security reserves will grow.

The land-use aspects of regional sustainability would also reduce municipal costs. If we don’t build in floodplains, we won’t have to pay for infrastructure repairs when floods and earthquakes occur.

With more well paid jobs, people will be able to purchase more of the things they need and want. This will generate sales tax revenue. With more money in local circulation, more people can qualify to purchase a home or purchase or start a business. This would increase property values and thus increase property tax revenues. With more money in people’s pockets, more people would be able to afford a comfortable, safe place to live. This would benefit the rental market. Additionally, with reduced municipal costs and increased revenue pouring into municipal coffers, there would be plenty of money to solve the social problems that expanding business and full employment don't solve.

In addition to the economic, social and spiritual benefits discussed above, using resources more efficiently, and developing those available in the region sustainability, would provide a number of other benefits:

+ Efficient resource use and regional resource development bring the added security of being less vulnerable to resource delivery cutoffs and corporate and politically-generated price fluctuations.

+ Efficiency and renewable resource development would also reduce pollution and ecological damage in general. As pollution is reduced, we will be healthier, happier, and more productive. With less damage to the region's ecology, less money is needed for cleanups and repairs.

There is also the aesthetic value of living in a pristine environment where the air and water are clean, the food tasty, nutritious, and pesticide free, and where the landscape is beautiful and rich in plant and animal life.

Although these benefits are less easy to quantify, their dollar value is at least as great as the economic benefits described earlier. If considered from an overall quality of life and sustainability perspective, the value of these benefits is infinite.

After Word

I do a lot of public lectures on creating sustainable economies and ways of life regionally and planet-wide. After I've given one of these presentations, I'm often asked if I think we can make it. By this, the questioner means, "will we make the economic and lifestyle changes needed to sustain our planet's life support system soon enough to avoid a catastrophic decline?" My answer to this question is, I don't know.

Do I think it is possible? **Yes I do**. The potential is definitely there and potentially infinite. If enough of us decide that we want an economy and way of life that is humane and life-support sustaining, there is no question in my mind that we can create it.

Obviously, I'm personally committed to this path. I look forward to working with you toward this goal along the way.

Footnotes

1. It is assumed in this paper that the meltdown of one of the region's several nuclear reactors or the loss of water in one of their spent fuel rod storage ponds, whether the result of a terrorist attack or an accident, will not happen. If it did, the only long range planning we'd be doing would be calculating how many decades or centuries we would have to wait until our region would be safe to inhabit again.

2. Author's calculations based on balancing account data supplied by the California Energy Commission and our local utility watchdog, UCAN (Utility Consumer Action Network). The balancing account, which we are still paying off, topped out at $648,745,000. Additionally, there were several months of price gouging, that took place before the rate was capped and the balancing account set up, that were not included in my calculations.

3. Conversation with Patrick (Pat) L. Abbott, Ph.D., Professor of Geological Sciences, San Diego State University.

4. Just considering insurance rate increases related to global warming, a recent world conference of re-insurers reported that global climate changes (more severe storms and rising sea levels) could cost the world economy $300 billion per year. ("Climate Change Costs Could Top $300 Billion Annually," Environmental News Service, (Feb 5, 2001).

5. The $20 billion figure is an estimate based on data taken from the SAN DIEGO REGIONAL ENERGY PLAN, Volume 2, published in December 1994 by SANDAG. Also see NEWS, Published by the U.S. Department of Labor, Bureau of Labor Statistics, released April 18, 2002, (Consumer Spending Patterns in San Diego, 1999-2000.) Although this $20 billion figure is more or less accurate today, it could ratchet up rapidly if there is any serious restriction on the flow of energy, water or food to our region. Our recent energy crisis is a graphic example of how price-explosive such occurrences can be.

6. Just as for longtime residents, almost all the money tourists and new residents spend for imported energy, water and food is exported to where the energy, water and food came from. If the region were energy, water and food self-sufficient, all the money spent on energy, water and food would be kept in our local economy, benefiting everyone's bottom line.

7. Clark, Mary E. Contemporary Biology. W. B. Saunders Company, Philadelphia, London, Toronto, (1979): p. 152.

8. Brown, Lester R. et al. The Earth Policy Reader. Earth Policy Institute. W. W. Norton & Company, New York, London. (2002): p. 95. For a quick tutorial of what's happening to U.S. and world soils, I suggest you also read pages 31-37 & 195-199 in Brown's book.

9. This 7.1 percent figure assumes there are 500 square miles of San Diego County land covered by buildings and parking lots. Five-hundred square miles x 7.1 percent = 35.4 square miles. The 500 square mile figure for county land already covered by buildings and parking lots was derived from a land use analysis of San Diego County provided by SANDAG which lists 96 land use categories and the number of acres each land use category occupies. In my analysis, I looked at each category and estimated the amount of land in each category that would be covered by buildings and parking lots. For example, for the category of educational facilities, I assumed that on average, school properties are 50 percent covered by buildings and parking lots. In the case of industrial parks I assumed 90 percent coverage. For the open space category, currently 50 percent of the county's land area, I assumed zero

buildings and parking lots even though there are obviously some buildings and parking lots associated with open space management and to accommodate visitors.

After assigning a percentage of buildings and parking lot coverage to all 96 land use categories and then adding them up, the total was 576 square miles. To be conservative, I've used 500 square miles for all related calculations. (Note: In the first version of this book I used the figure of 300 square miles of buildings and parking lots in San Diego County to be extra conservative. After reviewing my calculations however, I concluded that the 500 square mile figure I'm using in this version of the book is still conservative and closer to reality.)

10. Marion, William and Stephen Wilcox. Solar Radiation Data Manual for Flat-plate and Concentrating Collectors. National Renewable Energy Laboratory, U.S. Department of Energy, Midwest Research Institute, Contract # DE-ACO2-83CH-10093, (April 1994): p. 42. This manual shows that each square meter of horizontal surface in San Diego County intercepts, on average, 5.0 kWh of direct solar energy each day. Converting 5.0 kWh of sunlight into electricity at an efficiency of 10 percent equals an average of .5 kWh of electricity per square meter per day or 182.5 kWh per square meter per year.

All the electricity sold in 2002 in SDG&E' s service area (San Diego County and part of Orange County) for all purposes equals 17.83 billion kWh. Dividing 17.83 billion kWh sold by SDG&E in its service area by the service area's population of 3.09 million equals 5,770 kWh per year per capita or 15.8 kWh per person per day.

Assuming the same consumption level for the 2.9 million San Diego County residents, 2.9 million x 15.8 kWh per day equals 45,820,000 kWh per day. Dividing 45,820,000 kWh per day by .5 kWh per day per square meter equals 91,640,000 square meters. Multiplying 91,640,000 square meters by 3.86 x 10 to the -7 (the constant to convert square meters into square miles) = 35.4 square miles. Dividing 35.4 square miles by 500 square miles of buildings and parking lots = 7.1 percent coverage. In other words, covering only 7.1 percent of the county's buildings and parking lots with solar (PV) panels would produce enough electricity for San Diego County to net meter out electrically. (Net metering out means that solar (PV) panels installed in San Diego County would be pumping as many kWh of electricity into the Western States Grid each year as the grid supplies to our county each year.)

11. To replace all the energy services (40 kWh per capita per day for 2.9 million people) currently supplied to our region by imported electricity, natural gas, gasoline and diesel with solar generated electricity would require 89.6 square miles of solar PV panel coverage. Dividing 89.6 square miles by 500 square miles of buildings and parking lots equals 17.4 percent coverage. (This figure is rounded up to 18 percent in the text.)

Note: Some estimates for the amount of kWh of electricity sold by SDG&E in 2002 are lower than the 17.83 billion kWh I've used in my calculations. If in the final analyses the amount of electricity sold to San Diego County in 2002 is lower than the estimate I'm using, it only means that we would need less than 7.1 per cent coverage of our buildings and parking lots to become renewable energy self-sufficient for electricity.

In addition to making our county energy self-sufficient, covering 20 percent of our county's buildings and parking lots (100 sq. miles) would produce enough electricity to make our county water self-sufficient as well. Assuming only 10 percent efficiency of converting solar energy into electricity, just 8.3 square miles of roof top and parking lots or 1.7 percent, would produce enough electricity to replace all the freshwater used in San Diego County each year (600.000 acre feet) if used to power large scale reverse osmosis systems to convert seawater into freshwater. With large scale reverse osmosis, each kWh will produce 50 gallons of freshwater from seawater. See footnote (37) for details.

12. Covering 36 percent of our county's buildings and parking lots would produce twice as much energy each year as is currently used. At today's costs, this would add an additional $6 billion to our region's economy each year. The $6 billion we return by becoming energy self-sufficient, plus the $6 billion we would earn by selling excess production into the grid would add $12 billion to our local economy each year and $24 billion in new economic activity each year via the economic multiplier benefit.

In other words, the more excess capacity we have to convert free solar energy into electricity, the more money we can make selling energy into the grid. As of this writing, there are California state institutional hurdles to overcome to be an equal player as energy suppliers, but these hurdles, which are largely illogical and anti-free-market, can be changed by working with our local state assembly members and state senators.

13. The 10 percent coverage number assumes that the aggressive pursuit of efficient energy-use improvements could reduce energy consumption in San Diego County by 50 percent with equal or better energy-use services than we have today. If this efficiency level were achieved, we could increase regional economic activity by $24 billion each year by covering only 28 percent of the county's building and parking lots with solar panels. Remember, the 36 percent coverage figure used in footnote (12) assumes no energy-efficiency improvements.

14. The $6 billion figure for the amount of dollars exported each year to pay for imported electricity, natural gas, gasoline, diesel and propane is an estimate derived from the following sources: <u>SAN DIEGO REGIONAL ENERGY PLAN, Volume 2</u>, published in December 1994 by SANDAG. Also see <u>NEWS</u>, Published by the U.S. Department of Labor, Bureau of Labor Statistics, released April 18, 2002, (Consumer Spending Patterns in San Diego, 1999-2000.). With upward volatility in energy costs, this $6 billion figure can rise rapidly.

15. Bell, Jim. <u>Achieving Eco-nomic Security On Spaceship Earth</u>. Ecological Life Systems Institute Inc., December (1995): pp. 6-7. My research shows that if all the health costs related to our dependence on non-renewable energy resources were included when we purchased energy, the price would double. Everyone breathes, drinks and eats the pollution from our present energy system. When we ingest these pollutants they stress our bodies. This is most evident during respiratory distress attacks as with asthma. But because most of these energy production pollutants are also known carcinogens they increase the rate of cancer across the board. Instead of paying these energy costs up front, we pay at the hospital, doctor's office and for health insurance or in just feeling lousy when we could feel good if the air we breathe, water we drink and food we eat were energy production pollution free.

16. “Climate Change Costs Could Top $300 Billion Annually,” Environmental News Service, Feb 5, 2001.

17. Bear in mind that the $6 per capita per day cost for energy used in the text only includes what we pay at the pump and for electricity and natural gas. Not included in this $6 per-day-energy-cost-per-capita estimate is the energy consumed in delivering imported raw materials to our industries and farms or the energy consumed in producing and delivering imported manufactured and agricultural products to our regional markets and ultimately to our homes. If the cost of this energy is included, the $6 dollar per day figure cited could double again. If the environmental costs that come with using fossil fuels and nuclear power are included, the per capita dollar cost will be higher still.

When we add the military costs of keeping imported energy supply lines open, the true-cost of energy climbs even higher. See Amory and Hunter Lovins titled "Winning the Peace," RMI Newsletter, Vol. VII, No. 1, (Spring 1991): p.1. This article showed that the cost of Middle East oil would be $100 a barrel if the military cost of keeping oil supply lines open were included in its price. Bear in mind that this estimate was in 1991.

18. Author's calculations based on data from – State of California, Department of Water Resources. Evaporation from Water Resources in California. Bulletin No. 73-1, State of California, May 1974. With global warming and reduced cloud cover due to fewer storms, evaporation losses are probably increasing.

19. Locating underground tanks in the communities they serve increases community water security. Reservoirs formed by dams are often considerable distances from the population centers they serve. Even if a dam survives a severe earthquake, it is quite likely that the piping system from the dam to where the water is needed will fail. When water is stored in the community it serves, even if piping systems are severely damaged, water can still be pumped out of storage tanks and distributed through temporary pipes and fire hoses until normal delivery systems are repaired. Since fires often accompany earthquakes, community-based water storage would also aid in their control. An added bonus of having community-based tanks could be a reduction in fire insurance premiums. Tank covers also protect stored water from air-borne pollution.

20. Ibid. Around 50 percent of the pollution absorbed by open reservoirs comes from polluted air.

21. An urban network of underground tanks would be less vulnerable to sabotage than the typical open storage system. If a tank or even several tanks were damaged or contaminated, the impact on water security would be less than if a single large reservoir were contaminated or if its containment dam failed. It would require many tanks to store the same quantity of water as is stored in one large open reservoir. Thus it would require the contamination or failure of many tanks to reduce water security to the degree that the failure or contamination of one large reservoir would cause. Their number, distribution, and the fact that they would be covered means that it would be more difficult for one or even a small number of people to contaminate a significant amount of water. With open reservoirs, this is not the case. Covered tanks also reduce the potential for large scale water supply contamination from toxic air pollution, whether released intentionally or accidentally.

22. Covered underground tanks are less vulnerable to earthquakes than are dams. Large impoundment dams are very tall, some over 300 feet, and must be able to totally support the water stored behind them. Additionally, the weight of water behind dams can actually trigger earthquakes. Tank walls are shorter, usually less than 50 feet. The cylindrical shape of tanks also makes them very strong. Additionally, the walls of underground tanks get extra support from the earth that is packed in around them after they are completed. With much smaller volumes of water stored in each tank, it is much less likely that tank storage would trigger an earthquake, especially considering that the water stored in an underground tank will be lighter than the earth removed to accommodate the tank. The removed earth would be processed to reclaim its topsoil, extract sand for beach replenishment, and to repair soil erosion problems throughout our region.

23. When dams are built, they flood large tracts of land behind them.

24. When dams fail, downstream flooding can have catastrophic and life threatening consequences. With underground tank storage this threat is eliminated. If an underground tank fails, the water in storage will be contained by the surrounding earth. At worst, the released water would slowly seep

away. This would give plenty of time to pump the escaping water to another storage facility or to dissipate it safely.

25. Since the earth below ground level is relatively cool (usually around 55 degrees Fahrenheit in temperate climates), underground tanks and the water they contain will also remain close to that temperature. During periods of warm humid air, this air would be drawn into cool tank environments. As the humid air cools, some of the water it contains will condense out and thereby increase the amount of water in storage. While the quantity of water that can be collected in this way is not large, if combined with the water not lost to evaporation, the net gain is substantial. Adding condensed water to storage also improves water quality. Water condensed out of the air contains no minerals and thus would improve the quality of the water in storage by diluting its mineral concentration.

26. The technology for the construction of large underground water storage tanks is already well established. In fact, DYK Prestressed Tanks INC., based in El Cajon, builds underground water storage tanks all over the world. The number of tanks, their capacities, and their locations would depend on a community's geology, topography, population, population distribution and the desired level of water security. The more tanks a community builds, the more water-secure they will be. Since tank covers are supported structurally by columns, the areas over them can be used as parks and community gardens and for recreational activities like tennis, basketball, baseball, and soccer, or any combination of the above, depending on community choice.

27. Although residential water use accounts for only about 8% of the water used in the United States, from an ecological security perspective it is important to use water more efficiently on every front. Using residential water more efficiently also makes good economic sense. This reality has many municipalities and agencies getting on the efficiency bandwagon. In the San Diego County part of our region some water agencies offer rebates, $75 for ultra-low-flow toilets and $125 for efficient clothes washers. Call your water agency for details. The City of Glendale in Arizona passed an ordinance that gives residents up to a $100 cash rebate for installing low-flow toilets (1.6 gallons or less). This is because city leaders realized that rebating toilets was much less expensive than increasing water supplies and sewer capacity. The California Department of Water Conservation estimates "that installing a low-flow toilet can save a family of four $25 to $50 a year on water bills." The producers of Consumer Reports magazine reported an even larger savings potential. "By our own calculations, an average family that uses municipal water can save as much as $50 to $75 per year on water and sewer bills by switching to low-flow showerheads and low-flush toilets." In addition to saving money on water, low-flow showerheads and water efficient appliances also save on energy costs. Just changing from a 6 gallon-per-minute to a 2 gallon-per-minute showerhead can save more than half the energy used in a home to heat water. This can be as much as $50 per year. Faucet restrictors, automatic shutoff faucets, and water-efficient appliances can also save water and energy. Faucet flow restrictors and automatic shutoff faucets can cut the use of sink water in half while reducing energy consumption for water heating. State-of-the-art washers and dishwashers use only 70 to 75 percent of the water and energy consumed by less efficient models. The Staber System 2000 washing machine uses only half the water and the energy of similar models. If all the efficiency measures just described were in general use, household water consumption in the U.S. could be reduced by 70% or more. Water use can be further reduced through the use of dry or composting toilets. Composting toilets come in a variety of designs ranging from the old-fashioned outhouse to the modern chambered versions installed in bathrooms. In these toilets, wastes are composted and the composted residues are periodically removed and used as fertilizer. These modern systems usually include a port for adding kitchen scraps that are composted along with toilet wastes. Sawdust or other similar material is added after each use

to control odors. Some composting toilets work better than others so do your homework if you are considering a purchase.

Climate-appropriate landscaping can significantly reduce residential water use. In low- rainfall areas, the amount of water used for residential landscape irrigation can average 50 or more gallons per day per capita. The use of water-efficient irrigation equipment and landscaping strategies and plants that are climate suitable, can greatly reduce this requirement. Efficient water use in landscaping does not mean that landscaping themes have to be sparse. Even in arid areas, there are numerous beautiful plants from which to select. Nor does such a strategy preclude having a vegetable garden, fruit trees, or grass. Reducing water use in other parts of a landscape, coupled with gray-water use frees up water for these purposes.

If climate-appropriate landscaping is combined with water-efficient irrigation equipment, even more water can be saved. Water-efficient irrigation equipment ranges from various drip irrigation systems and low flow drip emitters and sprinklers to sophisticated irrigation control tools called tensiometers. Tensiometers are electronic devices that are installed in the soil where they measure soil moisture content. They can be read and water applied accordingly or they can be used to activate automated irrigation systems when water is needed.

As far as climate appropriate plants to choose from, there are literally hundreds of attractive drought-tolerant trees, shrubs, vines, and ground covers that can be included as part of a low-water-use landscape palette. Additionally, there are numerous drought-tolerant plants that produce food and other useful materials. These plants include the California black walnut tree, the fig family, the oriental persimmon, the quince tree, members of the grape family, the guava family, loquat trees, aloe, bamboo, and many more.

Even modest efforts toward coupling water-efficient irrigation systems with climate-appropriate plants in landscaping could cut irrigation requirements in low-rainfall areas in half. If climate appropriate plants are used exclusively, irrigation requirements can be reduced to zero after plants become established. If gray-water recycling systems are incorporated, even relatively water-intensive landscapes can be successful without using potable water for irrigation.

28. Changes in operational strategies and manufacturing processes can increase efficient water use even more. In 1978, U.S. manufacturing industries used each unit of water 3 to 4 times before it was discharged. It was predicted at the time that by the year 2,000 the water-reuse rate for industry would have increased to over 17 times before discharge. As of yet my research has not turned up any studies to confirm that prediction, but in a telephone conversation an EPA water expert said that industrial water recycling has increased substantially since 1978 but he did not have a definitive study that gave actual numbers.

Even in the 1980's, some innovative firms were already approaching or exceeded this 17 time reuse level of efficiency. Pioneer Metal Finishing, a plating firm in New Jersey, exceeded this goal by developing a water recycling process that totally eliminates sewer discharge. In the Pioneer process, all water is recycled and most of the chemicals and metals extracted from it are reused. Pioneer is now looking for a use for the small quantity of dry residue left over from their recycling operation. "Armco steel mill in Kansas City, Missouri, which manufactures steel bars from recycled ferrous scrap, (scrap iron and steel), draws into the mill only 9 cubic meters of water per ton of steel produced, compared with as much as 100-200 cubic meters per ton in many other steel mills—the Armco plant uses each liter of water 16 times before releasing it after final treatment, to the river." "One paper mill in Hadera, Israel, requires only 12 cubic meters of water per ton of paper (produced), whereas many of the world's paper mills use 7-10 times this amount."

Water use in industry can also be cut by using non-chemical water treatment processes to prevent biological fouling and water-scale buildup in boilers, water lines, and cooling systems. Non-chemical water treatment consists of exposing water to magnetic and electrostatic fields to prevent mineral scale from attaching itself to pipes and other metal surfaces and to remove such deposits where they already exist. Non-chemical treatment also creates an environment hostile to the growth of water-borne bacteria, fungus, and algae.

The buildup of scale and bacterial slime reduces the efficiency of heating and cooling systems by restricting water flow rates and by insulating heat exchange elements. A 1/16- inch-scale buildup requires 15% more fuel to achieve the same heating results. A 1/4-inch-buildup increases fuel consumption by 39%.

In the U.S., chemicals have been the predominant method used for treating such problems. But chemical treatments are labor and material intensive because they need regular chemical mixture adjustments. Maintenance is also high because chemical treatments reduce the rate of scale buildup but do not prevent it. This means that heating and cooling systems have to be drained and manually cleaned on a regular basis. Additionally, all the water in chemically treated systems must be periodically purged because evaporation losses increase the concentrations of chemicals and minerals beyond acceptable levels. This purging wastes water and releases treatment chemicals like algaecides, fungicides, bactericides, and phosphates into the environment.

Non-chemical treatment minimizes or avoids most of these problems. Although they have been slow to catch on in the U.S., non-chemical treatment systems have been the preferred treatment choice in Europe and in the Russian Commonwealth for decades. But this is changing as is evidenced by the numerous high-profile firms like Kodak, IBM, Hewlett Packard, Ford Motors, Holiday Inn, Pepsi Cola, Coca Cola, Marriott, and Bantam Books that have already switched to non-chemical treatment processes.

29. Bell, Jim. Achieving Eco-nomic Security On Spaceship Earth. Ecological Life Systems Institute Inc., December (1995): p. 84. Today, the most prevalent form of irrigation in the world is to periodically flood fields with water. This form of irrigation is inexpensive to establish where land is flat but is it is not particularly efficient. This is because a large percentage of water will run off fields unless they are perfectly level, (little land is) before it has time to soak into the soil. In porous soils, substantial quantities of water can be lost because it percolates to underground levels beyond the reach of plant roots. If this water returns to the aquifer from which it was extracted, this can be positive but not if the water becomes contaminated with pesticides, chemical fertilizers and salt along the way. Sprinkler systems are generally more water-efficient than flooding because the amount of water applied and the evenness of its distribution is more easily regulated. On the negative side, sprinkler systems are expensive to install and maintain. Sprinkler systems also increase the amount of water lost to evaporation. Water evaporation is increased as it is dispersed in small droplets through the air and as water sits on plant foliage. Such losses can be avoided to a large extent if sprinklers are used at night when the humidity is usually higher than during the day.

The efficiency of large sprinkler systems can also be enhanced by attaching "drop tubes" to sprinkler arms. To reduce evaporation losses, drop tubes deliver water closer to the ground and in large droplets. The efficiency of flooding and sprinkler systems can be improved if fields are precisely leveled. Laser technology can be used to guide farm equipment to insure accurate leveling.

Drip irrigation, a technology developed in the 1960s in Israel, is a further advancement in the efficient use of water for growing plants. This method delivers water directly to each plant by means of small tubes that supply just enough water to saturate plant root zones. Other drip technologies include soaker hoses and various specialized emitters suitable for different crops. Soaker hoses, for example, are good for many row crops because they weep water along their whole length. Drip irrigation devices can be used on the surface, on the surface below mulch, or below the surface depending on plant requirements. Losses to evaporation can be almost completely eliminated when emitters are installed below mulch or beneath the soil surface.

While drip equipment is relatively costly, increased crop yields coupled with money saved by reducing water consumption can result in a quick payback on the investment. In Israel, where drip systems are used to “supply water and fertilizer directly onto or below the soil...experiments in the Negev Desert have shown… yield increases of 80 percent over sprinkler systems.”

Computer technologies are also being mobilized to increase water-use efficiency in agriculture. One device called a tensiometer measures the moisture content of the soil and the amount of moisture in the soil that is actually available to plants. This second feature is important because some soils, like those with a high clay content, are so absorptive that they do not give up the water they hold easily to plants. Sandy soils, on the other hand, do not hold water like clay soils. They may have a relatively low moisture content but almost all the moisture in a sandy soil is available to plants. When tensiometers sense that the moisture content of a particular soil is too low to meet plant needs, they activate an automated irrigation system. Tensiometers can also be read manually for more low-tech applications.

Automated irrigation systems can be programmed so that irrigation water is only applied at night to minimize losses to evaporation. Automated systems can also be designed to detect leaks, compensate for wind speed, control the application of fertilizer, and optimize the effect of the fertilizer used. Though they are costly to install, such “systems typically pay for themselves within 3 to 5 years through water and energy savings (using less water means that less energy is needed for pumping) and higher crop yields.”

Another development in the efficient water-use arsenal is to combine water-efficient technologies with weather monitoring programs. The University of Nebraska’s Institute of Agriculture and Natural Resources has developed a computer program called “IRRIGATE” that compiles information gathered across the state of Nebraska from small weather stations. By calling a telephone hot line, farmers can “find out the amount of water used by their crops the preceding week, and then adjust their scheduled irrigation dates accordingly.” The California Department of Water Resources is involved in a similar program called the California Irrigation Management System or CIMIS. The aim of CIMIS is to save 740 million cubic meters of water annually by the year 2010. (740 million cubic meters equals a little more than 600,000 acre feet or about the same amount of water used in San Diego County today.) Like Nebraska and California, Wisconsin has developed its own system of weather monitoring to assist farmers. This system, which is called the Wisconsin Irrigation Scheduling Program (WISP), is managed by irrigation specialists through the University of Wisconsin.

30. Ibid.

31. Ibid.

32. Growing climate-appropriate crops is another way to use water more efficiently in agriculture. With water-efficient cropping, the water requirements of a particular crop should be reasonably close to the natural precipitation that could be expected in the climate zone where it is grown. Irrigation could still be used, but only to even out yearly rainfall totals and as a way to supply water during periods when rainfall is below normal.

To date, research in the development and use of low-water-use crops has been poorly funded. The dollars that are spent are usually spent on water conservation, but mostly to reduce the water consumption of existing crops. Nevertheless, there are a number of promising plants now being grown, some commercially and others experimentally. Sweet sorghum, for example, is already widely grown. It requires a third less water and half the fertilizer required by corn to produce a crop and sweet sorghum is an excellent animal food. Currently, most of the corn grown in the U.S. is used for animal feed. According to Steve Staffer, an alternative crop expert with the California Department of Agriculture, sweet sorghum can also outperform corn as an energy crop. An acre of corn can be processed into 360 gallons of ethanol. Processing an acre of sorghum can produce 600 gallons. Staffer estimates that by growing low-water-use plants like sorghum, "California could produce 25% to 30% of its energy needs, without affecting our price of food".

Given Staffer's projections, producing ethanol from sorghum alone could more than supply all the energy needed in California today if the efficiency measures described earlier were in place.

Other promising low-water-use crops include:

<u>Canola</u>, a seed bearing plant, which is used to produce one of the healthiest cooking oils around. Canola requires a fraction of the water needed by many other crops grown in the Sacramento, California region;
<u>Buffalo Gourd</u>, a perennial that is native to the Mojave Desert, has seeds that can be processed into lubrication oil and a starchy root that can be used to make alcohol;
<u>Guayule</u>, a plant that yields rubber;
<u>Kanaf</u>, an African plant which can be used as food, clothing fiber, packing material, carpet backing, and as high quality newsprint that is so absorbent that the hands of newspaper readers stay clean;
<u>Tepary bean</u>, a drought-tolerant high-yield food crop that contains as much if not more protein than most edible legume crops;
<u>Hemp</u>, though much maligned, is an energy, fiber, food, resin, soil-improving and medicinal crop. Its seeds produce some of the world's healthiest, most easily digested plant oil and protein and are used in many health food products. Hemp was praised and grown by founding fathers like George Washington and Thomas Jefferson. It was also grown during World War II as an essential fiber in support of the war effort. Hemp is currently grown commercially in 24 countries including Canada, China, France, Britain, Germany and Spain.

While the strategies discussed above to reduce water consumption in agriculture may seem obvious, they are not necessarily used. This is because farmers who benefit from federal subsidies, which allow them to purchase water at rates as low as 1/10 the price that urban dwellers pay, have little incentive to invest in efficient water-use strategies or grow more climate-appropriate crops.

In his book <u>Cadillac Desert</u>, Marc Reisner points out that such subsidies lead us into absurd *Alice in Water Land* situations. In 1986, four low value crops grown in California (pasture [grass and hay], alfalfa, cotton, and rice) consumed 5.3, 3.9, 3.0, and 2.0 million acre feet of water respectively.

Added up, this is almost three times as much water as was consumed by the 27 million people living in California at the time, including all the water they used to irrigate landscapes and keep swimming pools full. Note: California's population today (2004) is over 38 million.

Even if all these low-value crops were totally discontinued and no more water-efficient crops were grown in their place, the economic loss to the state would be less than one third of one percent of California's yearly economy.

Additionally, if we converted a little more than half the land now used just to grow grass and hay to grapes or other specialty crops with a similar or greater dollar value, the economic loss would be erased. Grapes require roughly the same amount of water per acre as grass and hay pasture. Plus, eliminating pasture irrigation for the remaining land would double the water available for urban uses. This is a perfect example of how the lack of true-cost pricing promotes practices that are not in anyone's long-term interest. Even farmers, whose over-irrigated soil is becoming increasingly unproductive, as salt and other minerals are concentrated, will win.

A parallel aspect of growing low-water-use crops is related to the production of meat. Currently, "Over half the total amount of water consumed in the United States goes to irrigate land growing feed for livestock." To put this fact into perspective, a 50% reduction in the production of livestock nationally would free up almost twice as much water as is currently used in the U.S. domestically, commercially, and by industry combined. Though the production of meat in all its forms is water intensive, growing beef requires the most water. It takes approximately 2,500 gallons of water to produce a pound of beef (some water-use estimates are much higher). Given this 2,500 gallon figure, it takes up to 100 times more water to produce a pound of beef than it does to produce a pound of wheat. Rice requires more water than any other grain, yet rice requires only a tenth as much water per pound as meat.

33. Primarily, this is because local farmers have been paying much higher prices for water than their Imperial Valley and Central Valley competitors.

34. In some states, home gray-water recycling is illegal. (Check with local health officials) The reason for this prohibition is that gray water may be contaminated by harmful bacteria, viruses and parasites. Contamination can occur in a number of ways, such as washing diapers at temperatures too low to kill harmful organisms, or from the small amounts of fecal material that is washed off our bodies when we bathe. For this reason, gray water that has not been disinfected should not be used to directly water vegetable parts that are to be eaten raw or on lawn areas where direct human contact is likely. Although the use of gray water could be potentially harmful, it's worth noting that health officials I consulted knew of no documented case of illness caused by gray-water use even though it is used by millions of people to one extent or another just in California. During times of drought, gray-water recycling has been encouraged by state officials.

Since there is a small possibility that diseases could be transmitted by gray-water contact, gray water should be used carefully. Gray water can be used safely to water fruit and other trees, or in landscaping. It can also be used for vegetables if it is applied sub-surface with a soaker hose or by some other sub-surface system. Sub-surface application is the most preferred way to use gray water because direct exposure to gray water is eliminated and soil organisms kill pathogens.

Soaker hoses can also be used with relative safety on the surface in gardens since water applied by them does not splash onto the edible parts of plants. Although the uptake of pathogens by root crops does not take place, root crops watered with gray water should be carefully washed and/or well cooked before they are consumed.

To maximize safety, gray water can be disinfected before it is applied. Historically, water has been disinfected by adding chlorine. Chlorine does disinfect but its use can also result in the creation of compounds like chloramine. Chloramine, which is toxic to soil and aquatic organisms, results when chlorine reacts with the carbon in water-borne organic materials. If the level of organic materials is low, the amount of chloramine created is small. But if the organic load is high, the amount of chloramine produced becomes a problem. Chlorine is also toxic to soil and aquatic organisms but it dissipates faster than chloramine.

If water is disinfected with ozone, this problem is avoided. Ozone, a form of oxygen that links three atoms of oxygen together, is even more effective at killing pathogens than chlorine and does not cause harmful side affects. It can also break down many organic pollutants and can be used to remove heavy metals through a process of precipitation. Though the adoption of ozone water treatment systems in the U.S. has been slow, ozonization has replaced chlorine in 99% of the swimming pools in Western Europe.

Soaps containing phosphates can also be used without negative consequences in most gray water recycling situations. Phosphate is a much-maligned nutrient because it stimulates aquatic plant growth in lakes and waterways. These plant “blooms” can cause fish to die from suffocation. At night, aquatic plants need oxygen which they extract from the water. If the number of aquatic plants in a volume of water is excessive, oxygen levels can drop below levels that can support fish.

Excessive plant growth also threatens fish with suffocation when plants die in the autumn. With large quantities of dead plant material available, decay bacteria multiply rapidly. These bacteria require oxygen and can quickly reduce the oxygen content in a body of water to levels below which fish can survive. In soil, however, phosphate (unless too concentrated) is a nutrient readily usable by plants and needs only to be avoided if there is a possibility that the phosphate will enter a waterway instead of becoming part of a terrestrial plant system.

35. The complete Ecoparque treatment cycle takes less than 30 minutes.

36. Another potential system that fits the limited land and low evaporation needs of our region has been developed by John Todd. Todd’s system uses translucent tanks inside greenhouses to maximize decomposition of organic solids. The nutrients released through this process are taken up by plants through photosynthesis. As the wastewater flows through a series of semi-transparent tanks a complex community of aquatic plants and animals purify the water by consuming and converting the organic waste into animals and plants (biomass). At the end of the process, the clean water can be used for irrigation or it can be safely discharged into streams. In addition to water, the process also produces a crop of fish and other aquatic organisms and aquatic plants that can be composted and used as a soil amendment. This system will work well in our region if its greenhouse enclosure is designed to capture evaporated water and return it to the system.

37. Large scale reverse osmosis systems produce 50 gallons of freshwater from seawater per kWh of electricity consumed. To produce 600,000 thousand acre feet of water each year (San Diego County's current use) from solar generated electricity would require 8.3 square miles of solar panels using the

same assumption described in footnotes (10), (11), (12) and (13). Calculations – currently San Diego County uses 600,000 acre-feet of water each year. Six hundred thousand acre feet of water x 43,560 cu. feet per acre foot = 2.6 x 10 to the 10th power cu. foot of water x 7.48 gallons of water per cu. foot = 1.96 x10 to the 11th power gallons of water divided by 50 gallons of freshwater from seawater per kWh of electricity consumed = 3,909,945,600 kWh per year divided by 365 days per year = 10,712,180 kWh average per day divided by an average of .5 kWh of electricity produced per square meter each day = 21,424,360 square meters x 3.86 x 10 to the -7th power (the constant to convert square meters into square miles) = 8.3 square miles. Eight point three square miles is less than 2 percent of the 500 square miles of land in San Diego County already covered by buildings or parking lots.

38. www.floatinc.com.

39. These figures assume a historic rainfall average (including melted snow) of 18 inches per year and the collection of only half of the coastal watershed runoff, or 50 percent of 18 inches. If collected and stored in underground water storage tanks, it would be enough water to supply a 6-million-person San Diego/Tijuana region with 53 gallons of water per person per day.
This 53-gallon figure is based on the assumption that:

+ The total area encompassed by the Tijuana/San Diego Region's coastal watersheds is 6,220 square miles or 3,980,800 acres.
+ The average rainfall over this whole area is 18 inches per year. (Historic yearly rainfall in the region ranges from around 10 inches along the coast to 40 inches plus in the higher mountains.)
+ 12 percent of the region's yearly average rainfall of 18 inches runs off into the ocean or is captured behind dams.
+ Only half of this runoff (6 percent of the region's historic average rainfall) can be collected from the 3,980,800 acres that make up the region's coastal watersheds without causing unsustainable trauma to the region's (plant and animal) watershed communities.

In addition to the 53 gallons per capita per day that could be collected from watersheds, another 21 gallons per capita per day of runoff can be collected from impervious surfaces like rooftops, parking lots, paved playgrounds, driveways and patios. When rain falls on these surfaces, close to 100 percent of it can be collected. (This 21-gallon-per-capita figure is based on impervious surface estimates derived by the author from data published 3/29/94 in SANDAG/SOURCEPOINT taken from "Source: Series 8 Regional Growth Forecast." Note: Road and freeway surfaces are not included in the calculations as potential collection surfaces.)

Obviously, water collected from parking lots and driveways would need to be filtered for most uses. Even water from rooftops, patios, and paved playgrounds would need filtration. Filtering can be expensive, but if coupled with a good watershed education program, its cost can be greatly reduced. A good watershed education program can improve the quality of the water collected from impervious surfaces markedly. As more people come to understand how their activities affect the water they drink, they will be much more conscious about releasing pollutants that will end up in it.

In addition to collecting rainwater from watersheds and impervious surfaces, there is around 100,000 acre-feet of water that can be extracted sustainably from the region's groundwater supplies each year. If these resources are developed, it would add another 15 gallons per capita each day for the projected regional population of 6 million people. Adding these three sources together (53 gal. + 21 gal. + 15 gal.) indicates a water supply of 89 gallons per capita per day for 365 days a year for a 6 million person population.

If 80 percent of this water is recycled after it is used, it would supply another 71 gallons per capita per day for irrigation. This 71 gallons added to the 89 gallons that could be collected, adds up to a total per capita water-use allowance of 160 gallons of water per capita per day. The per capita water used in the San Diego part of the region today is around 180 gallons per day for all purposes, (residential, commercial, industrial, and for agriculture).

40. Conversation with hydrology faculty at SDSU and UCSD.

41. Author's calculations based on the facts and assumptions presented.

42. Ibid.

43. Conversation with hydrology faculty at SDSU and UCSD and the author's calculations based on the facts and assumptions presented.

44. Author's calculations based on the San Diego County Water Authority 2001 Annual Report. p.14, and SANDAG population statistics for 2001.

45. Author's calculations based on an average of .5 kWh of electricity per square meter per day of horizontally mounted solar (PV) cells and the production of 50 gallons of freshwater from seawater per kWh of electricity consumed by large scale reverse osmosis systems.

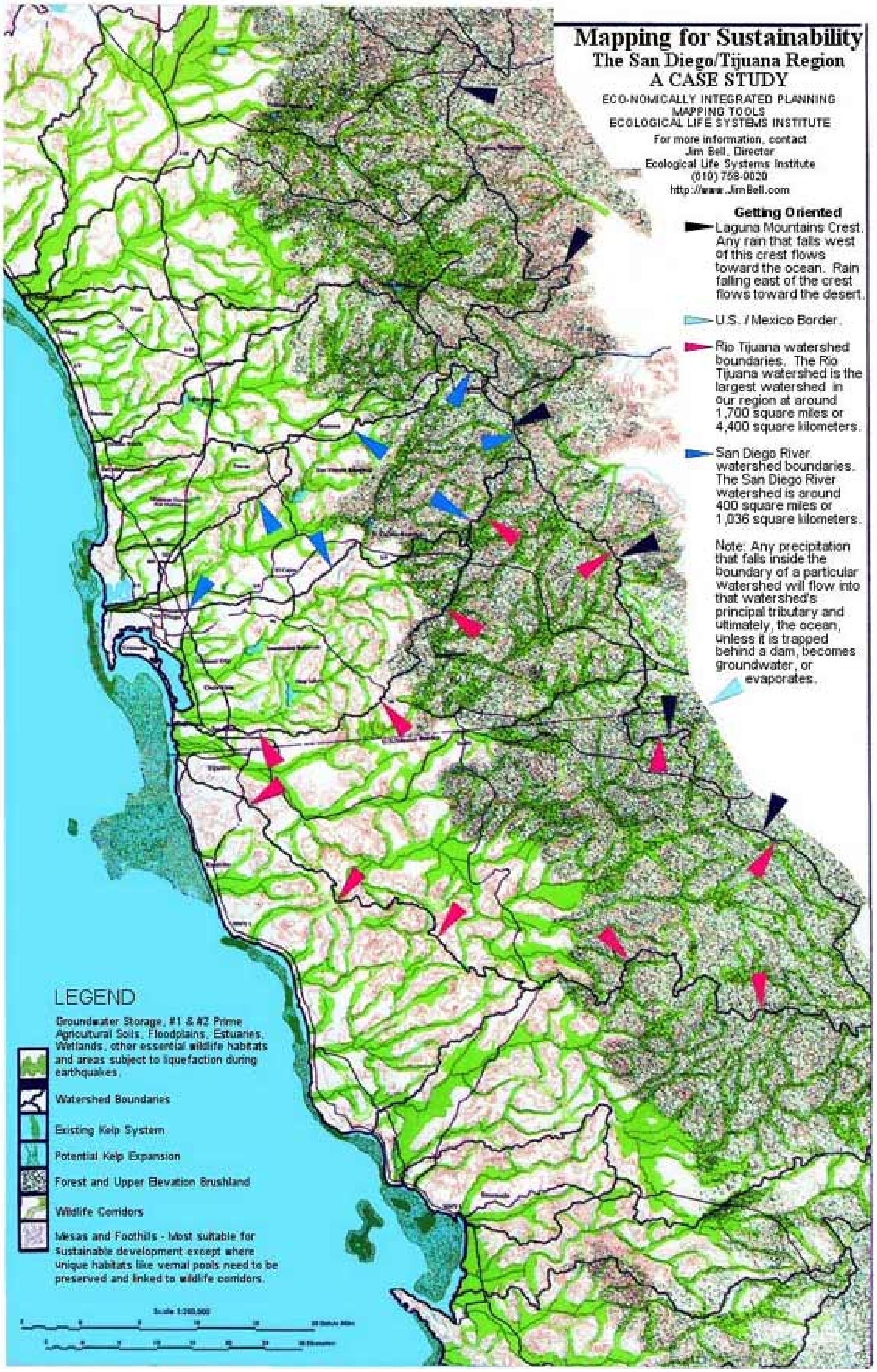
46. www.floatinc.com, www.poemsinc.org

47. Author's calculations based on maps and data published by the U.S. Department of Agriculture. Soil Survey – San Diego Area. U.S. Department of Agriculture, Soil Conservation Service, in cooperation with the University of California Agricultural Experiment Station, U.S. Department of the Interior, Bureau of Indian Affairs, Department of the Navy, United States Marine Corps. Issued December, 1973.

48. Bell, Jim. Achieving Eco-nomic Security On Spaceship Earth. Ecological Life Systems Institute Inc., December, (1995): p. 43.

49. Ibid. p. 49.

50. See footnote (29) for details.



Mapping for Sustainability
The San Diego/Tijuana Region
A CASE STUDY
ECO-NOMICALLY INTEGRATED PLANNING
MAPPING TOOLS
ECOLOGICAL LIFE SYSTEMS INSTITUTE
For more information, contact
Jim Bell, Director
Ecological Life Systems Institute
(619) 758-0020
http://www.JimBell.com
Getting Oriented
Laguna Mountains Crest. Any rain that falls west of this crest flows toward the ocean. Rain falling east of the crest flows toward the desert.
U.S. / Mexico Border.
Rio Tijuana watershed boundaries. The Rio Tijuana watershed is the largest watershed in our region at around 1,700 square miles or 4,400 square kilometers.
San Diego River watershed boundaries. The San Diego River watershed is around 400 square miles or 1,036 square kilometers.
Note: Any precipitation that falls inside the boundary of a particular watershed will flow into that watershed's principal tributary and ultimately, the ocean, unless it is trapped behind a dam, becomes groundwater, or evaporates.
LEGEND
Groundwater Storage, #1 & #2 Prime Agricultural Soils, Floodplains, Estuaries, Wetlands, other essential wildlife habitats and areas subject to liquefaction during earthquakes.
Watershed Boundaries
Existing Kelp System
Potential Kelp Expansion
Forest and Upper Elevation Brushland
Wildlife Corridors
Mesas and Foothills - Most suitable for sustainable development except where unique habitats like vernal pools need to be preserved and linked to wildlife corridors.

Mapping for Sustainability

One of the most fundamental aspects of creating a sustainable economy lies in how we answer the question:

Where is it appropriate to do what?

Where are the best places to site our cities? What land should be set aside for agriculture and for wildlife habitat? How can we use hazardous areas like floodplains and other geologically unstable lands, safely and productively?

Map Description

The Mapping for Sustainability Map is designed to answer these questions for the San Diego/Tijuana region specifically and to serve as an example of how such maps can be used to develop sustainable economies in any region around the world.

What is a watershed?

Watersheds or drainage basins are landforms that are shaped by and direct the flow of rainwater and snow melt on their path to the ocean. From countless raindrops, to billions of rivulets, to millions of streams, to thousands of creeks, and finally to hundreds of rivers, unrelentingly gravity pulls water runoff to the sea. The Amazon River watershed, the world's largest, is larger than most countries. The Mississippi River watershed, the largest watershed in the U.S., is larger than the land area of California, Arizona and Nevada combined. By comparison, our region's coastal watersheds are tiny. But, to live here sustainably, it is essential that we understand how they work and how we can maximize our benefit from them in ways that are completely sustainable. The total area covered by the coastal watershed boundaries encompassed on the map is approximately 6,200 square miles or 16,058 square kilometers.

Watersheds as planning units

Watersheds are important to planning because they direct the flow of water and any water-borne pollution. Watersheds are also semiautonomous ecological communities. Though there is considerable interaction between the ecologies of adjacent and even distant watersheds, (some birds and animals migrate great distances), most of the life in them is native or indigenous. Natural watershed communities are inherently valuable as unique examples of life's complexity, beauty, mystery and tenacity and if healthy, they benefit our human community in profound and practical ways. For example, healthy watershed communities maximize the creation of fertile soil. When plants and animals die or when animals eliminate wastes or plants loose their leaves, soil organisms convert them into soil. Healthy watershed communities also protect the soils they create from erosion. Plant foliage and dead plant debris protect the soil from pounding rain and water runoff. Root systems in concert with tunneling organisms make it easier for water to be absorbed into the soil. In the soil, water is used by plants or becomes groundwater that emerges as springs or is stored in groundwater basins. Healthy watershed communities help minimize flooding by absorbing rainwater and snowmelt runoff for slow release via springs and groundwater recharge.

Getting oriented – Watershed boundaries

Look for the black arrows to find the Laguna Mountains Crest. Any rain that falls west of this crest flows toward the ocean. Rain falling east of the crest flows toward the desert. The light blue arrow indicates the U.S.-Mexico Border. Straddling this border is the Rio Tijuana watershed, indicated by the red arrows. The Rio Tijuana watershed is the largest watershed in our region at around 1,700 square miles or 4,400 square kilometers. The San Diego River watershed, indicated by the dark blue arrows, is around 400 square miles or, 1,036 kilometers by comparison.

Principle resources and hazards

The large solid green areas (see map Legend) represent a composite of the region's most important resources and its major hazards. They include our region's:

+ Number 1 and 2 prime agricultural soils.
World population is still increasing. The depth, fertility and acreage of our world's agricultural soils are declining. Preserving our region's agricultural soils is our best insurance to be able to feed ourselves in the future. Since we currently import up to 90 percent of our food, we are vulnerable to the failure of crops from where we import them or the failure of transport systems to deliver the crops to us. Although the map only includes # 1 and # 2 soils, given the world situation, we should protect the majority of our # 3 and # 4 soils as well.

+ Key wildlife habitat areas and their linkages.
As discussed earlier, protecting and even expanding wildlife habitats and their linkages is vital to our region's watershed health and therefore our region's economic health.

+ Principle groundwater storage basins.
If we don't pollute it or extract groundwater faster than its natural recharge rate, groundwater is a renewable resource that will serve us forever.

+ Major floodplains.
Developing floodplains is just plain stupid. Floodplains flood. They also liquefy, (turn into mush) during earthquakes. Some floodplains in our region are especially vulnerable because they have dams holding back large water storage reservoirs upstream. If any of these dams fail in an earthquake, a flood of water, mud, rocks and other debris would devastate whatever the earthquake left standing on downstream valley floors.

Forests and upper elevation brush lands

(See map legend). These areas are where most of our coastal watershed precipitation falls. As such, their health is essential to the general well being of humans and the life support system that supports us. This given, development in forested and upper brush land areas should be clustered around existing communities but not in floodplains and not on our region's best agricultural soils. Not only does this make it easier to maintain watershed health and ensure food security, it also saves money because it greatly reduces the cost of creating and maintaining roads, sewers and other infrastructural elements associated with sprawl. Additionally, sprawl hurts watershed health because it cuts the land up with roads, utilities and fences. Clustering leaves most forest and brush lands open for wildlife and for human activities like hiking, camping and other recreational activities for forest and brush-lands residents and the public at large.

A study sponsored by Bank of America titled BEYOND SPRAWL: New Patterns of Growth To fit The New California, published in January 1995, shows that though sprawl may make money for developers, it actually drains money away from already developed communities to create and maintain the infrastructure that sprawl generates.

Existing kelp beds and their expansion

(See map legend) Kelp forests grow along our coast and along the coastlines of many countries where they are periodically harvested. KELCO is our local harvester. And unlike most things we harvest, kelp is harvested sustainably. Once harvested, kelp is processed to extract algin and other commercially valuable products. Algin, the primary product, is the smooth in ice cream, the foam in beer, an ingredient in numerous food and health care products and has uses in the textile industry. The residues of kelp processing can be used in a 2-stage process to produce methane (natural gas) and an excellent fertilizer. Kelp in our region grows by attaching itself to rocky reefs at depths of 40 to 100 feet. At depths greater than 100 feet, there is insufficient sunlight to support kelp growth. At depths less than 40 feet, wave action makes it difficult for kelp plants to become established. Kelp gets its nutrients from upwelling currents that bring nutrient rich water from the ocean's depths to the surface. In addition to the uses cited above, kelp is valuable to our economy and well being in other ways. For example, kelp is the foundation of the coastal food chain: the more kelp, the more fish, lobsters, abalone, etc.

Sometimes, normal upwelling nutrients are reduced because of changing ocean currents like El Niño and La Niña. To the degree this happens, kelp production declines. If nutrient reduction is severe, kelp forests can shrink dramatically. This can be overcome by using wave power to pump nutrient-rich water from a depth of a thousand feet to kelp forest stands when natural upwelling is insufficient. Since we would be pumping water through water, very little energy is required to pump large quantities of nutrient-rich water to the surface.

Kelp production can be increased even more by placing waste concrete rubble like the foundations and the slabs of demolished buildings next to existing reefs. As reefs are enlarged, kelp plants will colonize them, expanding kelp production and all the benefits that come with it.

Using Mapping for Sustainability as a teaching tool

Mapping for Sustainability is designed to help people understand the principles of sustainable land-use planning. Creating a sustainable future requires the preservation of watershed health and vital human support resources like agricultural soils and groundwater storage basins. It also depends on using the region's hazardous lands like floodplains in safe, productive and sustainable ways like for parks, wildlife habitats and organic agriculture. The better these principles are understood and followed, the easier it will be to develop an economy and way of life that is completely life-support sustaining in our region and ultimately planet-wide.

As a transparency, the map can be placed over maps of the same scale that show existing and proposed development. This overlay will show past land-use mistakes and help us correct them and avoid similar mistakes in the future. This knowledge is also a prerequisite to restoring land misused in the past to its former state of health and sustainable productivity.

Jim Bell – A Brief Biography

Professional Life

Jim Bell is an internationally recognized expert on life-support-sustaining development. His projects include the design and construction of the San Diego Center for Appropriate Technology and Ecoparque, a prototype wastewater recycling plant in Tijuana, Mexico that converts sewage into irrigation water and compost. He also worked as a consultant for the Otay Ranch Joint Planning Project and the East Lake Development Company. He has also served as the ecological designer for a life-support-friendly hotel for Terra Vista Management and for the recently completed Ocean Beach People's Food Cooperative's new "green" store. Jim has more than 40 years experience in the design and construction industry.

As a lecturer, Jim speaks to many groups each year. His lecture credits include the AIA California State Conference, the Society for International Development's World Conference in Mexico City, and keynote addresses at the University of Oregon's first "Visions for a Sustainable Future" conference and the State of Oregon's Solar Energy Association Conference. Jim is often interviewed on television, radio, and by the written press and has been a guest on National Public Radio's "Talk of the Nation."

His honors include: The Society of Energy Engineers’ Environmental Professional of the year for the Southwestern States, a "Beyond War" award, and a City of San Diego Water Conservation Design Award for one of his projects.

Political Involvement

In 1996, 2000 and 2004 Jim ran for Mayor of San Diego. He ran for the 2nd District City Council in 2002. Though he has not yet been elected, his ideas relating to making our region as energy, water and food self-sufficient as possible, as soon as possible are being embraced by an increasing number of elected officials and planners. Jim also served on Mayor Murphy's Environmental Task Force and SANDAG’S Long Range Planning Group.

Work History

During high school, Jim helped support his family by working as a gardener, ditch digger and as a carpenter's helper. During and after college he worked as a carpenter. During the late 60s and early 70s Jim became concerned about the impacts of human activities on the environment and our quality of life. He became increasingly convinced that there were "smarter" ways to conduct our lives and build our communities that would minimize negative impacts. Toward this goal, starting in 1974, Jim pursued a career as an Ecological Designer, and as a public lecturer on the principles of Ecological Design. He is the author of Achieving Eco-nomic Security On Spaceship Earth and numerous other articles and papers on creating sustainable economies

Working with People

Jim has served on the Board of Directors of the San Diego Ecology Center, I Love a Clean San Diego, Environmental Health Coalition, and the California Association of Cooperatives. Currently, he serves as Director of the Ecological Life Systems Institute and the San Diego Center for Appropriate Technology. He's also a Board Member of Ocean Beach People's Food Coop and has recently been working with the San Diego Apollo Project.

Family History

Jim was born in Wilmington, North Carolina in 1941. His family moved to Long Beach, California in 1943 and to San Diego in 1951. Jim has lived in San Diego ever since.

Education

Jim attended Chesterton Elementary School, Montgomery Junior High School (in Linda Vista, 7th and 8th grade), Grossmont High School (9th – 11th grades), and graduated from El Capitan High School in 1960. He attended Palomar College and Long Beach State University. He graduated from SDSU in 1985 with a Bachelors Degree in Art and Art Sciences. In high school and college, Jim participated in a number of sports, including track, cross-country and basketball. He played varsity basketball at Palomar College and Long Beach State University.

Dear Reader,

Late in the game of getting this book printed, the printer told me that we would have 2 blank pages in the back of the book. So I decided to include the following in the hope it will add another dimension to rest of the book. Jim
++

A MESSAGE TO EVERYONE
AND ESPECIALLY TO OUR YOUTH AND FUTURE GENERATIONS

Respect yourselves and each other, for every human is a miracle. Through all the twists and turns of existence, the chance that anyone of us would be living today approaches infinity.

Even if we only consider the one sexual union between our mother and father that resulted in our conception, the chance of our particular sperm and egg connecting was around two hundred trillion to one. (Your mother contributed one of a million egg-lets of which 500 matured and your father contributed some 200 million sperm.) One-million egg-lets x 200 million sperm make the odds of any genetically unique person being conceived during the particular sexual union that resulted in their existence is around 200 trillion to one.)

If we consider the times when our parents had sex other than when we were conceived and the one-hundred-thousand or so generations of people who had to live long enough to raise adult children and so forth for us to exist now, the chances for any one of us to exist today approaches infinity.

What does this mean?

It means we should respect our self and each other for the miracles that we are. Young people seem to get this. “Don’t dis me.” Don’t disrespect me.

As we learn how to respect each other, we also need to learn how to respect all life and our planet's life support system as the miracles that they are.

We should work to become more conscious. The more conscious we become, the better we will be able to apply our talents and planetary resources in ways that maximize fun and prosperity now and to ensure that our children and future generations have a healthy, happy prosperous and life-support sustaining world in which to grow up and flourish in.
++

OUR SITUATION AND WHAT WE SHOULD DO

We, the human family, now and future generations, are totally dependent on the health of our planet’s life-support system for our prosperity, well being and even the very continuance of the human family.

Therefore, for us to prosper now and in the future we must accomplish 4 things in concert as soon as possible:

I. Develop an economy and ways of life that are kind and gentle to each other and completely life-support sustaining.

Basically this means an economy and way of life that nurtures the human spirit, is powered by renewable energy and that uses our planet’s resources in ways that are non-polluting and renewable. (1)

II. Develop a Space Debris Detection and Defense System to protect our planet’s life-support system from errant space objects on collision courses with our planet.

Look at the moon. Its surface is wall-to-wall craters. If the earth did not have weather, plate tectonics and vulcanization, its surface would be covered with craters just like the moon.

If we don’t develop an effective space debris detection and defense system, sooner or later some space rock large enough to cause serious life-support system damage is going to hit us. In 1908 a 100-meter diameter object exploded due to rapid heating from atmospheric friction over Siberia in Russia. The result was 1,000 sq. kilometers (386 sq. miles) of flattened forest. If this object had enter earth’s atmosphere 3 hours later if would have hit Moscow with an explosive force of 10 megatons of TNT or 1,000 times more powerful than the nuclear bomb dropped on Hiroshima Japan in 1945. (2)

Depending on where they hit and the angle they hit on earth's surface, Colliding with objects between 1 mile (1.6 kilometers) and 2 miles in diameter has the potential to extinguish all higher forms of life on our planet. (3)

Since we already have all the technologies necessary to avoid such calamities, it would be foolish to create a sustainable economy and way of life on our planet only to have it ripped away from us by some errant space rock.

3. Store sufficient energy, food and water to supply everyone in every community on our planet with the essentials for life for at least one year and longer as it becomes possible.

This is only prudent given that political, economic and ecological uncertainties are increasing rapidly around the world.

4. Develop a worldwide educational program to show that it's in everyone's long-term interest for world population to decline, but at a very slow rate for the next 100 to 200 years. This is because if the rate of decline is greater than one percent, it would create unnecessary economic problems for young and old. One example: under our current social security system, young earners would have to contribute a higher percentage of their earnings to keep the system afloat for current social security recipients.

If everyone living today still capable of producing children choose to be the parent of no-more than 2 children during their reproductive years, the rate of population decline would be somewhere between 1/2 and one percent per year. This is because some people would choose to be the biological parent of one child or no children and some people would not have viable eggs or sperm to procreate. If world population declined an average of one percent each year, in 100 years the world's population would be in the range of 2.7 billion people, the world's population in the early 1950s.

Developing a life-support sustaining economy, a robust Space Debris Detection and Defense System, Storing more essentials like energy, food and water and slowly reducing the world's population are foundational to the well being and survival of the human family. It is the birthright of our children and their children's children on to infinity. It is the birthright of the future of consciousness becoming as it is manifesting in the human family.

It's as simple as this, the more our economy and way of life protects and preserves our planet's life-support system, the more secure, prosperous and happy we and future generations will be.

FOOTNOTES

(1) For details on how to accomplish the first task of creating a life support sustaining economy and way of life on our planet, read this book. To read on line or print out free copies, go to www.jimbell.com, then click on Jim's New Book, then the books title.

(2) For more details on protecting our planet from space debris search <u>Protecting Our Life-support System from Errant Space Rocks</u> on the web.

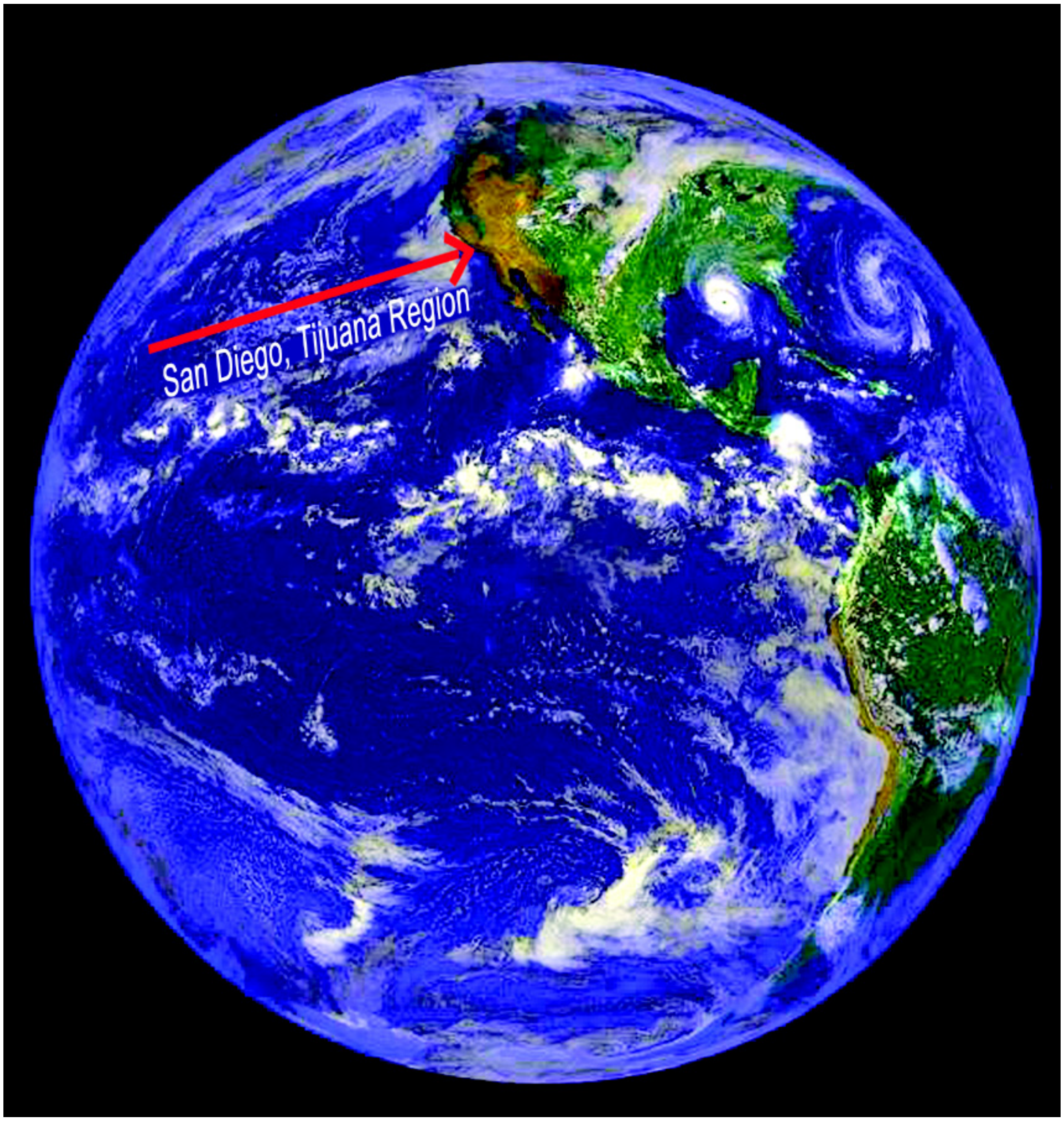
(3) If a one to two mile diameter space rock hit us on a dusty plain, it could kick up sufficient fine dust particles into the stratosphere and mesosphere to block sufficient sunlight to create a planetary ice age in a few days and even if less severe, it could cause a significant reduction crop production for several years.

If any thing close to this happens, the human family not killed immediately by the collision would be in a short race between freezing to death or dieing from insufficient or polluted water, common diseases or starvation -- if lawlessness doesn't first get whomever is left.

The life-support system damage sustained by colliding with any space object is contingent on the mass of the object, its speed and angle of approach, where it hits and many other variables. If a space rock 25 miles in diameter or larger hit us, the details probably wouldn't matter.

Odds are, there is no life-support threatening space objects on a collision course with us in the next 25 years, but no one really knows for sure because we haven't provided sufficient funding to find out.

As far as developing a space debris defense system, there has been some good scientific thinking about how to ward off space rocks but so far no space debris defense system is in development.



The Edge

The human family is at the edge of total darkness and total light.
And we have free will.
What a gift,
What an honor,
What a responsibility,
The Creator of all that is has bestowed upon us.