DESIGN FOR CATASTROPHE

By Joshua Smith

Every region typically has one or more catastrophe that can befall them. Fire and flood are examples for south central Oregon. Often in nature they are cyclical, although we may have a poor understanding of their timing. Let's look at some catastrophes that commonly occur in the continental US, such as hurricanes, tornadoes, fire, flood, earthquakes and landslides.

EARTHQUAKES

We think of them as occurring only in the Pacific states, particularly California, but fault lines are found all across this country. So while the likelihood of experiencing an earthquake depends on our geographical location, theoretically it could happen anywhere in the US. Earthquakes often occur prior to volcanic activity and tsunamis.

Here are some tips:

1. Avoid building on riparian outwashes, the deep, loose soil tends to shake much more violently than more stable ground. The same is true of fill material.

2. Avoid building on or at the base of steep terrain as landslides commonly result from quakes. On steep hillsides that are forested, trees can go down all over.

3. Buildings and especially foundations should be flexible. A slip-form foundation invented by Frank Lloyd Wright is very flexible, as well as inexpensive. Slip-form foundations are also called floating grade beams or footings. They are very practical for strawbale construction, which requires a broad foundation. Bamboo construction has proven to be extremely resistant to serious earthquakes, primarily due to its combined flexibility and strength. In earthquake-prone Japan, it was found that planting bamboo around the foundations of even skyscrapers dramatically reduced the ground tremors. The powerful root network of running bamboo resists the quakes' violent shaking and thereby helps reduce the structural damage to buildings.

4. Avoid land on the Pacific Coast that is near sea level. Tsunamis often follow earthquakes. For example if the Cascadian rift were to slip, the Northwest coast could be hit with a tsunami 25 minutes after the first quake. With the rising sea level resulting from global warming, seaside properties and many cities are at great risk of catastrophic floods, such as LA, NY, New Orleans, Miami, Boston, etc, etc.

TORNADOES

Are more common to the Plains. The mountains tend to break them up, so areas close to them like Boulder, CO are less likely to experience a catastrophic tornado, although smaller twisters will occur that can do significant damage. The invention of the tipi by the plains tribes is the perfect tornado-proof structure because it has nothing for the tornado to grab on to. For the same reason, tipis

are resistant to wind damage. Building underground in tornado alleys also makes a lot of sense.

Forests and woods can effectively reduce a tornado's strength and velocity if they are large enough and relatively mature. Settlements on the leeward side (the side sheltered from the wind) of such woodlands can receive significantly less damage than those on open land. Tap rooted tree species probably exert greater resistance than those with fibrous roots.

FLOODING AND MUDSLIDES

Riparian zones (the interface between land and a flowing body of water) all have natural flood cycles. In my experience, 20 to 30 year flood cycles are common in the West, with major floods occurring every 50 to 100 years or so. Just like houses and developments built on top of active earthquake fault lines in California, homeowners and developers often build in flood plains (in a growing number of places this practice has been outlawed.)

Upstream activities by humans can break the natural cycle, increasing the frequency, rate and volume of floods. Clearcut logging and 'the killer Eel' are examples. Northern California's Eel River once was a narrow river that ran deep. Unrestrained clear cutting of the watershed resulted in large sediment deposition in the river's bed. With the forest cover removed, the rate of erosion was appalling. The eroding sediments filled the river bottom, making it shallow and forcing it to widen. Then a large storm struck and with no trees to slow the runoff, the river rose roughly 20 feet above normal levels. Many people drowned, small towns on the Eel's shores were washed away and the highway was several feet underwater.

Logging and crown fires both create the perfect circumstances for flooding and mudslides. Building on steep land puts you at high risk from slides after clear cutting, or from forest fires directly above or below you. Even on heavily forested

slopes very destructive slides can occur. In the interior of British Columbia, I came across a river fork in a canyon where a massive slide occurred. A long steep forested slope with shallow soil over impervious rock below gave way under the combined weight of rain and trees. The poor anchorage of the trees couldn't hold themselves or the slope in place. From top to bottom, an area perhaps a quarter mile long and several hundred feet high simply slipped down slope, carrying the entire forest with it. Several people in the canyon died, and over a decade later the entire slope was still bare rock.

In the Santa Cruz Mountains of California, it is not uncommon to see one house built one above another clinging to a steep ravine. One year after a heavy downpour, a house near the top of the ravine lost its footing and began to slide. As it slid down slope, it encountered another house below it and knocked it off its foundation. Now both houses were sledding down slope at tremendous speed when they crashed into a third house below them. All three houses were totally destroyed and some of the occupants died in a domino effect. The moral of this story is to know your building site. Avoid flood plains, steep canyons and hillsides, and by all means learn all you can about the stability of sloping land above you. The huge network of logging roads in the Pacific Northwest are highly susceptible to major mudslides.

State Farm Insurance Company Report (8/04) Flood Facts

- There is 26% chance of a flood during the life of a 30 year mortgage.
- In the past five years, 61% of all disasters included flooding.
- Between 20 and 25% of all flood insurance claims are paid to people living outside of a high-risk flood area.
- Floods are becoming more severe because roads and parking lots are being built where forests and meadows used to be.

WILDFIRE

In the Western forests, wildfire is a serious and growing threat to our homes and communities. In fact, wildfire potential is catastrophic throughout the west. Grass fires on the plains are also common and can be just as devastating for those that live there. The chaparral or brush lands, of the Southwest are fire dependent, their natural fire cycle is often just five years between fires. Building in or near chaparral is a recipe for disaster.

When a human settlement is located on the forest edge, a forest fire can catch homes and buildings on fire and then spread fire from house to house. Defending ourselves against a catastrophic loss by such events is a priority of good permaculture design.

Avoid building at or near the top of a hill. Wildfires increase in velocity when moving uphill. In particular, avoid draws or canyons that in wildfire parlance are known as chimneys. Wildfire burns up a draw at a greatly increased rate due to a funneling or Venturi effect. Building in a draw, or the saddle at the top of a draw, is suicidal when wildfire and mudslides are factored in.

WILDFIRE SAFETY

Siting your structures or settlements well is the first step; place yourself in the least dangerous location. Use non flammable building materials and building techniques. Create a zone around buildings called “defensible space” which is clear of significant fuels. Educate yourself and your family on the dangers associated with wildfire. Have a set of do's and dont's and escape routes to learn and follow if such an event occurs.

Be fire truck accessible and let them know just how defensible you've made yourselves. Firefighting is dangerous, and firefighters when they have a choice will try to save a home that is most defensible over one that isn't. Show your local

fire department how you've protected your home, so they will remember if there is a fire.

Have strategies developed to further defend your place if threatened. Firetrucks often run out of water in rural areas, ponds are a critical resource for defense against wildfire. A non-toxic, biodegradable foam like “Silvex” will greatly improve water's ability to slow or stop a fire, it's a good investment. Roofs are often the first place to catch fire. You can set up sprinklers on your roof that can put out embers and firebrands. It's good to have an irrigation system when a wildfire is close to soak down your yard well.

In areas where the fire danger is high, various firebreak methods can be used. A living firebreak is planted between the likely direction of a hot wildfire, typically down slope of the protected zone. The planting is roughly on contour, and ideally in or at the base of a swale where possible. Trees with a large capacity to store water like willows and cottonwoods are used. If they are storing plenty of water when a fire strikes, they will certainly weaken it measurably, and may even stop it.

Large berms strategically sited can act as a buffer to impede a fire, or a ferro cement hollow wall (firewall) filled with water and painted white can be surprisingly effective as well. Another method lays an irrigation line on contour with a series of upright pipes six to eight feet tall topped with rainbird sprinklers, spaced at a distance allowing the rainbirds a 360° overlapping pattern. The fire will find it difficult to pass through the water wall, especially if the area was well saturated before the fire began its assault.

If you stay to fight the fire have an earthbermed escape shelter in the open. Keep a firefighters' blanket or two on hand, and if the going gets tough seek open space. Wildfire travels one to five MPH downhill or on level ground, fifteen to 35 MPH up hill. How fast can you run? Wildfires can travel even faster when driven by wind.

DEFENSIBLE SPACE

Site Selection: South slopes tend to have less vegetation and less fuel; fire intensity is generally but not always lower, so check it out. East and west slopes are the most dangerous because they have more moisture and so more vegetation, yet they dry out most in summer. Dry conditions and greater fuel load make them more fire prone and the fire's intensity is greater. North facing slopes have the greatest volume of vegetation and thus fuel, but they also have the highest moisture content as a rule. Fires occur on north slopes less frequently than other aspects (compass direction), but when they do, the fires are more intense. Wind patterns play a big role and can often make any aspect more or less dangerous. Avoid hilltops and especially saddles, and stay out of draws and canyons, as their characteristic features generate the most intense fires.

Defensible Space Zone Diagrams

Zone One: In the area immediately around the house, minimize the fuel load and favor hardscapes (landscape elements made of rock or stone, such as walls, paths and patios). Boulders, stepping stones, rock mulches and gravel paths create a micro-climate when liberally utilized that makes for warmer winters and summers (if not shaded). Landscaping should use low growing herbs and groundcovers. Keep the shrubs regularly clipped, this forces new growth that is more fire resistant. Avoid planting shrubs under the tree canopies because they can act as ladder fuels that can catch the crown on fire. Once on fire, flames can leap upward four times the height of the shrub. A few high branching deciduous trees for shade are ok as long as the branches don't extend over the buildings' roofs. An irrigated system will let you soak the ground and plants when fire threatens.

Zone Two: This is the area on the boundaries of the defensible space. Assuming this is a 2nd growth coniferous forest, it is probably overstocked with fuel. Conifers (firs, cedar, spruce, pine, etc) are called pyrophytes to indicate they contain

highly flammable resin. Such trees can burn very hot. Tree canopies should be spaced about 20 feet apart; if they're overlapping, they can be thinned. The oldest, biggest trees should be kept because they are the most resistant to fire and for their importance to carbon sequestering. Keep multiple ages whenever possible when thinning trees. Reduce ladder fuels and remove the lower branches up to eight feet on the bigger trees. Use the surplus thinned trees to build check dams and contour bunds (see Water for more information) to capture runoff, sediments and organic matter. The more available moisture, the more fire resistant the forest will be.

The first priority in zone two is the direction that wildfire is most likely to come from, or at least would prove the most destructive. Generally speaking, this will be down slope from the protected zone. Up slope in most cases will be the least threatening. Start your fuel reduction at the boundaries of the protected zone and work down and out from there.

Zone Three: Usually little is done in this zone until zone two has been completed. However, in certain highly vulnerable situations a green break (eco-fire break) may be desirable early on in a strategic location. Otherwise, with the possible exception of reduction of some particularly severe or critical fuel loads, zone three is on hold until fire reduction in zone two is complete. After that, zone three is treated in the same or similar manner as zone two.

Trees to use in the defensible space include cottonwoods (Populus species), aspens (Populus tremuloides) and willows (Salix species); hardwoods in general are the least flammable if they have received sufficient water to be at maximum storage capacity. When this is the case, they will be significantly resistant to burning.

Plant shrubs in open areas, not underneath tree canopies or eaves where they may act as ladders for a fire. Keep pruned or clipped, as new growth is more fire resistant. Plant away from walls and propane tanks. Some plants like yarrow

possess chemicals that retard burning. Other plants like those of riparian zones, such as willows and cottonwoods, have a high water content, although they can dry out and burn. Grow them as a buffer or fire break, keeping well irrigated during fire season. Some plants are very succulent like cactus, sedums (Sedum species), or ice plant (Carpobrotus edulis). Their leaves provide water storage and protect them against burning. Yucca (Yucca species) also has some kind of innate ability to resist burning, such as in desert groundfires.

Use low growing herbs and flowers by the house, and keep them dead headed (remove spent, dried flower heads or stalks) to reduce fuel. Irrigate well when fire threatens. Some herbaceous plants grow low to the ground and so provide insignificant fuel. Low growing thymes (Thymus species), dwarf catnips (nepeta species), penstemons (Penstemon species), greencarpet or smooth rupture-wort (Herniaria glabra), corsican mint (Mentha requienii) and many others offer no fuel for fires.

Lawns should be kept mowed and watered when fire first threatens. Site lawns on the side of the house or property fire is most likely to occur. Prevailing winds, hilltops, saddles and draws all influence the direction fire travels in.

Tribal peoples throughout the US practiced intentional low intensity burns to improve hunting, in this way their culture functioned as a part of the ecosystem, one of the many ways they were a keystone species.

LOW INTENSITY FIRES

In a typical US virgin forest, 20 to 50 trees per acre is about average density, resulting in low intensity fires. Old growth trees have thick bark and no low limbs. Fires burn groundcovers and young trees in the understory, while older trees survive with little or no damage. The result is a cool fire (not a crown fire) that remineralizes the soil. This type of fire is rejuvenating for the forest because it leaves the soil with an increase in available minerals. Commonly 2nd growth

forests have 200 to 300 trees per acre, and up to 2000 to 3000 trees. Compared with the 20 to 50 trees typical of virgin forests, 2nd growth is grossly overstocked.

Some seeds require low intensity fire to stratify (a treatment or condition administered prior to planting or germinating) and germinate. Many trees and shrubs that burn sprout and grow back from the roots that survive low intensity fires. After a slow, cool burn, more sun reaches the forest floor and competition for resources is reduced. With more sun, richer soil and better air circulation, biodiversity in the understory increases. Rejuvenation of ecosystems by the naturally occurring, low intensity fire cycle is a critical component of ecosystems' self-sustaining character. Low intensity controlled burns can restore habitat and forage for wildlife, with significant rejuvenation seen in three to four years.

Wildfire suppression (the Smokey Bear syndrome) is an ecological management issue. Natural forest fire cycles may occur every 20-60 years. Lightening is the principle natural fire starter and tends to strike ridges, pines, oaks and other species of tall trees most often. Over 90% of wildfires today are started accidentally or intentionally (arson) by people. Ecological stewardship of 2nd growth forests is needed, resources are abundant in forest ecosystems. We should live and work in them, making our livelihood restoring old growth characteristics and ecosystem functions by living on the capital of their diverse products. A continuous relationship overtime is necessary for good management purposes. Be a part of its function not an agent of its destruction.

90% of US forests today are 2nd growth. Timber companies see value in big trees only, contributing to global warming by deforestation through clear cutting. Old growth trees function ecologically as CO_2 sinks, and offer multiple products from forest environments (foods, fibers, essential oils, etc). Worker-owned co-operatives and light industries diversify eco-forestry production. When using portable mills, the tree diameter is not important. They have higher versatility, and can be used with a solar drier to add value to wood products. Another forest product useful for interior forests and cities is coniferous mulch, which can be

used to modify the native high alkaline soil pH for landscaping purposes. By reclaiming and rejuvenating 2nd growth forests, we can also stimulate the local economy.

HIGH INTENSITY FIRES

(Crown Fires)

High intensity forest fires cause a mega-release of CO_2 into the atmosphere, where it represents an overburden of carbon, and contributes to global warming. Hundreds of years will be needed to replace the carbon that was sequestered in the trees and soil of the burned clear cut forest, and regenerate the forests and carbon storage ability. A Douglas fir can live to be 1800 years old, and only starts sequestering carbon after 200. Controlled burns following fuel reduction forestry will mimic the natural fire cycle. Utilizing ecological standards, 2nd growth forests can be restored in time, while perpetually supplying an abundance and diversity of economic products.

Today most wildfires are caused by humans and most of our forests are second growth, having been clear cut at least once. Clearcuts grow back overstocked and competition is high, there is an abundance of dead and dry fuels on the ground or in the understory. When most 2nd growth forests burn, the fire quickly jumps into the crowns (flames can reach eight times the height of the burning fuel) and a catastrophic high intensity fire can result. A high intensity fire can destroy most of the essential soil biota, such as microbes, fungi, earthworms, etc. The seeds waiting for a disturbance to sprout are killed; even the root sprouters often die. These are all generalizations, with every wildfire there are numerous variables that result in a mosaic of possible outcomes, life and death can be very complex and nothing is either black or white. For example, understory Madrones may not act as ladder fuels, their hard, smooth bark gives little purchase for fire.

Steep slopes that burn in a high intensity fire are subject to extreme erosion and mud slides, often down to the base rock. Silt deposition in riparian areas and streams becomes severe, resulting in an overload of nutrients in aquatic ecosystems that's harmful, causing aquatic habitats to disappear. Flash flooding is also common after a severe fire.

Clearcutting alters the local climate significantly, causing it to get hotter in summer and colder in winter, there's more wind, moisture evaporation increases and annual precipitation is reduced. One way overstocking in the forest occurs is when cattle free range in them. The cattle eat the grasses which allelopathically control woody seedlings. Reduce or eliminate the grass and a riot of young trees emerges everywhere. Where there is sufficient precipitation, woody growth can spring up so that grasses are quickly shaded out. All this growth happening when resources have diminished leads to extreme competition. Many trees die from over shading, as do lower branches, or from lack of adequate water and nutrients. This leads to a high fuel build up of dry biomass awaiting the torch.

STATE OF OUR FORESTS

From the Forest System Documentation of Species

In 1994, Spain lost 1.2 million acres.
In 1998, Mexico lost 1.25 million acres.
In 1998, Indonesia lost 2 million acres.
In 2000, the western US lost 7 million acres.
(Oregon has experienced an increase in fires recently, too.)

Catastrophic forest fires are increasing world-wide, occurring at double the ten year average. Today in the US, 40 million acres are at extreme risk of uncontrollable wild fires due to very high fuel loads. Colorado is second to southern California for high risk in the US, having 1.5 million acres of Front Range / urban wildlife interface at high risk. Increasingly, Pacific Northwest forests are vulnerable, particularly tree plantations that spread fire into the forest.

We need the forests to supply clean water and air, control flooding and much more, we will suffer if we lose them.

The Yellowstone fire of 1998 burned 1.4 million acres, more than the total acreage burned in the park for the preceding 116 years, which amounted to 146,000 acres combined. That fire released energy equivalent to thousands of atomic bombs. As well as destroying the carbon sequestering ability and ecosystem functions of the forest, carbon is released from the soil and plants during a fire. In the 1980s and 1990s, the US Forest Service estimated Oregon's forest fuel load per acre as 280 gallons of gasoline per acre equivalent, on average.

WILDFIRE MITIGATION

Controlled burns should always be done after thinning (cutting & removing timber), since intentional burning in 2nd growth forests that have not been thinned often rage out of control and become catastrophic. Cut shrubs back hard to stimulate new growth that is more fire resistant, cutting back any shrubs under tree canopies to the ground (they'll probably sprout back anyway).

Thinning: Break up the canopy, spacing tree canopies (not trunks) approximately 20 feet apart on nearly flat land. On steep slopes, it may in some cases be appropriate to space canopies even further apart (30 feet), but before thinning is considered at all, the role the trees are playing in binding the soil to resist slippage should be determined. Always favor keeping the oldest trees that are most fire resistant, move toward old growth conditions. A few clusters of older trees with overlapping canopies can be left here and there to be thinned as needed in the future when they're more valuable. Remove lower branches up to eight feet high on the larger trees. Keep a mixed age forest of trees of various heights, ages and species for structure. Chip or shred branches and return them to the forest floor. If you have too much, then compost them or use them as mulch in the landscape.

Build check dams and contour bunds with the surplus logs and/or rocks to increase water catchment and retention in the soil and decrease runoff. Air pulls fire under deadwood fuel and ignites it, so eliminate air spaces under any woody catchments. Close the gaps between logs with soil or mud to eliminate air pockets. Inoculate log catchments with edible decay fungi like oyster mushrooms.

Spring or winter, starting in late fall is an ideal time to thin, because it's cooler and moister. Thinning itself can trigger a wildfire by chain saws' sparks, particularly in hot dry conditions over summer. Start early in the morning when its cooler and more humid, avoid thinning when it’s windy, and have a fire extinguisher for safety. Don't work alone when felling timber in the forest, have a cell phone, practice team work, follow a safe system and keep a medical kit on hand at all times. Debark the logs within a month, two weeks in hot weather, or it will become an impossible job.

Sheep or goats keep fuel suppressed, as well as providing wool or milk, etc, and are practical in many places in the western US. Weed eat tall dry grasses and herbs before they weeds form seed heads, but after natives go to seed. Selective understory management will favor natives over the weeds.

Green breaks can replace conventional (clearcut) firebreaks because they are just as effective, but are less harmful environmentally. They are applied only under the most vulnerable circumstances because they can still have a significant impact on the environment. Green breaks are a heavily thinned band, a minimum of 100 to 200 feet wide, on contour (or nearly), located at or just above slope bottoms. Space trees to be preserved 60 to 70 feet apart. Use them only where conditions are critical.

With the current exponential human population curve, the status quo of ecosystem exploitation and over harvesting, and the worlds' rapidly disappearing natural resources, preserving and restoring forest ecosystems will be critical to

our survival. Outlawing clearcutting, tree plantations and the use of destructive chemicals in forest management is very important. Most of all, creating a 2nd growth restoration forest economy is needed.

GLOBAL WARMING

The biggest catastrophe facing this generation and the next is global warming. Imagine living in a world that is hotter than since humans first emerged, hotter even than it was when primates were first seen in the geologic record. Today's global climate is already hotter than it's been in 12,000 years, according to NASA. That's what the scientific data tell us. Further more, this radical temperature change has occurred in 100 years or less. Radical temperature changes of this magnitude often require at least 1000 years or more, thus providing an opportunity for living creatures to evolve adaptations easily.

It is an accepted fact that burning fossil fuels for transportation and to produce energy for electricity top the list as major contributors to greenhouse gases flooding our atmosphere. The role deforestation plays in global warming is seldom reported even though it's severe. A report commissioned by the British government states that 18% of greenhouse gases enter our atmosphere as a direct result of deforestation. A UN report puts the figure even higher at 25 to 30% from deforestation alone.

Americans are conditioned to see everything in black and white. However, human-caused global warming results from a convergence of bad practices. An international study reported in a journal of the Royal Society of London details the study of human caused land surface changes, and their local and global effect on climate. These changes are brought about by urban-suburban sprawl, deforestation and industrial agriculture. The resulting changes redistribute heat in the atmosphere regionally and globally, regional temperatures rise and precipitation patterns change. Overall urbanization, deforestation and industrial

agriculture appear to be contributing as much or more to global warming than the world's total greenhouse emissions.

Ed Mazria is a New Mexican architect who argues that contemporary architects design and construct buildings that could be contributing almost 50% of the global greenhouse gas emissions. It's clear to me that everything in America is overbuilt and wasteful; this inefficiency demands deforestation to feed its lust for building materials, and that's the worst kind of design. Bigger buildings are harder to heat and cool, and rarely avail themselves to the free energy of the sun by being designed as passive solar, winter heat collectors.

As CO_2 levels in the atmosphere rise, the cell walls of trees become thinner and stretch out, making them increasingly weaker structurally. In the next few decades, more wood will be needed then today to construct buildings of equal size that exhibit the same strength and resilience. This will likely mean that engineering design will need to be beefed up.

We don't need to build everything of wood either, there are a variety of alternatives to wood structures, the most natural being adobe, strawbales, cob or stone. There are also fabricated materials having minimal impact on the environment, and fine buildings can be built of bamboo, which is a renewable building material. Not only are there passive ways to heat and cool a building as needed, there are also various ways to increase their energy efficiency. The US has a number of alternatives to satisfy the energy needs of the country with renewably sourced energy, but we the people must lead because as long as our government is ruled by corporations, politicians will drag their feet.

There are two general categories we can act on, one is in our personal life and the other is in our communities. Where communities are concerned we should think village, let everything be within walking distance or a quick commute on mass transit. In the early 20th century trolley cars ran on compressed air. Another

form of local transportation we should promote is mini-solar electric buses or jitneys.

In urban-suburban areas, once neighborhoods are converted to villages and compressed, air powered mass transit and solar jitneys are up and running, it's time to tear up the asphalt. We will need good parks in each village and the asphalt and concrete removed from roads and driveways can be used as retaining walls or other creative projects. For example, they could be stacked for use as outdoor thermal mass in winter to create warmed micro-climate niches for outside work or recreation. Removing the asphalt from roads and parking lots can be part of a strategy to eliminate the heat and ozone bubble that forms over most US cities, along with carefully crafted urban shade forest and green roofs.

We can tear out our backyard fences and turn the combined land into mini-farms and parks. Most people seldom use their backyards, but if you want a little privacy, take a portion of the backyard by the house and make it private, and donate the rest to the neighborhood commons. Design corridors of appropriate native plant communities to criss-cross the city to both support wildlife, and keep urbanites connected consciously to the living earth that supports their existence.

All landscaping both public and private should be designed using ecological methods that perform ecological functions, such as climate extreme modification, fresh air, clean water, biological pest control, self-fertilization, etc. Landscapes should feature an abundance of economically useful plants like fruit, nuts, perennial vegetables and greens, and plants used medicinally, for adhesives, fiber, cork, rubber, insulation material, waterproofing, etc.

A study conducted by the US National Center for Atmospheric Research indicates that the area stricken by drought worldwide increased 18% from the 1970s to 2005. About half of this increase is attributed to soil drying by An over-heating climate, and the other half by declining precipitation rates. With our government's official policy of destroying our forest watersheds in service to the

corporate timber companies, and the privatization of municipal waters and our over-heated climate, an unimaginable crisis is brewing. Capturing precipitation off roofs and other sealed surfaces and storing it for domestic use or irrigation will be critical to our well being, and even our survival. Snow packs in Oregon's Cascade Mountains have declined by over 30% at high altitudes, 66 to 77% at mid-altitudes, and 80 to 100% at lower altitudes.

GLOBAL WARMING AND AGRICULTURE

Some global warming optimists suggest that an over-heating planet will be good for agriculture. It's a fact that increasing carbon dioxide in a closed system like a greenhouse produces faster growth and bigger plants, as commercial tomato growers can confirm. Recent field research indicates that faster and bigger is not necessarily better. Scientists at the University of Michigan Biological Station began studying the effect of high CO_2 levels on plants in the 1980s. At first, additional CO_2 in the atmosphere looked like a boon to farmers, but then they started looking closer. What they found was that the plants had serious nutritional deficiencies. In other words, everything that uses plant material for food will need to eat more to weigh less. This includes wildlife, livestock and people. The nutrient imbalance research indicates this may have serious consequences for our health, and the whole food web may be affected.

Most worrisome is that as CO_2 increases, available nitrogen declines. For example, broccoli and cabbage grown at twice current levels of CO_2 (levels which are expected by 2050) contained 20% less nitrogen. Just as nitrogen is essential to plant growth, its conversion to protein by plant food consumers is essential for good health. Other studies have shown the same levels of protein decline in apples, brussel sprouts, carrots, potatoes and tomatoes. Seeds and the foliage of trees are similarly affected. Microbes, insects, fungi, fish, birds and mammals will all need to increase their food consumption or perish. When caterpillars were fed CO_2 enriched cabbage leaves they ate 40% more than they normally eat and yet they matured 15% smaller in size. Plant reproduction may also decline, although

the plants produce more seeds with higher CO_2 levels, their diminished nitrogen levels could impede germination and establishment.

New research by scientists from the University of Illinois at Urbana-Champaign is revealing that previous expectations of CO_2 induced bumper crops were also false. They are conducting open-air CO_2 enriched field trials with five major food crops. The initial higher yields expectation was based on closed system greenhouse plantings. The field tests, however, show that open air grown crops with equal levels of CO_2 yielded about 50% less than greenhouse grown crops. These tests simulated CO_2 levels expected by 2050.

Increased temperatures over the next 50 years will have a harmful effect on many perennial crops if climate models prove correct. Researchers from the Livermore National Laboratory, using over 20 different climate models projecting climate heating over the next 50 years have determined what effect it will have on California's perennial crops. They concluded that many of them, such as table grapes, citrus, almonds, and walnuts will become up to 20% less productive, while yields of crops like avocados will fall as much as 40%. Careful planning will be needed to know where to plant these crops from now on, because their present locations will be too hot for them. To escape the increasing temperatures, they will need to go north in latitude or up in altitude to climates in which they are currently borderline hardy, and later moved again to where they are not presently hardy at all.

What might we do about declining nutritional value in crops due to increasing CO_2? For one thing, organically grown crops are superior nutritionally to those that are chemically grown. Fresh food from your backyard will be more nutritious than foods that have been stored, shipped and stocked in your supermarket. Learning good food preparation methods also can provide additional nutritional benefits. Some foods are super nutritious, while others offer minimal value. This is most evident when perennial crops are compared nutritionally with annual vegetables and greens. Although as yet not well studied, perennial food plants

nearly always are richer significantly than annual crops (according to the research that has been done). Even some garden weeds like purslane (Portulaca species), malva (Malva species), lamb's quarters (Chenopodium album) and pigweed (Amaranthus species?) are richer in nutrients than even fresh organic vegetables. When we think of perennial crops, usually fruit and nuts come to mind, or maybe asparagus or artichokes, but there are many little known perennial vegetables for temperate climates. Among trees and shrubs, I can think of over 20 that that yield greens or veggies, and there are many more edible perennial herbs and flowers. Collectively, these perennial foods will grow in every US temperate climate zone, depending on the particular species.

Growing crops, raising micro-livestock and fish in your own neighborhood and backyard will reduce greenhouse gases in our atmosphere immensely, and can be done even in urban area with well laid plans. Reductions in transportation and cold storage that result in minimized carbon emissions should not be underestimated. Today food is transported great distances from continent to continent. In Africa we see citizens of a country starve in mass, while their nation's crops are shipped to markets in Europe. Today's global economy is the antithesis of what is needed in this time of climate change. The focus now must be local first, regional next and global only rarely. Local economies should focus on local resources for all basic local needs.

City farms will need to be intensive, making thrifty use of all the available space. Perennial crops are emphasized, planted in three dimensional ecological guilds. In essence, every urban and suburban neighborhood should be farmed. Labor-intensive agriculture will be the most productive, and will provide jobs close to home.

It is ever more important that we exchange our values as consumers of materialism to valuing our relationships, of sharing, helping and giving, of dancing, singing and playing together. It's a fact that regardless of how rich or poor you are, the quality of your life is highest when you have many positive

friendships. When we kick our addiction to materialism, human produced greenhouse gases will plummet.

A global boycott of corporate products, combined with meeting our basic needs through local, worker-owned businesses utilizing local, natural resources is the direction we need to go to reduce the impact of climate change. No more petroleum based products, no more products laced with toxic ingredients, no more wasteful oversize homes and businesses. We must stop designing communities for cars and start designing them for people and the environment.

THE EFFECT OF CLIMATE CHANGE ON PLANT MIGRATION

The natural biotic communities will also require us to take action in the face of a global heating catastrophe if they are going to be able to adapt. When the last ice age ended and the planet began to warm, plants and animals began moving north following the melting ice. Initially evidence suggested that trees and other plants only moved at a rate of 25 miles every 100 years, not enough to adapt to today's rapidly changing climate. When concerned scientists took a closer look however, it was realized that plant migrations may be able to migrate faster than first thought. Indeed, far more plants may be able to migrate to climates they can adapt to, even at today's quickly changing climate rate. That's the good news.

The bad news is that the avenues plants need to successfully migrate are now mostly blocked. The natural environment that acts as migration corridors is today badly fragmented by development, bad forestry and agriculture. Weeds that tend to specialize in long distance migration and are opportunists that can adapt to extreme conditions will likely fill much of the available space, reducing successful migration of native plant communities even further.

The subject is more complex than this, but the risk of mass ecosystem collapse from global warming is a grave matter. Good design, however, can help tremendously if applied to facilitate ecosystem migration and adaptation with our assistance.

To begin this process, we must start moving indigenous plants North in latitude, or up in altitude, or some of each. Moving plants 1500 feet up in altitude is roughly the same as moving a plant 200 miles North to a site of the same altitude. Most important is to move them into niches for which they are adapted, and into ecosystems that closely resemble those they natively grow in.

Trees are best adapted to quick migration when the climate changes abruptly, but understory and meadow herbs and grasses generally migrate slower, and are the most vulnerable. It's important that we help trees and other woody, indigenous plants migrate, but pay particular attention to relocating native herbs and grasses.

When the plants are eco-types (originating in a matching habitat), and are planted near local plants of the same species, the migrant species could pass its temperature tolerant genes on to the local species. This can happen fast with herbs and grasses, but slower with woody species, particularly big trees. This might prove to be an expedient method to aid ecosystem's adaptation to rapid climate change.

Along with the plants themselves, their fungal and microbial associate should be moved with them. When harvesting seed from indigenous species for migration, also collect soil microbial community samples and spores and hyphae of fungi from the soil around the mother plants. These will be used to inoculate the soil on their new site, or in the nursery if they're propagated in controlled conditions before being planted out.

If we had a functional government, we would be both researching and initiating these strategies of design for catastrophic climate change now, and doing it aggressively. Since this is not the case, it's up to us to demand it, support it and do it. It is our world after all.

RECOMMENDED READING:

Little, Charles. Dying of the Trees. Penguin Books, 1997. (For a good cry)