INTRODUCTION TO PERMACULTURE

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THE TERRIBLE TIME OF DAY

by Bill Mollison, 1981

I don't think anybody has summarized what is happening on the face of the Earth.
In order to change our ways, we seem to need to terrify ourselves, anticipating tidal waves and catastrophes. Now those things may come off, and the San Andreas fault may shift. But we can't do much about that. What is really happening is something for which we, as human beings, are personally responsible. It is very general. Almost everything we say applies everywhere.
The real systems that are beginning to fail are the soils, forests, the atmosphere, and nutrient cycles. It is we who are responsible for that. We haven't evolved anywhere in the west (and I doubt very much elsewhere except in tribal areas) any sustainable systems in agriculture or forestry. We don't have a system. Let's look at what is happening.

Forests

Forests have been found to be far more important in the oxygen cycle than we ever suspected. We used to think oceans were the most important element. They are not. Not only are they not very important, contributing probably less than 8% of the oxygen in atmospheric recycling, but many are beginning to be oxygen-consuming. If we release much more mercury into the seas, the ocean will be oxygen-consuming. The balance is changing. Therefore, it is mainly the forests that we depend on to preserve us from anarchic condition.
Of the forest, some are critically important, like the evergreen forests, of which there are two extensive systems. One is equatorial, multispecies; and the other, cool evergreen forests of the Russian tundra and the southern evergreen forests. Rain forests are critically important in the oxygen cycle, and in atmospheric stability.
The forests also provide a very large amount of our precipitation. When you cut the forest from ridges, you can observe the rainfall itself fall between 10% and 30%, which you could probably tolerate. What you dont see happen is that precipitation may fall over 86%, the rainfall being only a small fraction of the total precipitation. It is quite possible on quiet, clear nights with no cloud, no rainfall recorded anywhere on any gauges, to have a major precipitation in forest systems. It is particularly true of maritime climates. But it is also true of all climates.
Therefore it is possible to very rapidly produce semi-desert conditions simply by clearing trees from ridge top. This is being done at a great rate.
It is the character of forests to moderate everything. Forests moderate excessive cold and heat, excessive run-off, excessive pollution. As forests are removed, immoderate extremes arrive. And of course, it is the forests that create soils. Forests are one of very few soil-creating systems.
What is happening to forests? We use a great many forest products in a very temporary way - paper and particularly newspaper. The demand has become excessive. At present, we are cutting one million hectares per annum in excess of planting. But in any one month, that can rapidly change. Last month, for instance, that doubled because of the clearing of the Mississippi bottom land forests for soy beans.
Of all the forests that we ever had, as little as 2% remain in Europe. I don't think there is a tree in Europe that doesn't exist because of the tolerance of man or that hasn't been planted by man. There is no such thing as a primeval European forests. As little as 8% remain in South America. And 15%, I think, is a general figure in other areas. So we have already destroyed the majority of forests, and we are working on a rather minor remnant. Cutting rates vary, depending on the management practices. But in general, even in the best managed forests, we have a constant loss of 4%, giving 25 more years to go. But in fact, what we observe throughout Southwest Asia and in South America, and throughout the Third World, and wherever multinationals can obtain ownership of forests in the Western world, is about 100% loss. It is a "cut and run"system.
We have long been lulled into a very false sense of security by reassurances that the logging companies are planting eight trees for a tree cut. What we are really interested in is biomass. When you take something out of the forest in excess of 150 tons and put something back, which doesn't weigh much more than 10 ounces, you are not in any way preserving biomass.
What are the uses to which we put forests? The major uses are as newsprint and packaging material. Even the few remaining primeval forests are being cut for this. Forests that had never seen the footsteps of man, that had never experienced any human interference, are being cut for newsprint. Those are forests in which the trees may be 200 feet to the first branch, gigantic cathedrals. They are being chipped. There are trees in Tasmania much taller than

your redwoods. These are being cut and shipped out as chips. So, for the most part, we are degrading the primeval forests to the lowest possible use.
That has effects at the other end of the system. Waste products from forests are killing large areas of the sea. The main reason why the Baltic and Mediterranean and the coast off New York have become oxygen-consuming is that we are carpeting the sea bottom with forest products. There are, broadly speaking, about 12,000 billion tons of carbon dioxide being released annually by the death of forests. We are dependant on the forests to lock up the carbon dioxide. In destroying forests, we are destroying the system which should be helping us. We are working on a remnant of the system. It is the last remnant which is being eroded.

Climate

The effects of this, on world climate, are becoming apparent both in the composition of the atmosphere and in the inability of the atmosphere to buffer changes. In any month now, we will break the world weather records in some way. In my home town we are very isolated and buffered by ocean and forest. But we had in succession the windiest, the driest, and the wettest month in history, in two hundred years of recording. So really what's happening in the world climate is not that it is tending toward the greenhouse effect; it is not that it is tending toward the ice age; it is starting now to fluctuate so wildly that it is totally unpredictable as to which heat barrier you will crack. But when you crack it, you will crack it an an extreme and you will crack it very suddenly. It will be a sudden change. Until then, we will experience immense variability in climate. That is what is happening.
We can just go cutting along, and in maybe twelve more years we won't have any forests.
There is still another factor. It would be bad enough if it were just our cutting that is killing forests. But since the 1920's, and with increasing frequency, we have been losing species from forest to a whole succession of pathogens. It started with things like chestnut blight. Chestnuts were 80% of the forests that they occupied. So a single species dropping out may represent enormous biomass, enormous biological reserve, and a very important tree. Richard St. Barbe Baker pointed out that the trees that are going are those with the greatest leaf area per unit. First chestnuts, with maybe sixty acres of leaf area per tree. Then the elms, running at about forty. Now the beeches are going, and the oaks, the eucalypts in Australia and Tasmania. Even the needle leaf trees in Japan are failing. The Japanese coniferous forests are going at a fantastic rate. So are the Canadian shield forests and the Russian forests.

The Phasmid Conspiracy

Now we come to a thing called the phasmid conspiracy. Each forest varies in each country in that its elms, its chestnuts, its poplars, its firs, are subject to attack by specific pathogens. Insects are taking some sort of cauterizing measures. The American reaction would be to spray; the British reaction would be to fell and burn; and in Australia, the reaction is to say: "Aah, what the Hell! It's going to be gone next year; let it go!"
Really, is it these diseases? What are the diseases? Phasmids are responsible for the death of eucalypts. There is the cinnamon fungus. In elms, it's the Dutch elm disease. In the poplars, it's the rust. And in the firs, it's also rust. Do you think that any of these diseases are killing the forest?
What I think we are looking at is a carcass. The forest is a dying system on which the decomposers are beginning to feed. If you know forests very well, you know that you can go out this morning and strike a tree with an axe. That's it. Or touch it with the edge of a bulldozer, or bump it with your car. Then, if you sit patiently by that tree, within three days you will see that maybe twenty insects and other decomposers and "pests" have visited the injury. The tree is already doomed. What attracts them is the smell from the dying tree. We have noticed that in Australia. Just injure trees to see what happens. The phasmids come. The phasmid detects the smell of this. The tree has become its food tree, and it comes to feed.
So insects are not the cause of the death of forests. The cause of the death of forests is multiple insult. We point to some bug and say: "That bug did it." It is much better if you can blame somebody else. You all know that. So we blame the bug. It is a conspiracy, really, to blame the bugs. But the real reason the trees are failing is that there have been profound changes in the amount of light penetrating the forest, in pollutants, and in acid rain fallout. People, not bugs, are killing the forests.

Soils

As far as we can make out, we have lost 50% of the soils we have ever had before 1950. We have been measuring pretty well since 1950. And we have lost another 30% of the soils that remain. Now this is as true of the Third World as it is in the Western World.
The rate at which soils are created is at about four tons per annum per acre - much less in dry areas. Soils are created by the fall of rain and the action of plants. The rate varies. In the desert, they are being created at a much lesser rate. But in these humid climates, at about four tons per acre. If you don't loose any more than four tons of soil per acre per annum, you are on a break-even.
But let us look at the usual thing. In Australia, we lose about 27 tons of soil per cultivated acre per annum. You do a lot better than that in America, however. Where you grow corn, you can loose as much as 400 tons per acre per annum. While the average may be twenty, it will go as high as 400 or 500 tons. So we are not doing too well. In

Canada, they are measuring the humus loss, and that is about the same. There, they are running out of humus. In the prairies, where they started with good humic soils, they are now down to a mineral soil base.
Here is something that should be of interest to each of us. For every head of population - whether you are an American or an East Indian - if you are a grain eater, it now costs about 12 tons of soil per person per year for us to eat grain. All this loss is a result of tillage. As long as you are tilling, you are losing. At the rate at which we are losing soils, we don't see that we will have agricultural soils within a decade.
Apart from the soils that we lose directly by tillage, we are losing enormous quantities of soils to what is called desertification. In the state of Victoria, in Australia, we lose 800,000 acres this year to salt. That means not only a loss of soils which are tilled, but also a loss of the soils that we don't till.

Deforestation Causes Soil Loss

Now the main reason for disappearance of soils is the cutting of forest. And almost always the cutting of the forest is remote from where the soil is lost. That is, you can do nothing if your soil starts to turn salty here, because the reason lies way up the watershed, maybe a thousand miles away. We are now starting to get soil salting in humid climates in Australia. It is becoming a "factor out of place." It is no longer only occurring in deserts. It occurs in quite humid, winter-wet climates. How did this happen?
It is not a simple process, but it is easily understood. The rain, as it falls on hills and penetrates forests, has a net downward transfer. If we remove forests, what we now have is a net evaporation loss. Forests transmit clean water downward, and they release clean water into the atmosphere. This net downward transfer carries with it the salts which are an inevitable part of that additional four tons of soil per acre which is produced from breakdown of rocks. These salts normally travel on out in deep leads. They are not surface systems. Fresh water runs from the surface and soaks down. Even in humid climates, we have much saltier water at depth than we have on the surface. This is because the trees act as pumps to keep the leads low. If we cut the trees down, the deep leads rise at a measurable rate, and they are rising measurably across enormous areas in America, Africa and Australia. When they are up to about three feet below the surface, the trees start to die of "phasmids." And when they are up to about 18 inches below the surface, other crops start to die. When they reach the surface, they evaporate and the soil visibly goes to salt. Then the Australian government starts providing free pumps to farmers and they start pumping out the salt water. Where can they discard the water they pump out? Big problem!
The next step is to have concrete delivered, so now water diverted from the rivers soaks into the soil while they are pumping the salt water off to the sea. And they have to be doing that forever. You now want a thousand thousand pumps. At the same time that the government is supplying pumps to farmers, it is leasing additional wood-chipping licenses to the multinationals, who are doing very well. They are selling pumps on one hand and wood chips on the other. It is a happy circumstance for some people, but a catastrophe for the Earth.
Most people, however, aren't doing very well at all. So we are losing soils and increasing desert at a simply terrifying rate. And that is without any plowing for agriculture. You ask if the analysts of the multinational firms are aware of these problems? No, they have degrees in economics and business management and all sorts of irrelevant areas.
Mining is also a major factor in salting on a local basis, and has accounted on its own for the loss of whole hardwood forests in areas of Western Australia and no doubt elsewhere. Mining brings up a lot of residues which are evaporated on the surface.

Highways, Cities and Wells

The largest single factor in Britain causing loss of soils is the construction of highways. It is also a major factor in America. In Britain, I think that there is a mile of highway for every square mile of surface. And highways are being rapidly extended on the supposition that you will never need the soil and that highways will enable you to increase energy use. Highways account for the permanent loss of soils, as do cities.
Cities are located on the 11% of very good soils of the Earth. Canada is an interesting example, where cities are liable to obliterate the top quality soils, without any other factor, and in this decade, leaving agriculturalists to move on to less sustainable situations. At the same time, we are calling for at least sustained production, and in some cases an increase of production, on the soils that remain. As the loss of agricultural soils is largely due to the excess application of energy - mechanical energy and also chemical energy - then the fact that we are attempting to sustain productivity on the remaining soils means that the rate of loss must increase due to the fact that we use more and more energy on less and less surface.
Other factors work for loss of soils. In the arid southwest of this country, there is a sort of cut and run agriculture in which you sink a bore [drill a well] and pump up semi-saline water to annual cultivated crop. You keep this up for four years. By then the surface is heavily mineralized and you must seek another area and sink another bore, which results in a sort of carpeting destruction. You can see it. There are two or three good years, then returns fall below economic level. The soils are usually glued together with carbonates and they give up. pH rises by about two points per annum. You might start at pH 8 and rapidly go to pH 11. It is then that you pull out.
We look now at wind deflection of soils. This has brought about failure of the inland soils in America. There are soils blowing out to Los Angeles and falling as red rain. Soils from Central Australia marginal areas fall on the cities

as a sort of finely diluted mud, measurable at 12 tons per acre per day. Wind is a major factor in soil loss. The drier it gets, the more wind becomes the factor that we look to.
We don't have to look any further than the soil, or any further than the forest, to see a finite world. I think we can say with confidence that we don't have a sustainable agriculture anywhere in the world or a sustainable forestry.

Water

Let us move now to water. Even a decade ago, somebody said that water would become the world's rarest mineral. The water table everywhere is now falling rapidly. These are very ancient systems we are playing with. Many of them are about 40,000 years in evolution. No longer is there any way you can get cheap surface water. If you could, Los Angeles would buy it and use it. A major factor in this is the way we seal everything over in cities and towns. We don't get any recharge of soil water. We seal over huge areas with highways. We don't return water to the water table at all. As soon as water is in a river or creek it is gone. It is on its way to the sea, or it is evaporated on the desert salt pan. The flowing river is not really a very useful thing. It is on the way out.
There are two very critical areas for water. One is within cities. The other is on the edge of deserts. Both are running into real trouble. encroaching deserts are killing some millions of people now in Africa. It is visible from the air as migrations of herds and people out of the Sahara.
One of the dangers has been the long term disposal of atomic waste in the deep waters. Some of these are beginning to seep through the Sacramento Valley. You had better start counting the radioactivity coming in the water table in Maine, New Jersey and California, and, I have an idea, in lots of other places as well.
Industry has simply used deep bores to put dangerous wastes into the water table with the result that large areas of this water table have become unviable. I think Boston has ceased to use its ground water. And you'll never be able to use it again. There will be no way you will ever clean that foul water.
In many towns and cities now, water is running at 700 parts per million dissolved salts, which is at about the limit of the tolerance of the human kidney. At 1100 parts per million, you would experience fainting, accumulation of water in the tissues, all sorts of problems. Most deaths from that commonly occur in the cities, in Perth and Adelaide in Australia, in Los Angeles. In all these areas, perhaps, we shouldn't be using water for drinking. It's ok to shower in, although in Atlanta, the chlorine alone almost asphyxiates you when you shower. PCB's are a cause of sterility. I think about 20% of American males are now sterile by age 20.
The fact that water is becoming a scarce resources is manifestly ridiculous, because roughly half a million gallons fall on this roof right here annually. But you could be very short of water here soon unless you build tanks or surface storage to catch the water.
Now of course the loss of trees has a pronounced effect on this increased scarcity of water in cycle. The water is not cycling. We are losing water on the surface of the Earth. I think that 97% of water is locked up at all times and only 3% goes into any cycling at all. We are reducing that very rapidly.
There are yet other factors. There is industrial pollution. There is a desperate scramble for energy sources, whether they are wood, coal, oil or atomic power. These are all really dangerous things to use in terms of the general life system. We are going toward real trouble. The danger is mainly in the end result - what comes out of the process, what goes up the chimneys. But in the case of wood, it is also the fact that you destroy a tree.
Chemicals. What can you say about them? Most every broad-scale release of chemicals has unforeseen and long term results. These chemicals include DDT, PCB's, dioxin and chlorine.

A Desperate Future

At the very least, we have a desperate future. Our children may never believe that we had surplus food. It is mainly because of utterly ridiculous things. The entire output of atomic power in the United States is exactly equivalent to the requirements of the clothes-drying machines.
I literally can't stand being on the American highway. To me it is almost like being in a prison of madness. I can stand the background; but I can't stand the highways in Canada or here. Driving like crazy people. Where are they going? And why are so many of them going in that direction? They are all fleeing something. I would like to inquire what is in those trucks that are tearing down the road. Is it something of no use at all? Or something which is present where it is going? And often I have seen trucks, apparently carrying identical cargo, going in opposite directions, carting it here and there. The drivers tell me that they are carrying widgets.
Now all of this, including the energy problem, is what we have to tackle at once. It can be done. It is possible. It is possible to make restitution. We might as well be trying to do something about it as not. We will never get anywhere if we don't do anything. The great temptation, and one in which the academic takes total refuge, is to gather more evidence. I mean, do we need any more evidence? Or is it time to cease taking evidence and to start remedial action on the evidence already in? In 1950, it was time to start taking evidence and start remedial action. But the temptation is always to gather more evidence. Too many people waste their lives gathering evidence. Moreover, as we get more evidence, we see that things are worse than they had appeared to be.

Design For Remedial Action

When we design for permanence, we go generally toward forests, permanent pastures, lakes and ponds, and non-tillage agriculture. That is our business. Until we get more clues as to what will be sustainable, that is what we have to play with.

Industrial water can be supplied from roofs. Settlements can use that water. America is simply short of tanks. Now there are different sorts of tanks. One is the kind you put under the downspout from the roof of your house. Tanks of another sort are the cheap tanks - earth tanks. Absolutely no problem. Always enough water for all our uses - fresh water, which we presently let go into the sea.

We have three ways of water storage. We can store it in the soils; we can store it in surface earth tanks, and we can store it in sealed catchments. For an agricultural situation, we will use the soils. For domestic situations, we will use earth tanks. They are very much cheaper. For every 5.000 gallons we can store in concrete tanks, we can store 250,000 in Earth tanks at the same cost.

We have legal and financial strategies. We can convert locally into far more self-reliant bioregions. The people who are doing that are adding greenhouses to their houses and doing their own gardening. There is an immense conversion going on. That's where we start, dealing with an acre.

Now the thing that we have ignored, not only turned our backs on but often fled from, is conversion of high level investment capital to these low energy systems. There are a whole set of strategies to do so that we are assembling as an "Earth banks" service. Some of these strategies will benefit our social happiness as well.

The only way we can do things fast is by making the least number of moves in the fastest possible time, and by very rapid delegation of work to people. There is no hope that we can get this done in the next five years if we keep it to ourselves. Therefore I have come here to break the monopoly of the elite alternative in America. We have got to let experts loose on the ground. We need hundreds and hundreds of them. We don't want at any time to patent anything or to keep any information to ourselves, not even keep our jobs to ourselves. The time for that is gone. What we are involved in is a co-operative, not a competitive, system. There are a very few of us operating at this end of the system, therefore we have to act in a very efficient way in order to create the greatest amount of change in the shortest period of time.

I think we have an ethic here: to stop admiring the people who have money. There has to be a big ethical change. It is an interesting time to be living in. The big twist we have to make is away from our educational system. All the methodologies and principles we use arose as a result of observation of natural systems, and are stated in a passive way. The mind twist that has to be made to create permaculture is to realize that you can get hold of that and do it. We have to make our knowledge active. We have to move from a passive to an active thought level.

"Agriculture is a destructive system."

What are the strategies by which we don't need agriculture? Agriculture is a destructive system. Well, we need a lot more gardeners. Gardeners are the most productive, most hands-on sort of agriculturists. They always have been. There never has been any debate about it. When you make a farm big, you just accept a suddenly lower productivity and yield, but less people get it. That is why it is economically "efficient." When you talk about efficient farming of this order, you are talking about dollars. When you reduce the size of the owned landscape, providing you don't reduce the lots to less than a quarter of an acre, the agricultural productivity goes up. You get a lot of arguments to the effect that breaking up large farms into five acre blocks is uneconomic. Five acre blocks are. One to one-quarter acre blocks are not. They are highly productive.

How many gardeners are there in the United States? Fifty-three percent of households now garden. They garden only 600 square feet on the average. They make something like $1.50 a square foot. These household gardens are producing 18% of the food in the United States, at a value almost equivalent to total agriculture.

Now let's look at Russia. The peasant farmer, on a half-acre to an acre, is producing some 84% of the food. The state farms, which occupy most of the agricultural land, produce the remainder. But the state farms are not doing their job. They have a 6% deficit, which is shipped in from Canada or the United States. The glamorous agriculture, the large scale, broad scale agriculture, is not the agriculture that is producing the food. We are now down to about 20 basic foods. The day of soybeans is probably arriving. You can make just about anything out of soybeans.

Control of Seeds

I don't think that there are very many seed companies left in the world that don't belong to a consortium of not more than 10 companies. It is certainly true in Australia. The seed is now being grown for and distributed by the multi-nationals. Can you buy a non-hybrid corn in the United States? Here and there. In Australia, we can't. But we do have one seed company. It is called Self- Reliance Seed Company in Stanley, Tasmania. Maybe we have two. [Self-Reliant Seeds is now defunct, but it was replaced by Phoenix seeds, also of Tasmania. Ed.]

The next move of the large seed-growing consortiums was to have been seed-patenting legislation. At this point, a lot of people started to get a bit suspicious. The patenting of biological materials was a slightly suspicious move. Then the World Council of Churches looked into the situation and produced Seeds of the Earth. The cat was out of

the bag. So there has been a general ground- level revolt against take-over of a basic resource. Kent Whealy's Seed Savers Exchange is just one of these moves.
But one thing this may have taught is that you can't run away from systems. Holing up in two acres out in the New England forests isn't going to get you out of the system unless you are into a seed-growing operation and know exactly what you're doing. Most people do not. If you are training yourself to be a good gardener, there are still certain areas you just haven't got into, and seed growing is one of them. In one valley in Tasmania, among a group of hippies living there, you might find 50 Ph.D.s. Most of them are sitting home knitting or weaving or running around getting blackberries, just leaving it to the really ruthless people to get on with what they are doing. We must involve all our skills to organize life forces, not just a few.
In the permaculture garden, we must deal with the question of ways in which elements are to be placed. Some of these elements are manurial or energy-exchange systems for other elements; others are defensive elements that protect other plants in a whole set of ways; and some act as trellis systems for others or provide shade. So there are physical relationships involved and there are whole sets of rules that govern why certain elements are put together. And we understand some of these rules. A lot of them are quite obvious.

Diversity

Diversity isn't involved so much with the number of elements in a system as it is with the number of functional connections between these elements. Diversity is not the number of things, but the number of ways in which things work. This really is the direction in which permaculture thinking is headed. I was sitting up one evening, studying how many connections are made by putting just two elements together - a greenhouse and a chicken coop. I think I came up with 129 sorts of beneficial connections. So what we are really talking about is not some grandiose complication of 3,000 species on a site.
It would be nice to make 3,000 connections between 30 species or 30 elements, with those connections defined as being beneficial or non-beneficial. You can see hundreds of examples, particularly in social groups, where diverse interests are not necessarily beneficial. Diversity of itself doesn't give you any stability or advantage.
So what we are setting up is a sort of guild of things that work harmoniously together. There are rules to follow on placement within the area. There are rules that have to do with orientation, with zonation, and with the interactions. There are whole sets of principles which govern why we put things together and why things work.
The agriculture departments have defined agricultural land. What they mean is land which can be tilled. But I don't see any landscape as being non-agricultural. There is a whole hierarchy of productivity in landscape, and it all can be used for production. So there are really two strategies for our consideration in agriculture. One is to find out what is the minimum level to which we can reduce agricultural practice, and to go about that. Another is to find the level at which we can increase the use of land termed non- agricultural for agricultural products. There are all sorts of new games to be played. I am literally amazed how little these forests in America are used for sustained productive purposes, as forests.

Principles

Let us look at the sets of principles that govern these systems. These principles, rules and directives are based on the study of natural systems. Axioms are established principles or self-evident truths. A principle is a basic truth, a rule of conduct, a way to proceed. A law is a statement of fact backed up by a set of hypotheses which have proved to be correct or tenable. Theses and hypotheses are ideas offered up for proof or discussion. There are also rules and laws laid down which are neither rules or laws. They do not pay much attention to defining how they got there. Now I have evolved a set of directives which say: "Here is a good way to proceed." It doesn't have anything to do with laws or rules, just principles.

Energy, Source, and Sink

We deal with the Earth, which has a fairly constant energy input from other parts of the universe. We are dealing with energy which has a renewable source, the sun. [Not true--the sun is using itself up. However it will expand and consume the Earth before it ceases to be a source of the shorter wavelengths. -DH] Between the source and the sink is where we intervene. The more useful storages to which we can direct energy between the source and the sink, the better we are as designers. So what we are up to is making an efficient set of storages that are useful to man [sic.]. Some of these storages may be useful in the creation of other storages. The amount of complexity we can build into that flow, the amount that we can direct to useable storages in order to hold back energy until we start to use it, that's where the skill of the designer lies. Furthermore, a lot of energies unusable in a mechanical sense are usable in the biological sense. So we need biological as well as mechanical storages.
Energy can be transferred from one form to another, but it cannot disappear or be destroyed or created. So we have a choice in the type of flow that we allow through the system. We can determine whether it is stored or whether we let it leave.
That is the choice we have with water, with rainfall. We can store it or we can let it leave; and if we let it leave, it becomes unavailable to us.

If we would recover it, there is a lot of work to making it available again. Engineers go down to the valley, because everybody can see there is water down in the valley. So they put a block in the valley and the water backs up behind it and you have water, a big lake down in the valley where it is least useful. Where it came from was up on the hills. Had the engineers stored the water where it came from, then they could have run it through all sorts of systems before they let it escape into the valley. The closer to the source that we can intervene, the greater use is the network that we can set up. So we edge up close to the source to start to intervene in the flow. It's not the amount of rainfall that counts, it is the number of duties we induce that water to perform that counts.
Not all energy that goes into the system is efficient. Whenever we change the line of energy, we lose a little. No matter how well we design, we must always lose a bit.
A lot depends on the maintenance of the global biological-chemical cycle of essential elements, particularly carbon, nitrogen, oxygen, sulphur and phosphorous. We are worried about some of these cycles.
The probability of the extinction of a species is greatest when the density is very high or very low. There is a density dependence. You can see how high density is a dangerous thing for species because of very rapid transmission of plague resulting from the exhaustion of critical elements upon which the species depends. It is more difficult to see how very low densities are also critical situations. The factor of number is a factor ignored by most communes or communities.
"The probability of the extinction of a species is greatest when the density is very high or very low."
I don't think we know of any society of man whose continuance depends on their own genetic health that can exist below 300 in population, and not even at that number without very rigorous genetic control. We are breeding for extinction in several areas. High density populations often also start to include an enormous range of genetic disasters or mutations.
It is possible to make small changes in a general system to bring about a higher chance of survival of the elements of the system, or high yield within the system. There is an horrific statement called the over-run thesis which says:
"Our ability to change the face of the Earth increases at a faster rate than our ability to foresee the consequences of that change."
And there is the life-ethic thesis, which says that living organisms and living systems are not only means but ends. In addition to their value to man, or their instrumental value to human beings, they have an intrinsic worth which we don't allow them. That a tree is something of value in itself, even if it has no value to us, that notion is a pretty foreign sort of thought to us. That it is alive and functioning is what is important.

Resources

Resources are something you can feed into a system and increase its productivity, or its yield, or the number of useful storages. But if you continue beyond that point of productivity, then the system itself collapses. And that comes down to the statement that any integrated system can only accept that amount of energy that it can productively use. So you can over-manure anything, over-heat anything; you can over-plow anything. Whether we are talking about money or manure, you can put too much of it in. What then happens is first you start to get less and less increase in yield and then more and more increase in a lethal factor. You can't continue to pour in more of the same thing and get a continued increase in yield.
A friend of mine went to Hong Kong. He ran a sort of energy budget on the city, paying a lot of attention to agriculture. He told me that the older Chinese agriculture (weeding by hand) produced, under very intensive conditions, using natural manures, about three times as much energy as it consumed. Then they modernized, utilizing small tractors, artificial fertilizer, and weeded by little hot jet flames. I think he said that they put 800% more energy in and got a 15% increase in yield. And then as they continued to pour in more energy, the yield decreased. By now they are into the same kick that we have. They only get 4% to 6% of that energy out again.
So agriculture went from an energy productive to an energy consuming system, just as the sea has gone from being oxygen producing to oxygen consuming, all because we are putting too much nutrient into it. You can do it to a pond very quickly and to a nation or a continent more slowly.
Then there are categories of resources that are of a totally different sort. There are resources which are unaffected by use. You can look at a beautiful view all day and it really doesn't affect the view. Information is such a resource. [But information is preserved by use. -DH]
There is another category of things that is interesting in that they increase if you use them. The more you use them, the more that they increase. Some forms of browse fall into that category. Some categories of animals and plants increase each other by interaction, and some other categories of resource also do that. And some resources, particularly quick turnover resources, simply decrease if you don't use them. Annual grass is a good example. If not used, the amount of annual grass in the system decreases. To some extent, so does firewood in a fire-prone situation. It accumulates as a fuel for wildfire when all of it is consumed at once.
But most resources lie in the category of resources that need to be managed to maintain them. They are those which decrease if used. We will call them finite resources.
There is still another category made up of resources that, if you use them, decrease everything else. We have a good example of that in uranium or plutonium. Plutonium in use tends to lay waste to other resources and some of those uses are horrific. Things like dioxins, if used as a resource, start to decrease the general resource.

So resources have a sort of hierarchy of management and a hierarchy of being beneficial or not beneficial. Most of the things that make us happy either are very manageable or there are plenty of them. There a few things which we think we need, but which make us miserable.
I think we can pollute with time, and I expect that we can, also, with diversity. Just by putting a lot of things together, we might reach the stage where we pollute the system simply with diversity.
Petrol (gasoline) is a resource which has created disorder in Western society. I can't think when someone last productively used a gallon of gasoline. Nearly all of it is used non-productively. I used a pint or two once to destroy a nest of bull ants to which I am allergic. As far as I was concerned, that was productive. I also do not know of a case in tractor economy where a machine produces more energy than it uses. You have to take the oil out of the ground, you have to refine it, you have to ship it. You argue that petrol fueled the jet upon which I traveled when I came over here. Right. But I came over here just so that you wouldn't have to go over there. It is true that petrol has some present uses - what I call restitutional uses. But generally speaking, the use of gasoline has resulted in terrible disorder. It reaches right into the social structure. Chaos is really the opposite of harmony. It is conflicting competition and individualism. When everything is in chaos, if there are two or three of you going in one direction, you have to win, hands down, for everything else is really falling to pieces. So maybe we will win; maybe we are seizing an historic opportunity.
When we design, I keep coming back to what we do. We have a two-fold job: to recommend only the energies that are productive, energies that are not harmful, and to attempt to build harmony into functional organization, to pickup the pieces and make harmonious order.
We should not confuse order and tidiness. Tidiness is something that happens when you have frontal brain damage. You get very tidy. Tidiness is symptomatic of brain damage. Creativity, on the other hand, is symptomatic of a fairly whole brain, and is usually a disordered affair. The tolerance for disorder is one of the very few healthy signs in life. If you can tolerate disorder, you are probably healthy. Creativity is seldom tidy.

"Tidiness is symptomatic of brain damage."

Tidiness is like the painting of that straight up and down American with his fork and his straight rows. The British garden is a sign of extraordinary tidiness and functional disorder. You can measure it easily, but it doesn't yield much. What we want is creative disorder. I repeat, it is not the number of elements in a system that is important, but the degree of functional organization of those elements - beneficial functions.
Yield is the sum of useful energy stores. It is the sum of energy conserved and generated in systems. It is never just product yield, not the number of pounds of tomatoes, or pounds of fish, or of acorns - which is the normal way people have of measuring yield - but it is the sum of the energy in useful storages. Yield is a function of design, and it is theoretically unlimited. That is, I haven't seen a system where we can't, by better design, increase the yield.
As the design itself is a function of our understanding of the system, so does the yield also depend upon the degree to which we understand things. It is the intellect that decides all these things, rather than any extrinsic factors. I am not quite sure what the intellect is. I have put it as our ability to understand, which may not be intellectual but empathetical.
Between the source and the sink, diversity increases: energy stores may increase and organizational complexity may increase. Our job is to convert those pauses in the flux of some of those categories into beneficial resources. It is the number of niches in a system that will allow a number of species and varieties to co-survive. It is the woodpecker's hole within the forest.
Now, again, the number of niches in a system depends on the design of the system. So now we have come to the active case. In situations which should be saturated with species, and with yield, we can make a vast difference by seeing where we can create more space, often by very small movements. [After first seeing where the unfilled niches, the empty spaces, exist, and filling them. Temperate ecosystems, in particular, often are incomplete.-DH]
The numbers of pairs of pigeons breeding on a cliff depends on the number of ledges. It is easy to increase the ledges. Often, what is holding down a yield isn't the basic factor of food. In fact, food ceilings are very rare things to bump. It is some other factor totally unrelated to food. There are tons of food [acorns] around this environment [Wilton, New Hampshire], with nothing eating it.
What we must do is to see how things work, how different things work. Tribal lore prescribes that one should only carry out necessitous acts, that non-necessitous behavior tends to be very destructive. The rest follows. Therefore, one apologizes for whatever one has to do and does it. But you don't see people doing unnecessary acts.
Some time around 1952, I had a house in the bush, and I thought, as a curious thing to do, I wouldn't cut down a tree unless I had to. I never had to. But we could also live in the bush and cut trees down. Unfortunately, if you have money, it is hard not to. You are always doing something because you have to get rid of that money. Like petrol.
As I see it, tribal myth was a way to teach care of the environment. I believe that we are involved in a more complicated game than we had previously thought.
If you put fish and a set of algae in a pond, and one of those algae is particularly delicious, the fish chomp on the delicious algae until there are none of those left. Thus they disfavor them. Then the other algae, not palatable to the fish, increase, thereby controlling the fish, starving the fish out. Fish eats algae; algae destroys fish.

We let cattle go on landscapes, and the landscapes respond. The cattle disfavor plants that they like and thereby produce a system of plants that they don't like. That closes the landscape off to cattle. Some of those plants are poisonous to cattle. Time and time and time again, this is what we observe, that the landscape responds.
There is a response within the landscape against damaging things. I don't know how it works against one of these coal machines that chew up the Earth, but it probably has a long-term response, which may be acid rain. So, you don't push something without it sort of pushes back. We are into all this mechanical physics, which says that every action has an equal and opposite reaction. But the Chinese say, "No, that's not true." If you kick a living system, it kicks back harder. Its reaction is often unfairly oppressive. You might simply push someone out the door. That person re-enters with a pitch fork, not just pushing back in, but ready to poke holes in you.
Now there are different sorts of acts. There are necessitous acts and harmful acts. But there are also beneficial acts. And that gives us another hypothesis - that you probably will get more good back than you design. And this seems also to be true. What has probably been happening from the beginning of a consciously designed system is that when we put three elements in conjunction so that they are pretty harmonious, other beneficial results come out that we didn't design. Now that has happened almost without exception.
This is something that isn't being taught: that once we have done one thing correctly it goes on and it proceeds to do a lot of other things by itself. This seems to be happening. So it looks like there is something going on there, and it is very hard to analyze. Sometimes you make a single move, simple and right, which you intend to be beneficial, and you discover, if you stand back and observe it and leave it alone, that it goes on and gives you maybe another 10 benefits which you didn't count on. Then, if you look into it closely, although you put it together for a single reason - you had reasoned it out - you see that once you did that, there were 12 or 15 other reasons why you should have done it. I think we all know examples of this.
When somebody clamped the greenhouse onto the front of the house instead of standing it out there in the sun, he may have done it for a single reason, to heat the house, perhaps, or simply to make it easier to tend it. But then lots of other good things came out of that.
We are not quite sure what they are doing, but the aboriginal groups go around polishing up their country with little ceremonies. They are fairly secretive about what they do, but certainly they are doing a little countryside adjustment. They have to do a little ceremony to keep the springs flowing along certain a mountainside. We laugh at them. We know those springs will flow whether they have a ceremony there or not. But if we take their religions away, the springs will stop flowing. You don't talk to idiots about advanced concepts. Anyway, they won't tell us much about what they know. I suppose they would worry about what we would do with the information.
So here is another whole way of thinking about things which I think we would find very productive because it is a usable way to summarize a lot of things. We can make principles out of it, if we like. "Everything works both ways," is one of them. "If you do something right, it will do a lot more right itself," is another.
Now we have arguments as to whether we start from principles and to the real world, or - as I try to proceed - we go to the real world and get to principles. Do we look at what is really happening and sit down under a tree and think: "Well something like that is going on out here"? Or do we start going into nature and try to understand what is happening and then go to the garden? We have this argument about which way you proceed: Philosophy to garden or garden to philosophy. I think that there are people traveling both ways, people coming from the abstract to the garden and people coming from the garden to the abstract. Most of us are coming up out of the garden and heading towards the philosophy. A few have been up to the temple and are coming down to the garden.
I think, again, in our general education, and particularly in our primary education, that we get an awful lot of static phenomena taught to us, and cross sectional phenomena. But we are not taught interactive processes, and we are not taught much about the resonance of things. The real world that we live in is in constant flux. Things are on their way somewhere all the time. There isn't such a thing as a quiet picture of a natural phenomenon. Everything is on its way to other phases. Yet we teach things as sort of rigid truths. We are culturally blocked. It is because it is a scientific culture; we try to measure everything. There are different ways of coming at things. I can't handle symbols; some people cannot handle numbers; some cannot handle dimension. This is why it is beneficial to associate in small groups, just to try to bring different lights on the same truths, trying to comprehend the different shadows of reality. This dynamic is lacking in education.
There is something we ought to be sitting on the floor and talking about a lot. There is this harmonic that, if we could get hold of it, would give us a lot of understanding, a lot of control over events. Our job is to put things in the right place and then let them rip. But to get one in the right place, we have to have a lot of information about it. Anything we are trying to place, whether it is a building or a tree or an animal or a road or a structure or a person, we have to know these things about it. We have to know its intrinsic functions, what is natural for it to do,the things it can't help doing by virtue of just being itself, being alive. Some animals and plants must spawn and they do that in different ways. Then there are things that we can categorize as yield, which we might be interested in. These may be of two or three levels or natures. There are what we might call direct yields. Chickens lay eggs. Then perhaps there are yields which are derived, secondary, or processed yields. Chicken manure will yield methane. And we have to know what the different yields are.
It also pays to know how elements function. They have behaviors, things that they do. They walk around or they sway about. They have properties. They will or will not reflect light. They have properties by reason of what they are. They have a color. They behave. They have a whole set of interactions and stimulus-response behaviors.

Behaviors are short -term and long-term, too. Too often we comment on the short-term behavior of things, which isn't how they behave in the long term. Our science, and particularly psychology, suffers a great deal by not looking at the long-term behavior.

Now if we knew enough, if we had enough information, then a lot of these things could be listed for each element in the system, each entity. And then we could make a tremendous amount of design use of it. But they are not the things that are being listed as knowledge about the entities. You can obtain knowledge of almost anything about a tree except these things. Bad luck! Very little is known about the properties of a tree. As to the yield, it may be almost unknowable. I once tried to find out how people have used walnut trees. I found out that there is a people who base their whole culture on the walnut; other people may base their culture on bamboo. Or you can just take the walnuts by themselves. It is up to you.

If you have a fair idea of what is known about something, then you are able to place it so that it can function, so that its intrinsic function is possible to it. Then it will give its yields and its secondary yields can be taken advantage of, and it will behave in a friendly way because we put it near to things that are beneficial to it.

There is an enormous difference between the way we make a design in permaculture and the way an agriculturist would make it. Really, what we are up to is trying to let things function in a natural way.