Intsangano Website: Fourth Core Article

"Developing a Quality of Life: Including Concerns for Society and Nature in Technology" or "Critique of Technology" ***Written by Jytte Nhanenge***

Article from www.intsangano.com: ñForum for Holistic Transformation: Ending Patriarchy, and Creating a Quality of Life for Society and Nature Worldwide - An Educational Websiteò

Categories: 2. Economics, production, trade; 4. Knowledge, education, information, religion, technology 5. Nature, climate, minerals; 7. Poverty, crises, Third World development; 8. Society, population, culture; 10. Worldviews, perception

Tags: Technology, Poverty, Third World Development, Nature, Exploitation, Quality of life, Worldviews.

Keywords: Access to energy, appropriate technology, Banqiao Dam, clean drinking water, critique of technology, dam effects, destructive technology, development history, economic growth, energy poverty, energy, environmental issues, Gilgel Gibe III Dam, inappropriate technology, Intermediate Technology, Narmada Valley Project, poverty, Sichuan Earthquake, small-scale hydropower, solar lantern, solar light bulb, solar panel, solar power, South-to-North Water Diversion Project, technical development, technology, Three Gorges Dam, values of technology, water dam, yang, yin.

Abstract:
This article argues that perceiving development as a technical ñfixò for poverty alleviation is a paradox. While applying modern technology may increase economic quantities and create a modern living standard for the elite, it removes lands, forests, and waters from local peoplesô subsistence, destroying their quality of life and creating poverty. The construction of large water dams is used as an example. While hydro technology is generating economic growth, the dam effects are giving social and environmental damage. To understand why this happens, the underlying values of modern technology are analyzed, and it is examined how development became a technical fix. The analysis clarifies that technology is dominated by vested interests, promoting large-scale, capital-intensive technologies meant for individual profit-making, rather than for social benefit. Modern technology therefore concentrates power and wealth in few hands, while making the majority poorer and more powerless. Thus, ñinappropriateò technology has become a means for the elite to dominate society and exploit nature, opposing democracy. The article ends with presenting alternative technologies, which are cheap, small-scale, gentle to nature, and designed to serve poor people. Appropriate technology can create human well-being and independence; it can alleviate poverty and bring about sustainable livelihoods, all of which will contribute to a needed decentralization of power.

Biographical Details:
Jytte Nhanenge is a Danish woman, who has been working with Third World development in Africa for many years. Being troubled about developmentôs inability to alleviate poverty, she decided to find out what is wrong with development. She then embarked on a lengthy study period at University of South Africa (UNISA). Her search was for an ethics in development. Using inputs from many insightful authors, Jytte compiled the outcome of her search in a comprehensive dissertation titled, ñEcofeminism: Towards Integrating the Concerns of Women, Poor People, and Nature into Development.ò She rewrote the dissertation into book form, and in 2011 it was published by University Press of America. In this article, Jytte shares some of the insight she gained during her long search for limitations in development. Jytte lives in Chimoio, Mozambique.

Developing a Quality of Life: Including Concerns for Society and Nature in Technology

"I have no doubt that it is possible to give a new direction to technological development, a direction that shall lead it back to the real needs of man, and that also means: to the actual size of man. Man is small, and, therefore, small is beautiful. To go for gigantism is to go for self-destruction.... To re-direct technology so that it serves man instead of destroying him requires primarily an effort of the imagination and an abandonment of fear." E. F. Schumacher ñSmall is Beautiful,ò 1976 (1993, 131).

Technical Development: Causing Crises for Society and Nature

Introduction

The focus of mainstream Third World development is on increasing economic growth in the developing countries. Most politicians, economists, and government officials assume this is necessary in order to alleviate poverty and create modern societies. The plan is to use modern, scientific technology as a means to raise a countryôs productivity, which is anticipated to result in economic growth. Nevertheless, after more than 60 years of economic development, poverty is still rife. There are around 1.4 billion absolute poor people living below 1.25 USD per day, while approximately 1 billion people are hungry. Many commentators find that this dire situation is not due to lack of development; it is more correctly the development approach that is causing such impoverishment. Development activities normally focus on ñmodernizingò peopleôs lives, which includes increasing consumption, rather than improving human well-being. As a consequence of this view, development becomes the source of social misery and environmental destruction. When development turns natural resources ï which provide a large number of people with decent subsistence livelihood ï into industrial raw materials, the profit from which benefits relatively few, then poverty is created. When development projects are using the lands, soils, and waters of traditional people to produce electricity for industries, to cultivate commercial crops for international trade, and to manufacture food for the formal market, then traditional people cannot anymore live from their natural resources. When development projects remove people from their traditional society into another social constellation with different norms where they cannot participate, then development causes them to lose all that gave meaning in their lives. Before development was introduced, people were not dispossessed or poor. People lived modest but self-sustaining lives from their natural environments. They were also considered useful and productive members of their communities. However, when development activities diverted their natural resources towards economic growth, people could no longer be self-provisioning. Therefore, when Northern and Southern governments introduced the project of development, people became poor and their natural resources became exhausted. From this it follows that development destroys wholesome and sustainable lifestyles, creates scarcity of basic needs, excludes an increasing number of people from their entitlement to food, and generates real poverty and misery. Perceived in this way, the modern project of development is a threat for the survival of the great majority. Rather than being a strategy for poverty alleviation, development is creating poverty and environmental destruction. (Ekins 1992, 8-9; FAO 2009; Shiva 1989, 10-11; Shiva 1990, 197-198; World Bank 2010).

This article will present some reasons as to why development gives these results. The discussion will focus specifically on the Northern and Southern governmentsô one-sided focus on modern, scientific, and inappropriate technology as a tool to promote economic development in the South.

The Case of Water Dams, and the Dam Effects

Fresh water is needed for all forms of life on Earth. However, population growth and modern standards of living has meant increased water demands. Thus, water use has amplified 4 times during the 60 years as from 1934 to 1994. The high requirements for water relate mainly to modern agriculture, which accounts for 2/3 of global water use. The scientific method of crop production, with its application of artificial fertilizers, chemicals, and its high yielding variety of seeds, require irrigation. In order to direct water to agricultural uses, large water schemes are proposed and water dams are constructed. Since these also produce electricity, water dams have become popular. However, as discussed below, this type of water management is highly doubtful when we consider the negative dam effects. (Ekins et al. 1992, 17; Houghton 1994, 97).

Large dams have long been a prestige symbol in modern industrialization and development. In the modern perspective, a dam is a scientific technology utilized to increase economic growth. In the world there are about 50,000 large dams (above 15 meters high) and around 800,000 dams of a lesser height. Most large dams were built in order to irrigate cash crops. Hence, 30 to 40 percent of the 271 million hectares irrigated agricultural fields in the world are irrigated by water from dams. Water dams are also important for production of hydro power. Sixty-three percent of renewable energy used in the world is produced by dams (2005 figures). Building of dams worldwide topped during the 1970s, when around a thousand large dams were being erected annually. However, it slowly became evident that construction of big dams has many negative side-effects. Hence, at the end of the 20th century the harmful impacts of poorly planned and inadequately implemented water projects became clear. The building of these colossal structures meant that governments displaced their own indigenous people, causing human misery and poverty. To investigate the effects of water dams, the World Bank and the International Union for Conservation of Nature created in 1998 the World Commission on Dams. In their report, published in year 2000, the Commission established that, ñLarge dams have had serious impacts on the lives, livelihoods, cultures, and spiritual existence of indigenous and tribal peoples.ò The Commission also recognized that large dam projects, ñhave led to the impoverishment and suffering of millions.ò Thus, the report recommends that building of future dams should be guided by tribal peoples free, prior, and informed consent. The dam effects do not only give social tragedies, the water dams also have huge negative impacts on nature. The Ecologist Magazine has called these giant water projects for ñmassive ecological destructions.ò They are recommending that due to the negative effects of dams, decision makers stop all large-scale water development schemes. In spite of the documented human sufferings and the stern environmental warnings, planning of large dams is resurfacing. Hence, decision makers ignore experiences; they are again marginalizing indigenous peoples worldwide and destroying their lands. (Ekins 1992: 88-89; Good Planet; Survival International 2010).

One example of a gigantic water development scheme meant to support economic growth is Narmada Valley Project in Indiaôs states of Gujarat, Madhya Pradesh, and Maharashtra. Ever since the initial idea was suggested in 1945-46, and more clearly conceived in the 1960s, the project has been controversial. It is the most comprehensive hydroelectric and irrigation water complex ever proposed in the world. It comprises two very large dams, 28 major dams, 135 medium dams, and 3,000 minor dams to be built over a period of 50 years, costing 5 billion USD. The largest dam is the Sardar Sarovar Project, which has been the focus of controversy since the 1980s. The Sardar Sarovar Project is estimated to generate 1,450 MW [1)] of electricity and it is designed to irrigate over 18,000 square km of land. Moreover, it should supply safe drinking water to thousands of villages. The World Bank gave a loan of 450 million USD for the Sardar Sarovar Dam in 1988 and was considering financial support to a second dam as well. The Narmada is Indiaôs fifth largest river. It is the home and livelihood for around 21 million people and it is the destination for hundreds of thousands of Hindu pilgrims who visit shrines along its banks each year. Hence, the river has important cultural, religious,

economic, and ecological functions. Nevertheless, the economists at the World Bank saw that differently. According to their calculations only 4 percent of the water was utilized, thus the river is unproductive, and water is wasted. However, they decided this could be changed by the building of dams. In spite of their careful calculations, the Narmada Valley Project has been referred to as an environmental catastrophe, a technological dinosaur, and an example of flagrant social injustice. (Ekins 1992, 9-10; Elliott 1994, 48-49; Friends of River Narmada).

The proposed two large dams will officially displace 200,000 mainly tribal people. Unofficial figures are higher, suggesting that more than 320,000 people will be displaced, while the livelihoods of thousands others will be negatively influenced. Overall, due to related displacements by the canal system and other associated projects, at least 1 million people are expected to be adversely affected if the project is completed. There is no prospect of giving the displaced people fertile land elsewhere. A spokesperson from Survival International, an organization working for tribal peoplesô rights worldwide, had early on suggested that the Indian government did not identify land for resettlement because there is no land available. Almost all cultivatable land in the region is already farmed and the remainder is of a too poor quality for permanent cultivation. These tribal people will therefore become development refugees living in the slums of Bombay, like so many others before them. Survival Internationalôs assumption was later on confirmed. In the Supreme Court, the Madhya Pradesh government indeed declared under oath that there is no land to resettle the project-affected people. A government justification for still implementing the dams was that the project would provide clean drinking water to the poorest people living in the most arid lands. Nevertheless, this promise is unlikely to be fulfilled. Feasibility studies for supplying safe drinking water were initiated only in 1998 and no money from the Sardar Sarovar Project budget has been allocated for drinking water projects. Consequently, the main beneficiaries from the dam will be the better off landowners, who will receive water for irrigation of their cash crops. In addition, the damôs hydroelectricity will benefit cities, owners of industries, and the urban middle class. The authorities have for example agreed to allocate Vadodara city a substantial quantity of water. Hence, owners of various economic activities like sugar-mills, water-parks, golf-courses, and five-star hotels have lined up to obtain licenses. The government sees these activities as increasing overall productivity and thus promoting economic growth, which they assume is necessary for poverty alleviation. Thus, the government policy is to support the elite with water and electricity. This assumption is, however, false. Experience shows that the wealth gained from increased productivity does not trickle down to the poor. Rather, the difference between rich and poor will increase and poverty will intensify. The reason is that the wealth generated will flow into production of goods attractive for the high-income earners and for export to rich countries. Moreover, rich people in the South often want to spend their money on their own modern lifestyles. They therefore import luxury Western consumer goods, rather than investing their wealth into producing goods useful for poor people. Such productive activities will not alleviate poverty; they conversely make the rich richer. Consequently and paradoxically, application of modern technology in development, funded by Northern loans/aid, ends up benefiting the Northern and Southern elites. Conclusively, the assumption that economic growth in the South will alleviate its poverty is not based on reality; it is merely an economic theoretical model, which is inappropriate as a development strategy. (Ekins 1992, 9-10; Elliott 1994, 48-49; Friends of River Narmada; Trainer 1997, 585).

Apart from displacing hundreds of thousands of people without adequate resettlement and rehabilitation, the dams will submerge 2,000 square km of fertile land and 1,500 square km of prime Teak and Sal forest, including its rare wildlife and genetic biological resources. Also historic sites will be eliminated. Due to the decrease in rainfall the deforestation will cause, plans were made to replace natural forests with plantations. However, artificially cultivated forests are not ecologically effective as are natural forests. In sum, some environmentalists have estimated that environmental losses due to

submergence equal an amount three times the total calculated cost of constructing one dam. To make things worse, the dams will siltate. Silt is a common concept for soil particles and small rock fragments. Water and wind will pick up silt and deposit it as sediment elsewhere. Sediment is a name for matter that is deposited by a natural course of action. Siltation is consequently the process of a place becoming clogged by fine sediments. The result for the dam is that the water in the reservoir will be filled with mud and clay due to erosion from the degraded catchments areas. Siltation will limit the damsô performance and life. For this reason it is not unusual that hydroelectric dams produce considerably less electricity than the experts originally advertised. Serious health impacts from water-borne diseases are also expected to occur. Water impoundments considerably increase water evaporation, especially in hot areas, making a damôs reservoir a perfect breeding ground for vectors of disease, including malarial mosquitoes and snails carrying bilharzia. The introduction of irrigated agriculture into soils not meant to contain much water often results in water-logging and salinisation. Water-logging is the soaking of agricultural land caused by rising water-table often due to excessive irrigation. Water-logging will compact soils, depriving plant roots of oxygen, which may contribute to salinisation. Salinisation is accumulation of salts in the soil, which are released by irrigation and thus becomes poisonous for plants. Salinisation of soil will eventually make the land inadequate for farming. It is estimated that 40 percent of the farmland will be water-logged and salinisation will occur. A research showed that crop yields in one district declined after fields were irrigated with water from a minor dam. In addition to the above problems, damming has various negative impacts on backwaters and downstream ecosystems, including interruption of fisheries for local people. Changing the flow of a river affects the movement of the fish that live in it. Since fish is a major food source for many tribal peoples, decline in its numbers will cause food insecurity. Finally, Narmada lies in a seismic zone where thirty earthquakes have shaken the region during the last 200 years. The sheer weight of the new giant reservoirs could trigger an earthquake with serious effects for the area. (Ekins 1992, 89-90, 93-95; Elliott 1994, 47-49; Good Planet; Survival International 2010).

From this it follows that the water project will have disastrous ecological consequences, which have been completely overlooked by the World Bank economists. Those ï together with making the indigenous people destitute ï are huge sacrifices for modern ñprogress.ò The protests against the project have therefore developed into a powerful social movement. Some have referred to the anti-dam movement as Indiaôs first nationwide environmental protest. People demonstrate and refuse to cooperate in reallocation, bringing the construction work to a halt by non-violent actions. People feel that the staff of the World Bank gave them false information regarding the project and its negative side effects. At one moment it resulted in a major demonstration outside the World Bankôs Delhi office. The protesters have sworn not to give in but to intensify their opposition against the dams. Hence, the project is riddled with social unrest; poor planning; misinformation; negligence of respect for human beings, the environment, and economic issues. This again has led to widespread human rights violations by the Indian government. As a result the World Bank withdrew it financial assistance in 1994. (Ekins et al. 1992, 26; Ekins 1992, 89-90, 95-96; Elliott 1994, 49; Wikipedia on the Sardar Sarovar Project 2011).

In 1990 some 70 ongoing World Bank projects were forcibly displacing 1.5 million people. More than 60 percent of all population displacements endorsed by the World Bank relates to water dam projects. The World Bankôs own review of these projects, during a period of ten years, found that the number of people actually dispossessed was 47 percent higher than the estimates. Thus, underestimation of the number of people negatively affected by the dams is endemic. In almost all the cases the dispossessed are not given any land or they are given inadequate land, causing them to become impoverished, destitute, and dependent on aid. This is due to the inadequacy of the resettlement and rehabilitation process. Compensation for loss of land or livelihood is often available only to those who can prove legal ownership of the land. Most tribal people do not have titles deeds to their land,

and governments often refuse to recognize their collective and ancient land rights. For example, only 45 out of 300 families in the tribal village of Manibeli, flooded by the Sardar Sarovar dam, were offered compensation and resettlement packages for their losses. The rest were overlooked, although they had lived at the place for generations. Since they could not produce land titles the officials found that they did not qualify. (Ekins et al. 1992, 22-23; Survival International 2010).

The whole idea of offering financial compensation to traditional people in exchange for their land is irreconcilable with their traditional values and it is therefore highly unethical. For indigenous peoples no amount of money can make up for the loss of their land. The relationship between tribal peoples and their lands is profound. The land, the people, and the spirits of their ancestors are connected by an unbreakable bond. For most traditional people the land is alive, it is like a parent who provides for all aspects of their lives ï physical, mental, and spiritual. Tribal people who are taken from their land often succumb to alcoholism and depression. The loss of land, loss of way of life, loss of social relations, loss of cultural roots, and loss of livelihood may also drive some people to commit suicide. The suicide rate of tribal peoples who have lost their land is regularly higher than the national averages. Canadian Indians are up to ten times more likely to commit suicide than the rest of the Canadian population. (Survival International 2010).

The International Labor Organization (ILO) Convention 169 is an international law dedicated to protecting the rights of tribal and indigenous peoples. Yet, most countries refuse to ratify it. In 1985, Survival International complained to ILO over the Sardar Sarovar Project. The ILO upheld the complaint and instructed the Indian government to revise their resettlement program, in order to comply with ILO Convention 107 (the predecessor to ILO Convention 169), which India has ratified. The Indian government rejected the decision. By this choice, the government officials also decided to leave the tribal people, who are negatively affected by Sardar Sarovar Project, to continue their intense suffering. (Survival International 2010).

The current resurgence of dams is caused by lobbying from the dam industry. They present dams as the solution to climate change. The dam engineers are selling their product as a cheap technology for production of renewable and sustainable energy. The International Hydro-power Association has called hydro power for ñone of the cleanest and most reliable sources of energy.ò Nevertheless, some studies indicate that hydro power can be more polluting than coal power plants because of the greenhouse gases emitted by rotting vegetation in reservoirs. Specifically in hot, tropical areas, the rotting in the water basin releases large amounts of methane into the atmosphere. This greenhouse gas is almost 20 times stronger than carbon dioxide. The carbon count for dams could therefore be negative in some cases. The Tucurui dam is such a case. The Brazilian state owned Electricity Company built the dam in the 1980s. According to the National Institute for Amazonian Research, the Tucurui dam now contributes one sixth of Brazilôs total greenhouse gas emissions. In spite of such facts, the Brazilian Electricity Company still calls hydroelectric power production ñpollution-free.ò (Good Planet; Survival International 2010).

Regardless of the factual, documented, negative social and environmental effects from dams, China has just finalized building the main components of the worldôs longest water dam. The Three Gorges Dam is 2,335 m long and 185 m high. The reservoir is about 660 km long and 1.12 km wide. It contains 39.3 cubic km of water and flooded a land area of 632 square km. It has the worldôs largest hydroelectric power capacity generating a total of 18,200 MW, which is equivalent to 20 nuclear reactors. Apart from producing electricity, the dam is meant to increase the Yangtze Riverôs shipping capacity and reduce the potential for seasonal floods downstream. Moreover, the dam provides water for use in agriculture and industries. Fully operational, the dam will support only about 3 percent of Chinaôs total electrical power requirements (2006 figures). The estimated cost is 22.5 billion USD.

Complete cost recovery is expected to occur ten years after the dam starts full operation. The Chinese government regards the project as a historic engineering, social, and economic success. However, due to the dam effects, the project has been a controversial topic in China as well as abroad. It has the potential of becoming Chinaôs biggest social and environmental nightmare. The government displaced around 1.3 million people, and is encouraging an additional 4 million people to move by 2020. The dam also flooded some 1,300 archaeological sites. The presence of the dam is altering entire ecosystems and causing other serious environmental problems. It is a threat to animal, fish, and plant biodiversity. It may be causing weather changes. It is promoting microbial waterborne diseases. And, rather than preventing floods, the dam effects is causing drought in central and eastern China. The dam has reduced the flow volume of the Yangtze River by 50 percent. The colossal dam also triggers landslides. Dozens of landslides have already taken place. But the greatest fear is that the effects of the dam will give severe earthquakes, because the reservoir sits on two major faults. This would endanger millions of people who live in the region. The dam area registered 822 tremors during a period of seven months in 2006. Due to the landslides and tremors, villages of already relocated people will have to move a second time. (Good Planet; Scientific American 2008; Wikipedia on Three Gorges Dam 2011).

The threat of accidents to and bursts of dams is very real, especially as effects from natural disasters. China is located in one of the most active seismic regions of the world that has been plagued by numerous destructive earthquakes during its long history. Most will recall the tragic Sichuan Earthquake of May 12, 2008, which killed an estimated 80,000 civilians. The Ministry of Water Resources has reported that as many as 2,380 dams were damaged in the province due to the earthquake, including the main Zipingpu Dam. Scientists in China and abroad even believe that it may have been the weight of the Zipingpu reservoir, which caused the earthquake to take place. The phenomenon is known as Reservoir-Induced Seismicity. Seismologists from Chinaôs Earthquake Bureau had already in year 2000 warned the Chinese government not to build the dam due to its closeness to a major fault line, yet these warnings were ignored. China is also situated in an area with frequent typhoons. In 1975 heavy rains from typhoon Nina caused the Banqiao dam in the South of China to give way. When the dam wall broke down, the water created a large wave that was 10 km wide and 3 to 7 meters high. The water rushed downwards onto the plains below at a speed of nearly 50 km per hour. The wave wiped out an area of 55 km long and 15 km wide, creating temporary lakes as large as 12,000 square km. According to the Hydrology Department of Henan Province, around 26,000 people died from flooding and another 145,000 died during subsequent epidemics and famine. Besides, 5,960,000 buildings collapsed and 11 million residents were negatively affected. (Dr. George P.C.; International Rivers 2008; Wikipedia on Banqiao Dam 2011).

In spite of these overwhelmingly negative effects from dams, and the colossal risks they present to society and nature, the Chinese government continues prioritizing hydro power and expansion of dams. Presently the government is in the process of starting up a controversial 62 billion USD water scheme. The South-to-North Water Diversion Project is the largest of its kind ever undertaken. The venture involves drawing water from southern rivers and supplying it to the arid north. The work includes linking Chinaôs four main rivers ï the Yangtze, Yellow River, Huaihe, and Haihe. This massive scheme has taken 50 years to plan, when completed in 2050 the project will divert 44.8 billion cubic meters of water annually to the population centers of the dry north. (Water-technology.net).

The Chinese government has financed the majority of dams built in China, which account for about half of the worldôs total. Moreover, China is currently the single biggest funder of dams globally, replacing the World Bank. One such Chinese engagement is Gilgel Gibe III dam in Ethiopia, Africa. The dam is being built by request from the Ethiopian government, and the state owned bank Industrial and Commercial Bank of China is considering funding it. Gibe III will be Africaôs tallest dam.

Construction began already in 2006, before the dam was approved by the Ethiopian environment agency. The dam is being built on the Omo River as a part of a series of five dams. Gibe I and II have already been built. The majority of the local tribes have not been consulted. They also have no access to independent advice and have therefore limited perception of how the dam effects will influence them. It is difficult for the affected tribes to discuss the effects of the dam because in 2009 the Ethiopian government closed several community associations down, making it impossible for people to share information. The government plans to use the Gibe III reservoir to irrigate a huge area of tribal land placed in Lower Omo. They want to lease the land to foreign investors for the purpose of growing cash crops, including bio-fuels. The tribes who live in Lower Omo have not been consulted about the farmland grab, which is an obvious violation of the Ethiopian constitution and the United Nations Declaration on the Rights of Indigenous Peoples adopted by the UN General Assembly as Resolution 61/295 on 13 September 2007, which the Ethiopian government has endorsed. The Gibe III dam and the associated farmland grab, will affect the livelihood of at least eight tribes, so severely that these largely self-sufficient people will depend on food aid to survive. (Survival International 2010; United Nations 2007).

Conclusively, promotion of such economic profit-making technology has given heavy costs to society and nature worldwide: 400,000 square km of land is inundated by building of water dams globally, and dams have displaced 40-80 million people. To put these figures in a context: Germany covers a land area of 357,000 square km and it has around 81.5 million citizens. In spite of these facts, the World Bank changed its cautious water dam policy in 2003 and started again to invest in hydro projects. Currently, the Bankôs investment for hydro power and water dams totals 11 billion USD. Compared to 1997, it is an increase in funding of more than 50 percent. The African Development Bank is also increasing its water dam investment. (Good Planet; Survival International 2010; Wikipedia on Germany 2011).

The Effects from Redirecting and Exploiting Water

The above discussion showed the huge negative effects water dams have on indigenous people and nature. Now let us see what happens to the water itself when such inappropriate technology redirects it, dams it, and exploits it for the purpose of economic growth:

The global water cycle is a desalination process. Each year 38,000 cubic kilometers of water is transferred from oceans to clouds to lands. The water refills streams and rivers, ponds, lakes, and wells, above and below the ground. It ultimately returns to the ocean, after having supported life wherever it went. Water is a renewable resource due to its endless cycle between sea, air, and land, but water cannot be increased. The availability is limited by the water cycle. Water can only be diverted and redistributed. When it is used within its limits, water is available forever. (Shiva 1989, 182, 185, 205-206, 214).

Trees, soils, rocks, and sand help to conserve the water and the cyclical process. Natural forests are the best mechanism for water control. The soil is also a water reservoir. But its capacity depends on the vegetative cover and its organic content. Humus helps to retain water in the soil. Thus, in arid zones, which are dependent on rainfalls for water, the only viable mechanism for water conservation in the soil is to add organic matter. It is an insurance against desertification, and it gives food security. (Shiva 1989, 182, 185, 205-206, 214).

Ancient societies used river water to benefit people. They worked with the logic of the river. Irrigation was traditionally done as a round river. They divided water off its course, towards farmland and then back again to the river. The water use was always kept within the limits of its renewability. Such kind of irrigation works are adequate, it requires only maintenance and repair. Hence, water is

in abundance if people participate with its cycles and support the water process. To do this, one must think like a river. Therefore, water sustainability is based on cooperation with water. (Shiva 1989, 182, 186-187, 189, 215).

However, for modern scientists, water management does not include cooperation with the water and participating in its cycles. Instead water experts perceive water as a passive, limitless resource, which they can make productive by applying their technology. The purpose is to exploit water for generation of economic profit. Thus, the experts plan and build water dams, water reservoirs, and water canals. However, when scientists try to control water, to disrupt its course, to exploit it, water dries up. When humans interfere with the natural water system by their modern technology they damage its fine balance and negatively affect its cycle. This is violence against nature. It breaks down the cycle of life and threatens the survival of everything. Thus, when scientific engineers build water dams and divert the water against its logic, it has consequences, as explained below: (Shiva 1989, 182, 195).

The first consequence from building a dam is deforestation of the catchment area. That will inevitably reduce rainfall and consequently reduce river discharge. Most rain falls in the catchmentôs forest area where it contributes to the overall precipitation of the vicinity. Seventy-five percent of the rainfall in a rainforest is contributed by the forest itself. Hence, when we destroy forests, we decrease rainfall. It is falsely believed that one can cultivate trees elsewhere and compensate for deforestation. However, a plantation is an unnatural, man-made forest, which cannot perform the ecological processes required. Thus, even before the scientists have built their water dam, there is less water available. (Shiva 1989, 189).

Secondly, the command area, to which the water is directed, is not meant to contain so much water. It may react with water-logging, siltation, and salinisation. Ten million hectares of land has become waterlogged, and salinisation has globally damage 1.5 million hectares of agricultural land (1988 figures). Water-logging and salinisation degrade the water resources, resulting in availability of even less water. Besides, by time the dam will contain only salty, muddy water, before it will finally dry up. (Dankelman et al 1988, 31; Shiva 1989, 190-191).

Thirdly, division of water prevents the river from recharging ground water sources downstream. This will create water scarcity. The rivers also renew water below the ground. Without rivers ground water will inevitably dry up, which creates desertification and hunger. The Ethiopian famine is an example of that. When the government dammed the Awash River, it resulted in drying up of land down-stream, while flooding land up-stream. The water was redirected for the purpose of irrigating of, not food crops for local people but for cash crops like sugar canes, cotton, and banana plantations belonging to foreign companies. Before damming, the river supported 1.5 million local agricultural people in the valley. When the government built the dam, they resettled 20,000 people while the traditional pastoralists were marginalized. The famine that followed killed more than 1 million people and negatively affected another 8 million. (Shiva 1989, 193).

Fourthly, the dam will reduce the inflow of fresh water to the sea. Water is not wasted when it runs into the sea. It is an essential link in the water cycle. If scientists break the link they also disrupt the balance between land and ocean, fresh water and seawater. The result is that saline water will intrude inwards and seawater will erode the coastal line. This has various consequences as demonstrated by the Aswan Dam. The building of the dam blocked 94 percent of the water that once flowed into the Mediterranean Sea from the Nile River. This disturbed the ecological balance in various ways. It disrupted marine life due to lack of the nutrients the fresh Nile water brought into the sea. The dam also prevented the flow of fertile soil during the yearly floods. The soil used to fertilize the Nile floodplain, but now it builds up in Lake Nasser, slowly filling in the reservoir and drying it up. The soil

also used to build up on the coastal delta where the Nile met the sea. Because it can no longer do so, the coast is eroding. Thus, the Nile delta is receding. Blocking the natural washing process during the yearly floods has also meant an increase of salinisation. Besides, the available water is only half of the amount originally expected due to evaporation and losses from leakage in canals. In addition, the reservoir has bread snails that are causing an epidemic of schistosomiasis, a tropical disease carried by a worm resulting in diarrhea, urinal bleeding, and abdominal pain. Finally, the dam required relocation of 125,000 people. Hence, damming has numerous, interlinked, negative effects, causing there to be less water available. (Good Planet; Shiva 1989, 185-186, 194).

Conclusively, when scientists imprison rivers in dams, they prevent rivers from performing their multidimensional functions, which maintains ecological diversity of life. Hence, the drying up of the water sources in India and Africa are man-made. The major causes for this are submersion of catchments areas, division of surface water by large dams, and depletion of ground water by irrigation. In all cases, scientists divert water from its natural course in order to support scientific agriculture and industries for generation of economic profit. Every major dam project in India has displaced thousands of people from fertile river valleys. Between 1950s and 1980s the Indian government built 1,554 large dams. The magnitude of the human suffering and the natural destruction this scientific and inappropriate technology has caused is beyond words. This clearly raises questions about ethics of technology. (Shiva 1989, 188, 190).

According to the World Health Organization, less than 8 percent of the worldôs water is fresh. Of this water, agricultural irrigation uses 73 percent. Irrigationôs efficiency in increasing yields is low. Moreover, only between 20 and 30 percent of the water gets to its destination, thus the water waste is huge. Industries use 22 percent, while only 5 percent of global fresh water resources are used for domestic purposes. Heavy use of ground water depletes waterways and lowers water tables because natural recharging cannot keep up with the use. The result is that millions of people have difficulties in getting sufficient clean water for a healthy living. In more than half of the developing countries, less than 50 percent of the population has a source of potable water or facilities for sewage disposal. Thus, when development uses land for economic profit, it causes shortages of water for many people. It often also pollutes peopleôs water source. Those living downstream from cash crop farming and industrial sites get polluted water due the heavy use of chemicals. This may contaminate their clean drinking water. Seventy percent of the ground water in India is polluted. Eighty-five percent of all diseases in developing countries (diarrhea, trachoma, parasitic worms, and malaria) are due to contaminated water and inadequate sanitation. UNICEFôs 2010 report estimates that around 9 million children die every year before they are five years old. That is roughly 24,000 per day or 1,000 per hour or 17 per minute. Half could survive if they had access to clean drinking water. However, due to exploitation of water in order to increase economic growth, there is not sufficient water for the children. (Dankelman et al 1988, 14, 31-32; Shiva 1989, 179, 183; Curtin 1997, 85; Warren 1997, 7; Warren 2000, 6-7).

A related issue is **drought**. In regions without rivers, people get water from wells, tanks, and ponds. Rainfall supplies these places with water, which is stored in underground catchments systems. The belief that groundwater is drying up due to lack of rainfall is incorrect. A seasonal reduced rainfall rarely causes drought, human activities are the main cause. Groundwater is accumulated over thousands of years. It is only exhausted because it is used in excess. Even with good rainfalls, water tables are falling due to overuse. Water is rarely exploited for peoplesô survival needs. Exploitation of water relates to economic profit-making, mainly from irrigation of cash crop production. In addition, since economic activities are removing the vegetation and disturbing the soil systems that absorb and store water, land becomes more drought-prone. Thus, due to the pursuit for economic growth, water is diverted from local peoplesô sustenance functions to the eliteôs commodity production. That cre-

ates water famine. No wealthy person dies from drought and hunger; these are economic and class oriented tragedies. Yet, they are also related to gender and age. Drought and hunger mainly affect poor women and young children. (Shiva 1989, 193, 195, 202-3; Warren 2000, 8).

The 1995 report from United Nations states that **water scarcity** is a special concern for women and children. Many countries in Africa and Asia are water-scarce. We already know that 22 African countries are running out of water. Thus, using technology in order to exploit water for economic development has resulted in lack of water for poor people. Access to safe drinking water in the South is low. The World Health Organisation found already in 1980 that more than 70 percent of the rural population in Kenya, Tanzania, and Angola has little or no access to safe water. Only 25 percent of people living in urban areas have access to in-house water source. In developing countries it is the women and children who are collecting water for the household. Due to scarcity, they must walk farther for water. Studies show that women and children may spend up to 43 hours per week on collecting and carrying water ï on their heads. (Barlow 2002; Dankelman et al. 1988, 14, 31-32; Curtin 1997, 85; Warren 1997, 7; Warren 2000, 6-7).

Consequently, perceiving development as a technical fix, meant to alleviate poverty, is a paradox. Applying modern technology in the South may increase economic quantities, creating a modern living standard for the elite and gaining revenue for the government. Conversely, the application of modern technology is destroying the quality of life for women, children, poor people, and traditional people, and depleting the living environment. Conclusively, bias application of modern technology in Third World development is causing poverty for society and nature. One must therefore question such inappropriate technology, and the ethics of modern technology altogether.

How Development Became a Technical Fix, and the Consequences

The Speech that Created Technological Development

The subject matter ñdevelopmentò is based on Western domination, in the opinion of Jan Nederveen Pieterse. Although, the idea was constructed in a specific time in history, by a particular culture, it was presented as being universal. Its aim is to incorporate non-Western societies into the dominant mode of modern economic development, where the terms of discourse are shaped by Western thinking. According to Gilbert Rist, this was possible due to the strength of the development discourse, which is powerful in seducing people, in every sense of the term. It is able to charm, to please, to fascinate, to set dreaming, but also to abuse, to cover up the truth, and to deceive. How can one possibly resist the idea that there is a way of eliminating poverty from which so many people suffer? How dare one think that the cure might worsen the ill, which one wishes to combat? Development has the notion of self-evidence. It is therefore a concept that gains universal acceptance. Although development constantly is criticized for its lack of success, it appears to be justified beyond disputes. To explain this ability of the development discourse, it is necessary to go back in history, to the period after the Second World War. (Braidotti et al 1994, 20; Rist 1997, 1-2).

Development began with the Inaugural Address on January 20, 1949 made by US President Harry Truman. His ñPoint Fourò claimed that the larger part of the world was underdeveloped and that these countries consequently should be assisted to be developed. This started the development age. Trumanôs idea was based on *"making the benefits of our scientific advances and industrial progress available for the improvement and growth of underdeveloped areas"... "The United States is preeminent among nations in the development of industrial and scientific techniques. The material resources which we can afford to use for assistance of other peoples is limited. But our imponderable resources in technical knowledge are constantly growing and are inexhaustible. I believe that we should make available to peace-loving peoples the benefits of our store of technical knowledge in*

order to help them realize their aspirations for a better life. And in cooperation with other nations, we should foster capital investment in areas needing development."... "Greater production is the key to prosperity and peace. And the key to greater production is a wider and more vigorous application of modern scientific and technical knowledge." Consequently development assistance to the underdeveloped South was to be founded on transfer of Western scientific and technical knowledge together with capital investment. The purpose was to increase Southern productivity, which was assumed to give economic prosperity, leading to global peace and happiness. (Braidotti et al 1994, 21; Rist 1997, 71-72).

It was the first time the concept ñunderdevelopedò had been used as a synonym for being ñeconomically backwards.ò Thus, the underlying value was that ñbeing underdevelopedò could be changed into ñbeing developedò if (and only if) modern scientific technology was applied, in order to promote economic growth. Hence, there was only one way to develop: earning money. Moreover, the rhetoric sees underdevelopment as a state of poverty that exists without a cause, while development is a state of wealth that keeps growing and never is exhausted. There is nothing in between. Dismissed was the suggestion that underdevelopment was an effect of Northern occupation, colonization, and slave trade. If the Europeans had acted destructively, it was merely out of necessity for their own development. The South now needed to do the same. Besides, the speech served the interest of the northern elites, especially USA. It effectively ended colonialism, from which USA did not benefit; it justified US intervention in the South, arguing that one cannot remain passive when confronted with extreme need; and it placed USA at the top of the value hierarchy, because it produced more. The proposal was genuinely hegemonic, because it appeared to be not only the best, but also the only one. From this it follows that economic development is possible, necessary, universal, and based on conquest and exploitation of colonies. (Rist 1997, 72-76).

In spite of the underlying exploitative and dominant values, Point Four claimed development to be beyond ideology. President Truman presented it as a set of technical actions outside the realm of political debate. It included scientific knowledge, application of modern technology, promoting growth of productivity, expanding international trade, and more. By defining underdevelopment as a lack, rather than a result of historical circumstances, and by treating the underdeveloped as being poor, without seeking the reasons for their misery, development policy made economic growth and aid ï defined in technocratic and quantitative terms ï the only possible answer. (Rist 1997, 76, 78-79).

From then on, the Northern political leaders defined the people in the South as being underdeveloped. To develop the Southern people needed to be modernized. This could be done if people abandoned their own cultural values. That was the only way the colonized could gain the equality the colonials earlier refused them. Thus, people in the South lost their right to self-definition and self-determination. For the Southern people independence meant to let go of their identity and economic autonomy. They were by the North forced to travel the modern development path. To implement this path the Northern governments introduced new international institutions. The most important structure was establishment of Western-style nation-states in the South, meant to administer economic development. Consequently, development included the devaluation of traditional and diverse systems of knowledge, culture, institution, governing, and social arrangement. Local elites educated at Western universities were the promoters of Southern development. They had learned to see economic growth as a prerequisite for progress. They also accepted the definition of development. Anyway, being part of the elites, they knew they would gain power and benefits from the instruments of control and the institutionalization development and aid included. The whole development enterprise was put in the language of science and transformed into a technical problem. However, development was not a matter of scientific knowledge, theories, and programs concerned with true progress. De-

velopment was political ideologies meant to shape, control, and dominate the Southern reality. (Braidotti et al 1994, 21, 23; Rist 1997, 79, 85).

Conclusively, by President Trumanôs development speech, the Northern governments were able to create, control, and manage the underdeveloped countries in the South politically, economically, socially, and culturally. Consequently ï and due to demand of consistency ï one must see development as a neo-colonial institution. (Braidotti et al 1994, 21).

Technical Development: A Neo-colonial Invention

Consequently, the intention with development was to modernize the entire world according to the Western style, which was assumed to improve well-being for all. Hence, the ideal of a ñgood lifeò is the one prevailing in the affluent societies of the North. To obtain this standard of living, the South had to catch-up to the North, a process that involved industrialization, technological progress, and accumulation of capital by economic growth. As an input for this process, the Southern governments had to use natural resources. There was, however, a problem. Early industrial development in the North came from exploitation of natural resources extracted from the Southern colonies. From the 16th to the 20th centuries Western Europe would appropriate lands of the Americas, Asia, and Africa and reduce their population to servitude. The wealth accumulated by this vast expropriation would fuel high levels of scientific development and economic growth in Europe. The means were application of scientific technology to gain control over nature and enslavement of the indigenous people. This approach built strong economies in the North, while destroying local Southern economies. Due to the need for limitless natural resources, colonialism seemed to be a necessary condition for eternal economic growth. Since there were no more countries to be colonized and exploited, development of the South had to be done differently. Instead of conquering external colonies, the leaders of the new nation-states created internal colonies. As input for industrialization and economic growth, they appropriated natural resources, and in the process indigenous peoples were displaced. Thus land, water, and forests were removed from local peoplesô management, and governments took ownership. This destroyed the natural resource base on which indigenous people lived. Hence, development created centralized, national power structures, which consistently has meant that development activities erode peopleôs control over their lives and sustainable use of their natural resources. Development transforms people and nature into possessions to be exploited for the benefit of the elite. In this way, development is a specific way of wealth generation: its process of creating wealth for some is associated with creation of poverty for others. Consequently, although colonialism officially had ended, colonialism continued in the form of development. Development has left large parts of the population in the South worse off than they were at independence. The drive to catch up with the North has led to large debts, environmental destruction, increased poverty and violence, rather than prosperity and peace as President Truman promised. Development is benefiting the political and economic elites, while impoverishing an increasing number of people, mainly women. Therefore, colonialism is not a past phenomenon, it is very much alive. (Braidotti et al 1994, 22, 24; Mies and Shiva 1993, 55-56, 70-71; Radford Ruether 1993, 20; Rist 1997, 7; Shiva 1989, 1-3; Shiva 1990, 189-190).

Hence, development promotes the supremacy of the Western, modern culture. It is an extension of the modern wealth accumulation done by application of the modern scientific technology. It is destroying diverse cultures and exploiting nature. The main victims of development are women, children, peasants, and tribal peoples. The only difference is that this time around, it is not the colonial powers that are engaging in the actual exploitation, but the national political and economic elites. Nevertheless, the ideology is still masterminded by the global economic and political forces controlled by the former colonialists in the North. The fact that people are worse off now than before should under normal circumstances lead to questioning development and its technical practices. At least it should not be given as a remedy ñmore of the same.ò Yet, because it is based on ideologies

and due to its vested interests development goes on. Consequently, the South has experienced a brutal application of technological bias. Especially in the form of big-scale development projects, like large water dams, that serves urban and industrial interests only and thereby the modern economy. Development has displaced thousands of peoples from their lands and removed their means of livelihood. Thus, technical development is an important factor in destruction of nature; yet the real force behind the global environmental crisis is Western science and its violent and inappropriate technology. (Braidotti et al 1994, 9; Mies and Shiva 1993, 71; Shiva 1989, xviii, 1-3; Shiva 1990, 189-190; Simmons 1997, 248).

In response to the loss of livelihoods local people have staged impressive protest actions against development projects. Throughout the South, women, peasants, and indigenous peoples are struggling to free themselves from development, exactly like they earlier struggled to be liberated from colonialism. This popular pressure has resulted in an increasingly militarized world. In order to preserve the elitesô unjust monopoly on material resources most nations have been using a huge share of their state budgets and/or foreign loans for purchasing weapons used to repress their own impoverished masses. This has only reinforced the power of the North. Since the rich countries sit on modern technology, the northern elite have become the major exporters of weapons to poor nations. Consequently, militarization has boosted the wealth of the North and increased the indebtedness of the South. War and violence; abuse of human rights; environmental destruction, and the consequential devastating poverty, are all crises derived from a system of domination, based on science, its technology, and economic development. (Radford Ruether 1993, 20).

The Underlying Values of Technical Development

The world is a product of the technologies we have developed over the past two centuries. The force that pushes this technological development is the patriarchal pursue of control, power, and profit. It is founded on the belief that technology has answers to all obstacles that may arise. Thus, technological development is dominated by powerful economic and political interests. It means that technology is in conflict with the most basic human rights and democratic values. In order to better understand why we have destructive and inappropriate technologies like water dams or nuclear plants, it is helpful to analyze the underlying values. (Ekins 1992, 168-169).

Technology is Bias

Current, mainstream technology is developed according to the values of a modern, dualized, scientific world-view. The proponents of modernism focus on the masculine, linear, rational modes of perceiving, which produces inductive (general conclusion based on specific premises), empirical, and reductionist ways of thinking. They conversely dismiss the feminine, circular, intuitive modes of cognition, which produces deductive (specific conclusion derived from general premises), creative, and systemic thought processes. This has led to a priority of products over processes, objects over their interconnections, and a preference for analysis (examining separate parts) while synthesis (combining parts into a whole) is overlooked. This masculine, yang model sees technology as an objective (unbiased), scientific discipline. In this scheme technological assessment assumes that wholes can be fully understood by examining their parts. This in turn means that ñproblemsò can be defined by analysis and ñsolutionsò can be devised to fit them. (Henderson 1978, 328-330).

People in the modern culture, especially politicians and policy advisers, believe that science and technology offer the only hope for solving the global social and environmental problems, especially the ever-increasing need for energy. They assume that science offers objective and factual answers, thus they go there to look for help. Because the issue is highly technical, people find that scientific specialists must assist. However, such beliefs are false and holding them means that citizens surren-

der the authority to take decisions about their own world. When we are dealing with problems in nature and society we are dealing with questions about human value, not neutral technical solutions. If we leave these solutions to scientific experts, it only means that their values will prevail over the values of the citizens. Technological choices affect all and they therefore need to be decided in the political arena with the full participation of the citizens. When we conversely rely on what we believe are neutral technical solutions, it is highly likely that the state will support technology that is destructive for society and nature, while generating profit for businesses and economic growth for the government. (Des Jardins 2001, 6-7).

Therefore, science and its technology are not value neutral. The trust in science and its technology as the ultimate authority is a cultural myth. Science is a detailed, precise, and documented approach to knowledge. Its aim is to minimize assumptions, eliminate bias, verify results, and limit conclusions to what evidence supports. The ethics of science is then to ensure an impartial, accurate, and rational result. If practice measures up to this ethics, we may be confident about the rationality of its results. However, too often the method has hidden assumptions that influence scientific practice: **First** as mentioned, science leans to *the reductionist method*, thus its focus is solely on parts, while scientists are overlooking relations between parts and the whole. In a reductionist view, society is defined as a collection of individuals driven by self-interest. However, such a perception is not advisable in social sciences and in the study of ecology. Excluding relations and other complex interconnected factors in both parts and wholes mean that the outcome will be misleading and even destructive for society and nature. **Another** distortion is that science uses *mechanistic* explanations. Scientists are looking for the constant, deterministic laws of nature by a linear cause-effect method. The underlying assumption is that nature and society are mechanical, hence automatic and unthinking. Such a view cannot include the possibility for self-determined actions and a random change, or circular interaction where the effect may also become the cause. Thus, the outcome from reductionist and mechanistic science will overlook important issues like life itself, and make foregone conclusions that may be destructive to life. **The third** and essential problem that makes scientific outcomes bias relates to *the questions scientists ask*. To make a clear research they often limit the scope of possible answers to one part only. If we ask scientists how to supply more hydro power or nuclear energy, then we will receive factual scientific data as an answer. However, if we instead perceive the question more holistic and consider demand for energy in general, the research is open to other sources as well. Also in this case the answers are based on reliable objective facts, but the two studies will inform very different energy policies. Thus, asking a scientific question includes a value judgment. (Des Jardins 2001, 7-9).

The ones that ask the questions in science are normally those who can pay for the expensive research. Hence, usually only private industries and governments are involved in scientific studies. This means that scientific research is based on the values held by the economic and political elites. Having confidence in the values of political leaders, business people, and the scientists they pay, is risky. When using past experiences to assess their values one can above all argue that the thinking of the elite is not based on ethical principles. The elite often lack imagination and emotion. Many scientists are prepared to do morally questionable research as long as they are paid well. They generally find that scientific research must have no limits, while politicians decide upon their application. However, politicians are commonly focused on singular aspects like economic growth and defense policies. This is why research in nuclear weapons financed by the US defense department lead to nuclear energy. Similarly, chemical pesticides used on agricultural crops were developed after governmental research into chemical weapons. Imagine the knowledge and technology that would have been available now regarding solar energy ï a source of energy that is renewable, clean, and abundantly available ï if the money spent on nuclear weapons research would have been spent on solar power research. We must therefore not cheat ourselves into believing that because science demands

objectivity and neutrality then its users are objective and impartial. (Des Jardins 2001, 10; Ekins 1992, 174; Mies and Shiva 1993, 94-95).

Conclusively, due to hidden, underlying value assumptions, and a limited scope we cannot get unbiased solutions from science and its technology. Analysis of technical solutions to any crises requires a combination of all available and relevant disciplines, and a holistic view. However, since most governments do not pursue this ideal and because science and technology is their focus, the environmental crisis, the poverty crises, the energy crisis, and all other social and natural crises are solved by the value science and technology represents: domination of society and exploitation of nature for economic profit. This value has social and natural costs. (Des Jardins 2001, 11).

Technology: A Profit-Making Tool for the Elite

Technological growth and economic growth are inseparably linked. In order to expand its economic activities modern societies need more and more electricity. This calls for more and larger water dams or nuclear power plants, both of which are expensive and risky technologies. Yet, governments find this kind of technology economic efficient, forgetting that society and nature pay the costs of such ñefficiency.ò The government in the United Kingdom misled the public by claiming that atomic power is cheaper than other sources and that it can reduce the greenhouse effect. That is incorrect. The costs are colossal, much higher than investment in renewable energy. Government officials even falsified data from research project costs of alternative energy. In 1988-89 nuclear research received 247 million Pounds from public funds compared to 37 million Pounds and 19 million Pounds respectively for non-nuclear energy and energy-efficient research. Clean and safe solar energy could provide the equivalent power supply in a cheaper way, while creating many more jobs than nuclear energy and hydroelectricity do. Therefore, with the risk and the huge expenses involved one cannot call the use of nuclear energy for efficient. In this way, the concept ñefficiencyò is becoming meaningless. If alternative energy is both safer and cheaper, then why do politicians argue for nuclear energy? There are two reasons. One was already mentioned. The military prioritized nuclear because they want to maintain their weapons capabilities. The other pressure came from the nuclear industry. They enjoy the power and profit the project entails. Moreover, since industrial economic profits benefit the governmentsô economic growth ambitions, political leaders will choose nuclear energy. Thus, governments value economic profit over benefits for society and nature. (Ekins 1992, 174; Henderson 1978, 312-313).

Since the building of large water dams and nuclear power plants are highly attractive for profit-making, companies are keen on implementing them. Hence, the management efficiently organize to petition for public funds to underwrite such technological developments. The taxpayersô money pays the bill. Thus, although citizens do not have a say in choice of technology, they still must both pay for it and also endure the negative effects from their applications and their possible failure. This kind of technological innovation destroys democracy. It prevents citizens from exercising well-informed choices. Advanced technologies are complex and cannot be mastered fully by politicians or the citizens. They therefore become inherently dominative. Their scale requires huge investment, money which instead could have been spent to satisfy social and environmental needs, while it precludes peopleôs full participation in directing the choice of technological advance. Every major technological innovation also redistributes power. New ways of producing goods and services destroy some jobs and create others. This rearranges population patterns and creates new ranks of winner and losers. Thus, technology does not arise in a vacuum. There are vested interests whose interactions promote or suppress technologies. That is why institutional and financial commitments to nuclear energy and hydro power have starved solar energy for years. Therefore, big and capital-intensive technological innovation is not an objective solution to a problem. It is concentrating power, wealth, and knowledge in fewer and fewer hands, while making the majority poorer and more powerless.

Consequently, nuclear energy and hydro power do not support people and the environment, they are technologies meant to profit the political and economic elites while dominating society and exploiting nature. (Henderson 1978, 28, 315, 322-323).

With the introduction of neo-liberal politics technological domination has increased. Due to the requirement for deregulation, technological innovation is not adequately controlled by the government. Yet, it is necessary to test any new technology for its harmful side effects; hence technological innovation requires more regulation rather than less. Since new technology brings about a new dimension of freedom for some people, while destroying freedom for others, conscious policies are required to lessen the destructive effects of technological developments. Technological advancement therefore becomes inconsistent with a free market model. Societies, which have complex technology and laissez-faire policies, become unworkable. This gives rich corporations free hands to invent and introduce any profitable technology to its liking, even if it destroys society and nature. Hence, no one is safe from the effects of inappropriate technology. Geographical distance is no longer a guarantee for safety. What modern technology-man does in one place will eventually be felt by everybody since everything in this world is interconnected. (Henderson 1978, 28-29, 314; Schumacher 1993, 53).

Conclusively, if a technology is a danger to people and the environment one can hardly call it progress. Instead, one may call application of modern technology warfare against society and nature. Due to these dangers people must not leave technology choices to the ñexpertsò in politics, science, and businesses. Instead, people must demand an immediate end to nuclear power plants, water dams, and all other types of inappropriate technology that destroy nature and society. The people who choose to implement dangerous technology will eventually return humanity to the Stone Age, not those who protest against them. Consequently, Henderson finds that deciding to introduce such technology only shows that politicians are the products of a system that creates leaders who are helpless, incompetent, and/or corrupt. (Henderson 1978, 314; Mies and Shiva 1993, 95-96).

Technology: A Hardware Macho Activity

Technology focuses on creating hardware, while the necessary software to program its orderly functioning is overlooked. In Third World development the experts have almost exclusively been focusing on hardware as a means to generate economic growth. These hard technologies include water dams, irrigation schemes, industries, and mono-culture plantations. Without adequate software to guide them, many of these development projects failed. They are often referred to as, ñwhite elephantsò or ñred herrings.ò (Henderson 1978: 310).

There are various, interconnected explanations as to why people in the modern world over-rate the creation of hardware, while undervaluing software. **The first** reason relates to the fear of death and non-existence. When people are constructing buildings and dams, they provide for their material requirements. However, they also affirm their existence and importance. These physical artifacts are so tangible that they manage to reassure human beings of their own reality. **Secondly**, the passion for hardware is the result of a cultural overdose of the masculine yang forces. Lacking the dynamic tension with the feminine yin forces means that software becomes marginalized. Yang forces generate a consciousness attuned to manipulating external objects, competition, and creation of self-assertive hardware, suitable for central control. The yin forces by contrast generate an awareness adjusted to interpersonal and social relationships based on cooperation. Hence, the person who is overly focused on yang energy will be obsessed with hardware technology. **A third** reason relates to the previous explanation. Due to the over-rated yang consciousness prevailing in modern culture, people who decide upon technology automatically focus on domination. The active yang approach urges them to create technology that can manipulate the environment and people. It gives an enjoyment and a sense of mastery and control, together with the expression of the self in such creation. Lack of dynamic

tension with the opposite yin force means that such domination may become deadly for society and nature where it is applied. **A final** and related explanation suggests that human beings project their inner tensions and conflicts onto the outside world, rather than resolving them. The result is creation of hardware technology that can dominate society and exploit nature. If human beings were willing to examine their own psyches, getting to know themselves, and change their own meaning-structure, they could balance their inner yin and yang conflict and become harmonious, non-domineering people. Balanced people would ensure availability of adequate software to control any hard technology. Moreover, harmonious people would not harm anybody; hence, they would not develop technology that dominate society and exploit nature. They would consider it inappropriate technology. (Henderson 1978, 310; Rowe 1997, 391-392).

Nuclear weapons are a truly dangerous manifestation of hard, macho technology. In at least 10 countries worldwide the military-industrial complex has by political manipulation succeeded in extracting huge defense budgets for this destructive technology. In the USA 60 percent of scientists do research for the Pentagon. They use all their creativity to invent sophisticated means for killing people and nature. Thus, politicians find that defense problems, like all other problems, must be solved by hard technology. They have dismissed that a softer method ï like research in social and cultural sciences, trying to understand human behavior ï would be relevant for making and keeping of peace. The latter would require yin software like cooperation and interaction. However, such soft feminine traits are not compatible with the hard machoôs need for self-assertion, control, and domination via technology. However, by marginalizing the yin input, the yang approach results in technology that profoundly is anti-ecological, anti-social, unhealthy, and inhuman. (Capra 1982, 230-231; Capra 1989, 253; Henderson 1978, 311; Mies and Shiva 1993, 94).

Since our social and natural crises are increasing, we must conclude that hardware technology has failed to be the solution. It is therefore necessary to examine the underlying values of technology. We need to understand that if we want to solve our crises by technology, it must include software as well as hardware. We may with advantage focus on softer types of technology like conflict resolution, social agreements, and cooperation. Social security and wealth redistribution systems are as much technologies as any hardware system, and research has shown that they work well in limiting crime and violence. Other necessary software includes institutional redesign, decentralization of power, open political processes, holistic approaches to science, and alternative assumptions about nature and the universe at large. We also need a new appreciation of the importance of psychic structures, myths, and taboos. Moreover, we need internalized methods of behavior harmonization and self-regulation. To generate harmonious societies, human beings need more space for self-expression in art, craft, and production. This is a good path towards personal growth and balancing our inner yin and yang forces. If we do not prioritize creating a dynamic tension between our inner yin and yang forces, we can also not learn to apply a harmonious combination of hard and soft technologies. That could end us in self-destructing. We must then be considered a short lived species with an in-built fault that led us to over-use natural resources, turn land into desert, poison our waters, destroy the animal, fish, insect, and plant life that sustain us, pollute the air, change the climate, and kill one another, rather than co-operate. As Dorothy Rowe says, dinosaurs lasted for millions of years; Neanderthals for about a quarter of a million years, but Homo sapiens have existed barely 100,000 years and are fast running out of time. (Capra 1982, 232; Capra 1989, 253; Henderson 1978, 310, 400; Rowe 1997, 383-385).

Technology: Causing Social and Natural Crises

The scientific view has the implicit assumption that a problem must be solved by technology. This is so whether the problem is political, psychological, or ecological. Thus, science demands no change in human perception or values; technology will take care of all problems. In this way, technological

growth determines peopleôs lifestyles, their social organization, and the human value system, although it should be the other way around. It indicates that we prioritize means rather than ends, and by doing that we destroy our freedom to choose the ends we really favor. Thus, development of means (technology) dictates the ends (societyôs way of life). This is the consequence when we give a higher value to masculine yang science than to feminine yin ethics, arts, philosophy, and spirituality. Governments are using science and its technology to make policies that exclude any role of human values. This results in short-term, narrowly conceived, economic maximizing activities that exploit society and nature. Henderson calls this for ñtechnological determinism.ò It is a society where freedom of choice has become an illusion. (Capra 1982, 230-231; Henderson 1978, 328; Schumacher 1993, 36).

A controversial issue with technological application is its unanticipated, negative effects. The science of economics states that economic growth has no limits. Since we do live in a limited world, the supporters of economics promote the use of technology to overcome limitations. Yet, when the technology has solved one problem, like replacing fossil fuel energy with hydro power or nuclear energy, society and nature are faced with more negative effects. Hence, development of technology also develops increased dangers. These dangers include the destructive power that technology places in the hands of some people, its disruption of social and natural environments, and the increasing scale of industrial and economic operations it produces. Today the unanticipated effects from the growing scientific knowledge and its technology have outrun adaptive capabilities. The results are crises that governments seem to be unable to resolve. The crises manifest as environmental crisis, poverty crises, hunger crises, and many more. Nevertheless, the many individual crises are all rooted in one larger systemic crisis: the inadequate, reductionist, dualized, masculine, yang perception of reality. (Henderson 1978, 303-305; Schumacher 1993, 16).

When ñexpertsò analyze a specific crisis, they lose sight of other factors, which may affect the crisis in question. If they focus on the urban crisis with its over-crowding and poverty, they overlook that it is the result of technology. By introducing mechanized agriculture, experts assumed that food production and industrial employment in the cities would increase. Hence, hundreds of thousands of farm workers and small farmers moved to the cities draining the rural areas of their vitality. The government made no plans to develop alternative productive activities in the rural areas. They expected people to work in the new industries and from that gain their income. However, the promise of work was not fulfilled for many people. Instead they had to face alienation, stress, and social breakdown, often leading to poverty and crime. Consequently, the practical result was opposite from the theoretical plan: ending in unemployment and famine. By introducing new technology people lost their livelihoods, their social network, and their quality of life. By introducing this technology the government forced their citizens into urban poverty. The outcome was an unequal society lacking inner cohesion, leading to political instability. One must call that inappropriate technology. The problems it has caused cannot be solved by applying yet another technological fix. (Henderson 1978, 303-305; Schumacher 1993, 53).

With the current advanced technology the impacts from application are global. This makes reductionist perceptions directly dangerous because it leads to decisions based on inadequate data about technological impacts. Thus, lack of holistic and systemic perception creates many crises. However, crises also is the result when many smaller, rational, micro-decisions and actions add up, by default, to big, dangerous, irrational macro-decisions. When scientists lack systemic perception, they multiply effects. When one technology produces unanticipated side effects, they apply another technological ñfixò to ameliorate it. In this way, they add more and more unknown variables, which increase changes and possible negative consequences for society and nature. (Henderson 1978, 305-306).

The many technological mistakes come from limited understanding. Since the various interacting technologies were not designed systemically from the beginning, experts cannot manage them. Instead they try to manage smaller and easier parts, which will not solve our crises. Hazel Henderson calls this for ñsub-optimization.ò It means that experts produce ill-considered, limited technologies aiming to solve problems created by other technologies. When governments believe they can limit crime by applying more police and security hardware, without viewing crime as part of the social cost from unequal distribution of wealth, they sub-optimize. They need to include more elements before they can assess, which of our ñcrisesò are subject to a technical ñsolution.ò Henderson therefore calls the global crises of war and violence, poverty and inequality, human rights abuses, and environmental destruction for ñcumulative effects of myopic perception, narrow analysis, and sub-optimizationò (myopic means prejudice or narrow-minded). (Henderson 1978, 314, 316).

The focus on reductionist analysis and the disregard for holistic synthesis means that the leaders of modern society cannot deal with interdependent, global, systemic crises. Moreover, their trust in technical fixes has developed an unquestioned belief that technology always is the answer. The consequence is that solving any crisis requires technological fixes applied to parts of the problems only. For example, people in modern society perceive the solution to the ñcrisis of overpopulationò as being technical. They believe, if only women in the Third World could be made aware, then they would stop producing children. Thus, the African women need education in family planning and access to preventive technology. Yet, the analysis overlooks interrelated, holistic issues. Excluded is the fact that children often are the only social security mothers have: girls are a source of labor for overworked women; boys will inherit the land, making old age secure for their mothers. Excluded is also the dominant role men play in producing children: most women in the South do not own their own bodies, men do; therefore women cannot limit the number of children they get, men can. Completely forgotten is the exploitative role of past colonial regimes: had European governments left Africa with an intact resource base to sustain the African peopleôs livelihoods, women would not depend so much on children. Such synthesis places the rich countries as part of the problem, and it logically points to a solution that includes redistribution of the worldôs resources. (Cuomo 1994, 96-98; Henderson 1978, 97).

The modern, reductionist approach to the ñworld food crisesò is equally narrow and technical. During colonialism Western governments established cash crops plantations in the South. The crops selected had negligible or no nutritional value. They included tobacco, rubber, tea, coffee, cocoa, cotton, and other fibers. These crops became the leading exports from the South. At independence the North recommended the Southern governments to continue this policy in order to earn foreign exchange. However, the policy has trapped poor countries in the world trade forcing them to use modern technologies, advantageous for the rich countries and their corporations, in the following way: in order to maximize income the farmers must enhance production; for this purpose the North has transferred their agricultural technology. This has led to unstable monoculture, which requires costly application of pesticides, herbicides, fertilizers, irrigation, and mechanical equipment. For the South such technological fixes created further dependence on foreign exchange and outside supplies, which increased debts. It also degraded the natural environment and marginalized subsistence farmers and food producers, the majority of whom are women. This technological approach to agriculture has caused hunger and poverty among many in the South, while mainly the business elite has benefited. One may call that for inappropriate technology. Yet, development and application of this kind of inappropriate technology is lucrative for Northern corporations who earn huge profits from transferring their destructive technology. Since the activity is considered development aid, Northern taxpayers pay the bill. Cynics describe such development efforts in this way, ñTechnology transfer is when you take money from the poor people in rich countries and give it to the rich people in poor countries.ò

Such reductionist technological fixes conveniently avoid the important issue of economic redistribution, both between nations and within their borders. (Henderson 1978, 97-99).

Northern economists also have technical fixes for the ñhunger crisesò in the South. In their view, when we are applying the free marketôs demand and supply, the ñinvisible handò will place food where it is short. Nevertheless, such a limited view overlooks that food shortages relate to power, in the following way: rich people own the resources for food production; they only sell food for money, of which poor people have none. Moreover, food security relates to need as opposed to demand. Since the market can only register demands, via ability to buy for money, the market cannot register needs of poor people, who cannot pay because they have no money. Analyses also overlook that the increasing consumption of meat in the rich world is part of the global food crises: rather than using land to grow own food, the rich countries advice poor countries to produce animal fodder for export. Consequently, while Southern farmers grow soya beans as fodder for the Northern cows, their own children go hungry. (Dankelman et al 1988, 10-11; Henderson 1978, 97).

In a highly populated world with food scarcity and famine, giant food industries still choose technological solutions that focus on their own short-term profit maximization, rather than feeding hungry people. This attitude produces negative social and environmental costs, which the producers can externalize. The costs are borne by women, poor people, and nature. The effects are social and environmental crises created by sub-optimization. Due to our inter-dependence, application of sub-optimal technological strategies will eventually lead to the worst outcomes for all global players. Today it is women, poor people, and nature who suffer ï tomorrow the effects will hit the rich and powerful elite as well. (Henderson 1978, 103).

Technology: An Instrument for Violence

Consequently, in the eyes of the modern, scientific, yang person there is no problems technology cannot solve. Nevertheless, the solutions are based on an urge to control and conquer the world. Scientific and technological solutions, which poison nature, degrade social structures, create hunger, and generate wars, are violent. They make the rich richer, while they produce poverty and destroy life. Whenever technology becomes bigger it means bigger concentration of economic power in fewer hands, which exerts even greater violence against society and nature. (Schumacher 1993, 20, 126, 128, 130).

Science and technology could have enhanced society and nature. Yet, after patriarchal values infiltrated science, its technology was created to control, dominate, oppress, exploit, and kill. One reason for this is that patriarchal societies identify masculinity with conquest. Thus, technical innovation will focus on more effective ways to oppress and exploit. The highest priority seems to be given to technology that destroys life. That was evident from technologies that prevailed in Auschwitz, Hiroshima, Vietnam, Iran, Iraq, Afghanistan, and in other parts of the world. Patriarchal power has brought us global warming, military regimes, poverty, and countless other cases of suffering. It brought us men whose power made them lose all sense of reality and decency, and Schumacher warns that we must fear such abuse of power. The ultimate result of unchecked Patriarchy is social and natural catastrophes and nuclear holocaust. Such actions are working against harmony, destroying the basis of our existence. Nevertheless, as long as people leave questions of technology to the ñexpertsò we will continue the sub-optimal, violent, technological determinism. As long as economic growth is gained from applying modern technology to society and nature, and this method is the priority in politics, we cannot leave technology choice to experts. Ordinary people are often wiser, better capable of taking a more holistic and humanistic view than those who call themselves experts. (Eisler 1990, 32-33; Kelly 1990, 112-114; Schumacher 1993, 20, 126, 128, 130).

To solve our current crises of poverty, violence, and environmental destruction, we need alternative technologies from the current ones. Wisdom demands that we direct technology towards care for nature and social cooperation. We cannot build peace and harmony on the recklessness and violence of science and its inappropriate technology. The masculine, yang people are alienated from nature and therefore also from the ability to recognize measure and limitation. Nature knows when to stop. There is a measure in all natural things regarding size, speed, and violence. As a result, nature tends to be self-balancing, self-adjusting, and self-cleansing. That is not so with modern technology or the yang person dominated by technology. There are no self-limiting principles and no virtue of self-adjustment. Yet, any activity that ignores self-limitation causes crises. Therefore, when a society is founded on materialism, which includes permanent, limitless expansion in a finite environment, it cannot last long. (Ekins 1992, 174; Kelly 1990, 112-114; Schumacher 1993, 20, 120, 126-127).

Consequently, there is an end to the patriarchal, masculine, reductionist, yang world-view. At a certain moment its increased technological mastery, its domination of people, and its exploitation of the environment will negatively affect society and nature. This will lead to a process of decline, since decay and collapse are the proper systemic behavior under such circumstances. That is the moment the old instrumental yang is turning into a re-emergence of the subtle yinôs intuitive consciousness to restore the balance. (Henderson 1978, 329, 400).

Appropriate Technology: Supporting a Quality of Life for Society and Nature

We need a major paradigm shift in society ï away from domination of people, away from exploitation and pollution of nature, away from materialism and technological determinism. Rather than being a purely hard, reductionist, scientific, yang activity, technology must also be a soft, holistic, normative, yin process. Normative yin technology is rooted in and responsive to changing values in society. It is based on ethical consensus about what is good and right. This means that development of certain technologies is not permissible. Normative yin technology gives priority to conservation of nature and is concerned about the quality of life for all. We therefore need a synthesis of the two modes of human consciousness, thought, and perception. Policy makers need to learn that it is healthy to emphasize normative, qualitative considerations for society as well as including ecological concerns. We need to incorporate and balance both modes in technology assessment. The scientific yang and the normative yin schools are interdependent. They must therefore be given equal value and be shown equal respect. (Ekins 1992, 168; Henderson 1978, 329-331).

We need to open the issue and ask the right questions when it comes to technology. Such questions include: have all possible options been adequately explored? How will the costs and benefits be distributed among groups and individuals in society? Specifically ï due to past pattern of domination ï the effects for women, poor people, indigenous people, and other marginalized groups, must be clarified. Moreover, the overall social and environmental impacts must be assessed. In addition, we need to know what the consequences may be for future generations. We also want to know if the changes caused by the new technology will be irreversible. Since technology should be oriented towards democratically chosen goals, society must examine its priorities and clearly state its goals. Based on this, various means can be suggested, not relying on one option only. When society is searching for answers, it must be aware that nobody is neutral. Often the agency that makes the impact statement also promotes the project. We cannot assume that even the most prestigious scientist panel is objective. Organizational biases are endemic and it often happen below the conscious level. That is why public participation in every phase of technology appraisal is the best way to ensure broader perspec-

tives and more thorough analyses. If technology appraisals are done well, they will make aware of some negative consequences, and such findings must not be concealed. (Henderson 1978, 319-320).

Citizensô movements are important as a yin force to change modern, yang society and its desire for hard technology. They can start the debate about desired ends and ethical values. Hence, the people become a dynamic tension to the political and economic eliteôs one-sided focus on means and profit. Such a change will be difficult, because it includes a power shift. When the goal of knowledge is power, science and technology becomes the servant of the powerful. However, if society and nature should survive, and if future generations should have a quality of life, then we need to re-examine the goals of science and technology and analyze the vested interests to which they are connected. (Henderson 1978, 329-331).

Technology with a Human Face

The modern, industrial and patriarchal world has favored grand-scale, centrally controlled, dependency creating, capital-intensive, and ï seen from a social and natural point of view ï uneconomical, and at times directly destructive and harmful technologies. In the neo-liberal, production-oriented, profit-maximizing political economy it rarely occurs to governments to help develop technologies designed to assist people becoming more self-reliant. Moreover, since neo-classical economics allow businesses to externalize their environmental and social costs, the formal market has provided little incentive to develop resource-conserving and non-polluting technologies. Therefore, development of new, humane, and conserving technologies is vital. Promoting such technologies was E. F. Schumacherôs ideal, as he said, ñI know of no better way of changing the system than by putting into the world a new type of technology ï technologies by which small people can make themselves productive and relatively independent.ò (Robertson 1998, 37-38).

In his book ñSmall is Beautifulò Schumacher says (1993, 120-121) that there is nothing in the experience as from the 1950s, which suggests that modern technology can really help to alleviate world poverty and unemployment. We therefore need to develop alternative technology, which can solve our problems. That must be a technology with a human face. If technology should support people and alleviate poverty, it must make use of the best part of modern knowledge and experience, but it should be cheap, simple, small-scale, and compatible with natureôs needs. Technology should be gentle in its use of scarce natural resources and designed to serve the human being. Its application must therefore be specific rather than universal. Such technology would give a more satisfactory life for both people and nature since small-scale operations are less likely to harm the environment. Schumacher called it for ñintermediate technology.ò It is a type that lies between indigenous and sophisticated technology. Intermediate technology is superior to primitive technology but simpler, cheaper, and more useful than the super-technology of the rich. **Affordability** is important because when people cannot pay for the technology necessary to become productive they often give up, and even cease doing those things they had done previously. In this way, technology is not, as now, reserved to the rich and powerful. **Simplicity** is also important. When technology is simple it is understandable for people and suitable for maintenance and repair at the spot. Simplicity makes it easier to train people while supervision and organization also become uncomplicated. Thus, there is less vulnerability to unforeseen problems. Schumacher, however, found that it is more difficult to recapture directness and simplicity than to advance into the direction of ever more sophistication and complexity. It will therefore take insight to make things simple again. Most importantly, intermediate technology must be **small-scale**. For Schumacher there is wisdom in small-scale operations. Human knowledge is small and limited and we rely on experiment far more than we may realize, due to our limited understanding. It is therefore dangerous to apply our partial knowledge on a grand scale like the one we do with nuclear energy and water dams. It is not that we should have no large-scale technology. For every activity there is a certain appropriate scale. What scale is suitable depends on what

we want to do. Hence, we need both small and large structures. However, people seem to find it difficult to keep two seemingly opposite necessities of truths in their minds at the same time. They always look for one final solution, and that brings them to a universal worship of gigantism. It is therefore necessary to insist on the virtue of smallness. Using intermediate technology opens up new and useful opportunities. People can improve their skills, which gives a dynamic approach to development. Poor people need most of all simple things for daily use like building materials, clothing, household goods, agricultural equipment, etc. They also urgently need trees, water, energy, and crop storage facilities that will bring them better prices for their agricultural produce. All these are ideal fields for intermediate technology. Thus, intermediate technology will be able to create human well-being and independence; it can alleviate poverty and bring about sustainable livelihoods, all of which will contribute to a needed decentralization of power. (Schumacher 1993, 21-22, 49-50, 120-121, 126-127, 149-150, 153-154).

In 1966 E. F. Schumacher founded the Intermediate Technology Development Group. It is still a highly relevant organization that actively engages in poverty alleviation via practical action. Hence, suitably, as from 2005 the organization is known under the name of Practical Action. Through their international work, Practical Action demonstrates, in Schumacherôs spirit, that there are affordable, simple, and small-scale alternatives to the costly, complex, and large-scale mainstream technologies. These are intermediate technologies that can include concerns for poor societies and nature. The organization generously shares its wealth of technical information, experience, and knowledge with all, and by that it influences positive change that may resolve the root causes of poverty. Hence, apart from its practical action, the organization also advocates in order to influence policies, institutions, and processes towards supporting the concerns of women, poor people, and nature.

Resolving Energy Poverty

Worldwide, around 1.5 billion people have no access to electricity. Up to a billion more have access only to unreliable electricity networks. Roughly 3 billion people, from mainly Africa, China, and South Asia, depend on traditional biomass (wood, dung, agricultural residues) and coal as energy for cooking and heating. Energy impacts upon all aspects of peopleôs lives: everyone needs energy to cook food, to heat and light the home, and for income generation. Energy is also needed to make basic services available to the public, like electricity for health clinics and educational facilities. Hence, lack of access to efficient energy has a significant negative impact on the standard of living. Besides, use of traditional biomass and coal gives serious health consequences due the fumes they develop. Shockingly, 1.4 million people ï mostly women and children ï die each year as a result of inhaling smoke from traditional cooking stoves. To compare, this is 50 percent more deaths, than from malaria. To light homes often kerosene lamps are used. According to a World Bank study burning kerosene indoors is equivalent to smoking two packs of cigarettes a day. It is estimated that almost one billion women and children are breathing in kerosene on a daily basis. Continued use of these lamps can cause infection of the lungs or eyes, and give respiratory problems. In addition to the significant health risk, the lamp is also a fire threat. It is often women who are hit hardest by energy poverty. Due to gendered division of work many women are spending much of their day collecting water and gathering firewood so the family can eat and stay warm. Without access to energy, daughters often must stay home from school to help their mothers. In this way, girls miss out on the opportunity to improve their lives. Consequently, access to energy is a prerequisite for poverty reduction and sustainable development, therefore poor peopleôs access to energy is essential. (AllAfrica.com 2010; Practical Action on Energy Poverty; Practical Action 2010; United Nations, AGECC, 2010).

In September 2010 the United Nations Secretary General, Ban Ki Moon launched the target of universal energy access by 2030. He finds that access to energy is not only important for reducing poverty, but the foundation for meeting the Millennium Development Goals (MDGs). Most of the coun-

tries, which currently are behind on the MDGs are those with low energy access. For example only around 15 percent of Africans have access to electricity, while the figure is 40 percent in East Asia. Hence, if world leaders are serious about eradicating poverty and meeting the MDGs, they ï and all others involved in development ï must prioritize access to energy for the poor. Yet, in spite of the importance, agreements on international programs and actions towards increasing poor peopleôs access to energy have failed. (Practical Action 2010; United Nations, AGECC, 2010).

As already discussed, the current mainstream development model focuses on investing in large-scale energy infrastructure, like huge water projects, in order to provide energy for economic growth. Moreover, much of the energy produced in the South is exported in order to earn the country foreign exchange. The rest is directed towards use in domestic export industries and other urban economic activities. There is consequently a need to balance the focus on large-scale, centrally-controlled power technologies with small-scale technologies that can supply energy for poverty reduction in local communities. The energy needs of the poor are small, but small amounts of energy can make a significant difference to their lives. (Practical Action on Energy Poverty; Practical Action 2010).

It is important to consider all energy options for poor communities including connecting to the central electricity network or to a smaller local electricity supply network; using liquid and gas fuels for cooking or biomass where appropriate; consider renewable energy options like small-scale hydro power schemes, solar photovoltaic (PV) systems, and small-scale wind electricity generators. Which energy option is best, is based on the technologyôs appropriateness: using of local resources and sizing it according to need. Moreover, it must be operated, managed, and maintained locally. Hence, local people must participate in the whole processes of deciding and planning, installation, and maintenance. (Practical Action on Energy Poverty; Practical Action 2010).

Small Hydro Power Systems

Small hydro power systems have a long tradition. Two thousand years ago, the Greeks learned to harness the power of running water to turn the massive wheels that rotated the shafts of their wheat flour grinders. In the 18th century, thousands of towns and cities worldwide were located around small hydro power sites. Today, small hydro power projects offer emissions-free power solutions for many remote communities throughout the world. ñSmall-scale hydro power systemsò are those that generate a minimum of 100 kilowatts (kW) and up to 30 Megawatts (MW) of electricity. Hydro power systems that generate less than 100 kW of electricity are often called ñmicro hydro power systems.ò Most of the systems used by home and small business owners would qualify as micro hydro power systems. Consequently, a 10 kW system generally can provide enough power for a small enterprise or a farm. (Small Hydropower Systems 2001).

Practical Action promotes small-scale hydro power systems, which provide poor communities in rural areas with an affordable, easy to maintain, and long-term solution to their energy needs. The organization has developed small-scale hydro power systems with communities in Zimbabwe, Kenya, Peru, and Sri Lanka. The systems are designed to operate for a minimum of 20 years and each generally generates up to 500 kW of electricity. The system does not require construction of a dam or storage facility; instead water is divided from a stream or river, channeled to a valley, and dropped into a turbine via a pipeline. This system avoids the destructive social and natural effects caused by large-scale hydro power projects. The cost of a small-scale hydro power system varies depending on the circumstances. However, experience shows that the effect of improved income and quality of life from the energy makes the scheme economically viable and sustainable for the community. The electricity provides the village with domestic light and cooking; it recharges batteries, and it is used for various kinds of income generating activities. (Practical Action on Micro-hydropower).

Life is hard for people in rural Kenya and their need for energy is acute. Ninety-six percent of Kenyans live without electricity. In rural homes, families spend at least a third of their income on kerosene for light and diesel for milling of grain. In addition, Kenyan women utilize many hours on collecting, processing, and using wood and dung for cooking ï time which could be spent better on child care, education, and income generation. Mbuiru village is situated in the rural areas 200 kilometers north of Nairobi. The inhabitants are poor, having only few possibilities for change. However, the community was willing to help themselves when they got the opportunity to generate power. The ñTungu-Kabri Micro-hydropower Projectò is the first of its kind in Kenya. It was funded by the United Nations Development Programme and developed by Practical Action and the Ministry of Energy in Kenya. It is an affordable, sustainable, and small-scale technology that harnesses energy from falling water to make electricity. During a period of two years, the community discussed, decided upon, and built the hydro power station. And it works. It is estimated that the power generated will benefit around 200 households or 1,000 people. Since the river is running perennially, the system will keep on working also during drought. Thus, the villagers will be able to light their homes, mill their grains, run small enterprises with electricity, while saving time and money. This will increase their income for buying of food, clothes, and for payment of school fees for their children. Thus, the project enhances the overall well-being in the community. Moreover, hydro power means that less diesel, kerosene, wood, and dung is used, thus also nature benefits. (Practical Action on East Africa Energy).

Solar Power for the South

There are two other types of small-scale renewable energy systems: The first category produces electricity based on photovoltaic solar power (PV) and wind power. The second category produces geothermal energy for heating, drying, and cooking. Geothermal energy is energy generated and stored in the Earth. It comes from the original formation of the planet, from radioactive decay of minerals, from volcanic activity, and from solar energy absorbed at the surface. The geothermal gradient, which is the difference in temperature between the core of the planet and its surface, drives a continuous conduction of thermal energy in the form of heat from the core to the surface. Solar systems are by far the most common application of small-scale renewable energy systems in households, and its source is abundant. The sun emits more energy in one second (3.827 x 1026 J) than is available in all of the fossil fuels present on Earth (3.9 x 1022 J). Therefore, the sun has the potential to provide all current and future global energy requirements. Since solar energy is clean and free, Southern nations can support their people, protect their environments, and enhance a sustainable economic development by using renewable energy sources. Many African countries receive on average 325 days per year of bright sunlight. This gives solar power the potential to bring energy to virtually any location in Africa. A recent study indicates that a solar generating facility covering just 0.3 percent of the area comprising North Africa could supply all of the energy required by the European Union. Moreover, solar power is scalable. Thus, there are systems available from less than 1 watt to several megawatts. The technology can therefore supply energy on a large scale as well as on a small scale; hence it is possible to introduce electricity to a home or to the whole village. Because solar projects produce power where it is used, it provides a safe, reliable, and cost effective solution. Solar power systems are simple to set up, easy to operate, easy to repair, and they are durable. Consequently, solar energy can provide all of the electrical energy the rural populations in Africa require. (UNIDO 2009; Wikipedia on Geothermal Energy 2011; Wikipedia on Renewable Energy in Africa 2011).

Unfortunately, poor households have not benefited much from solar power systems because of the high upfront costs. However, the prices are not fair. A 1997 study, done by five American science laboratories, concluded that solar energy could supply 60 percent of the US energy needs at competitive prices, if there was fair competition and proper accounting of its environmental benefits. Hence, as long as social and environmental costs are not included in the economic calculations of energy

production, solar technology will be too expensive for most poor people. That is why the main progress in implementing solar energy has taken place in the North. (Capra 2002, 216-218; Greenpeace 2011; UNIDO 2009).

Nevertheless, the Southern economic and political elites are becoming interested in solar energy. In May 2010, the government of the Indian state Gujarat ï one of the states involved in the Narmada Valley Project ï recently identified a 2,000 hectare site near Charanka village in Patan district to build the Charanka Solar Park. Half of the identified area was degraded land. Information on how the government managed to find the other 1,000 hectares of land is not available. When it is ready in 2014, the Park will be among the largest solar power facilities in the world, producing 500 MW, using state-of-the-art technology. At completion, the project will save around 8 million tons of carbon dioxide from being released into the atmosphere and around 900,000 tons of coal and natural gas per year. The Solar Park is meant to increase energy access for businesses in the region. The cost of the whole venture will amount to some 280 million USD. With such huge investments one cannot help but to wonder why the Gujarat government could not adequately compensate the poor people who were driven away from their land in order to make way for the Narmada Valley Project! (Business Line 2012; Gujarat Solar Power Transmission Project 2011; Wikipedia on Charanka Solar Park 2011; Wikipedia on Gujarat Solar Park 2012).

China has also launched a mega solar works: Solar Valley. It is the biggest solar energy production base in the world. It will be a clean energy technology hub that China hopes will rival Silicon Valley in California, USA. The planned project is expected to cost 740 million USD and has already attracted around 100 companies, initiated factories and a research center. Solar Valley is located just outside the city of Dezhou, where trees are cut down for the paradoxical purpose: protecting nature. Dezhou, with a population of 600,000 and a suburban sprawl housing 5 million people, is becoming reputed as a clean energy city. Last year 10 million USD was spent to install solar lighting along miles of road. The city requires that all new buildings be equipped with solar water heaters. Another paradox is that the Solar Valley, which is placed near the northern, dry areas of China, is boasting its solar heated swimming pools. As part of the project, the lands of tens of thousands of farmers were expropriated, and the people were moved into concrete apartment blocks in order to make way for this grand new and clean energy development scheme. (Inhabitat.com 2010; Washington Post 2010).

Although solar energy currently is enjoyed mainly by the elites, there is hope that also poor people will get access. According to a new study, ñSolar Generation 6,ò published by the European Photovoltaic Industry Association and Greenpeace International, prices are decreasing. Since 2005, prices of PV systems have dropped some 40 percent and by 2015 the cost is expected to fall by an additional 40 percent compared to current levels. This means that it is highly likely that investments in solar energy will double worldwide by 2015. With this development, it is expected that global solar energy would hit 980 GW (gigawatt) in under 10 years. As a result, solar systems will within the next five years be able to compete with electricity prices for households in many European countries. The report foresees that solar power alone could account for 12 percent of European power demand by 2020, and up to 9 percent of the global power demand by 2030. The solar system is not only an important technology for combating climate change; the research also shows that it creates 35 to 50 jobs per ton of carbon dioxide saved. Moreover, it will secure reliable energy supplies and reduce dependency on expensive energy imports. It may even end the eternal struggles and wars over access to oil and gas; diminish the need for toxic nuclear power plants and for destructive large-scale hydro power projects. Hence, the report finds that solar power technology is on the brink of an economic breakthrough. (Greenpeace 2011; Treehugger.com 2010).

Consequently, slowly the price of solar energy becomes within reach of poor people in Africa. In Kenya a small Chinese-made solar panel costs 80 USD. The panel gives enough electricity to charge the battery of a cellular phone and run four bright overhead lights with switches. Sara Ruto from Kiptusuri village sold some of her animals and bought a solar panel. She had just got a cellular telephone that kept her in contact with relatives. However, charging the battery was burdensome and expensive since she had to travel to town to have it done. Hence, getting a solar panel was a better solution. Unknowingly, the solar panel brought her and her family more advantages: giving good light for studying, her teenage children improved their grades, and her toddlers are safe from burns from the kerosene lamp. Each month, Sara saves 15 USD in kerosene and battery costs apart from the 20 USD she spent on the travels to town. Others followed her example. Now 63 families in the village have installed their own solar power system. According to UN, 85 percent of Kenyans live without electricity. Although there is no reliable data on the spread of solar panels, the World Bank finds that the trend is accelerating. Small solar systems deliver useful electricity at a price that also many poor can afford; even herders in Inner Mongolia have solar cells on top of their yurts. In Africa, the market for small-scale solar panels is emerging in Ethiopia, Uganda, Malawi, and Ghana, as well as in Kenya. Nevertheless, although these small-scale systems are valuable for poor people and within many peopleôs financial ability, the distribution and financing is inefficient. Hence, solar power is not easily accessible. It may therefore still take time before availability is more widespread. (Rosenthal 2010).

Few current solar technologies can pass the test of being affordable, accessible, and appropriate. Thus, Practical Action initiated a research and from the results developed a solar lantern. A prototype is presently being tested by the target group. The solar lantern is meant for those households who currently are using kerosene or candles, and who would like to have better light, but cannot afford a solar home system. When sunlight falls on a photovoltaic panel it charges the lantern battery so that the lamp can provide light by a fluorescent tube of 5, 7, or 9 watt sizes. With a fully charged battery and the 5 watt lamp option, the lantern will give light for more than 5 hours. Charging time is around 7 hours. These lamps are six times more efficient than standard incandescent bulbs and have an operating life eight times as long. The battery can also power a small radio. Reactions have been very positive, with more people wanting to test the lanterns than there are prototype units available. The final unit cost of the lantern needs to be set at a level that is affordable for average incomes, and it must save the cost of kerosene and other lighting expenditure of the household. An additional issue is to ensure that the technology can be manufactured locally, which will make it sustainable. (Practical Action on Solar Lantern 2010).

There will soon be an even cheaper solar technology available in Africa: a solar-powered light bulb. A company called Nokero has begun producing the solar light bulb, which is intended for the market in the developing world. While distribution began in June 2010, the new solar light bulb has already been purchased in 30 countries, and shipments for testing have arrived in Liberia, Pakistan, Haiti, and Nicaragua. The solar bulb is rain-proof, made of shatter-resistant plastic, with four solar panels on the sides. When placed in full sunlight for eight hours, the solar light bulb will produce between two and four hours of light. Each of these solar light bulbs has a battery that is designed to last two to three years and is both replaceable and recyclable. The solar panels on the side are expected to last five years or more. At present, the cost of these solar bulbs is Nokeroôs main concern. A single unit is sold for 15 USD, but when sold in bulk, the price will be as low as 6 USD. Lately a new version has been produced that works for 6 hours, however, it costs 20 USD. Making these solar light bulbs available to poor households will reduce the number of kerosene lamps needed, providing safer and healthier living situations for the vast number of people living without electricity today. (AllAfrica.com 2010).

Conclusively there are alternative, gentle, and sustainable energy technologies. These would be greatly helpful to end many of todayôs crises, and most importantly, they would be supporting poor societies and nature. Yet, often the costs are too high and out of reach of poor people. However, if governments are serious about alleviating poverty, developing vibrant societies, and create healthy environments, they should consider to offer free energy to poor people, an investment that would increase overall economic well-being in the long term.

Addressing Access to Drinking Water

It seems unlikely that people living in the arid regions of Gujarat will ever receive clean drinking water from the Sardar Sarovar Dam. Millions of people in India are facing shortage of safe drinking water and they suffer, especially during times of drought. The government often responds poorly to peopleôs misery due to lack of coherent drought management strategies, coming from short-sighted development planning. There are, however, some Indian villages in dry areas that are having plenty of water, even during droughts. With help from NGOs and/or local governments these communities have adopted watershed management measures. Activities like rainwater harvesting, tree planting, and soil conservation have transformed these villages. The depleted groundwater table is being recharged and in many areas seasonal rivers are again perennial. The activities are small in scale, community managed and maintained, financially feasible, and environmentally sustainable. They offer viable alternatives to the large-scale centralized water supply schemes. Many are based on traditional practices that have been revived by local communities and improved by help from outside. They may not be the entire answer to all the water problems in India, but they constitute a large and important part of the solution. (Friends of River Narmada on Alternatives).

Such a remarkable transformation has taken place in the arid region of Alwar district, Rajasthan, an area in western India, north of Gujarat. Several hundred seriously drought hit villages have now become self-sufficient in water, and many have initiated impressive forest conservation measures. Helping them in this transformation is an NGO called Tarun Bharat Sangh, set up in the mid-1980s for rural development and environmental conservation work. (Kothari 1999; Shresth 1999).

There are 70 villages in the Arvari catchment. Around 200 water harvesting structures have been built along its catchment during a period of 10 years. These structures are based on traditional technology and have successfully replenished ground water, increased the water table, enabling the 40 km long river Arvari to flow perennially again. The villages Bhaonta and Kolyala are situated in the upper catchment of the river Arvari. Over a period of fifteen years, the inhabitants of these two villages have changed their lives from extreme hardships, to livelihood security and relative well-being. Before 1986, inhabitants from the two villages were plagued by severe water shortages and inadequate supplies of fuel wood and fodder. The nearby forests, which technically were reserved and protected under the custody of the Rajasthan Forest Department, had degraded because of heavy felling, overgrazing, and excessive fuel-wood extraction. Wildlife had substantially declined, due to habitat loss and hunting. Owing to lack of incentives, out-migration of men in search for employment was commonplace. (Kothari 1999; Shresth 1999).

Traditionally water conservation in this area involved trapping water during the short rainy season by constructing a series of small dams and tanks that require regular maintenance. Besides, the hill slopes must remain forested to avoid soil erosion silting the ponds. A series of meetings with the NGO ended in a decision by people from both villages collectively to protect forests and construct dams. To implement the program, a village council was formed. It is an informal body that addresses the common needs of the communities, but it has no legal authority. The village council made rules about sustainable use of forests, grazing, and fuel wood. The villages had to build a total of 17 structures, including two dams. The NGO paid 75 percent of the costs, while the villagers covered the last

25 percent in cash or as labor. In addition, the village council established a fund to which each household contributed grains from their harvest. Some grains were kept as reserve for village needs, while the rest were sold to build up a monetary fund for community concerns. (Kothari 1999; Shresth 1999).

Following 10 years of protection, the degraded 600 hectares forest is regenerating. The vegetations in the valleys are dense and lush green. There is a diversity of bird-life and mammals, though in small numbers. The reappearance of leopards is encouraging. According to the villagers, leopards disappeared from the area two decades back. Although, the occasional goat is taken by these cats, the villagers think this is part of the natural order. Moreover, the presence of predators will inhibit people from going into the forest unless absolutely necessary, which aids the conservation process. The success in revival of wildlife prompted the villagers to declare the area a Public Wildlife Forest. The community sees their efforts as a positive and an ideological alternative to the conservation policy followed by the Forest Department. The most visible change is the recharged water wells and the green plants in the villages. After 1990 there has been a rise in agricultural productivity and two units of crops can easily be harvested in a year. People have become more healthy and livestock more productive due to the improved nutrition. Out-migration has also decreased because of the increase in productivity. Some of the more active villagers have emerged as local leaders and got involved in the wider conservation work in the area. (Kothari 1999; Shresth 1999).

An important reason for the success was to perceive the activity holistic, thus linking water, forest, and agriculture with appropriate technology and peoplesô livelihoods. Such a holistic view is traditional and places peopleôs needs within a larger ecological process. In addition, people were involved in the activity from the very beginning, which gave them a sense of pride and ownership and increased their collective responsibility toward natural resources. The process also empowered the village. It has given people a new sense of confidence to assert their right to and ownership of their natural resources, even though the government does not recognize this. Lacking legal authority means that the village council cannot enforce forest protection regulations. There has therefore been an increase in incidents of tree-felling by people from neighboring villages, who have not experienced similar awakening. This has been demoralizing for the villages. There is also the uncertainty that one day the Forest Department may claim the forest as state property, and start tree felling. Another matter of concern, though not articulated by the villagers themselves, is the lack of involvement of women in decision-makings. The council meetings are almost always exclusively a male affair. Due to womenôs traditional duties ï including collection of water and fuel wood, production of food for the family and raising of small livestock ï being absent from participation is not conducive to the sustainability of the activities, neither can excluding half of the adult population be considered a truly holistic development activity. It is also a contradiction to the democratic decision-making that villagers demand from the state. (Kothari 1999; Shresth 1999).

Over 300 villages in the Alwar district have revived old or build new water harvesting structures. Many of them have also started regenerating and protecting surrounding forests. Accordingly, at a recent public meeting, villagers suggested to declare the entire Arvari basin a peopleôs sanctuary. Hence, an Arvari parliament has been set up. Its terms of reference are to decide on a range of development and environment related issues affecting thousands of people residing in the basin. (Kothari 1999; Shresth 1999).

The example of Bhaonta and Kolyala, and many other villages in India, point to the need for an urgent shift in technology in India. Given a chance and appropriate inputs, communities can conserve their natural environment and develop sustainable livelihoods. It also shows that the governmentôs efforts at conservation and development can be made significantly easier and more effective if they

gave communities a central role in decision-making and implementation of activities. Community-based, gender equal, and joint conservation efforts founded on appropriate technology is a good future strategy for preservation of water, biodiversity, and wildlife habitats. Yet, that would probably not satisfy the economic and political elitesô focus on economic growth and profit-making. (Kothari 1999; Shresth 1999).

Conclusion

If we want technology to be a means for poverty alleviation, we need to understand the underlying values of science, economics, and technology. When we realize that modern, scientific technology is supporting the elitesô vested interests, we are obliged to demand a change. Technology, and the knowledge system that determines its development, must adapt to holistic standards. Hence, technology needs to include concerns for society and nature, not only being a purely economic, profit oriented issue. While we are working on these necessary changes, we need to keep in mind that as long as modern technology destroys the quality of life for women, poor people, and nature, nobody, who is serious about poverty alleviation, should consider Third World development as a technological fix.

Jytte Nhanenge
Chimoio
Mozambique
April 2011

Bibliography

AllAfrica.com. 2010. *Africa: Solar Energy to Save Lives* http://allafrica.com/stories/201008161148.html and *Second Generation Solar-powered Light Bulb Lasts Thrice as Long* http://dvice.com/archives/2010/11/second-gen-sola-1.php *Solar Light from Nokero* http://www.nokero.com/ (accessed February 10, 2011).

Barlow, M. 2002. *Transcript of interview with Maude Barlow* http://www.carnegiecouncil.org/studio/multimedia/20021212/index.html (accessed January 24, 2011).

Braidotti, R., E. Charkiewicz, S. Häusler, and S. Wieringa. 1994. *Women, the Environment, and Sustainable Development: Towards a Theoretical Synthesis*. London: Zed Books.

Business Line. 2012. *How Gujarat made its place in the Sun?* http://www.thehindubusinessline.com/features/article3332653.ece?textsize=small&test=2 (accessed August 8, 2012.)

Capra, F. 1982. *The Turning Point: Science, Society, and the Rising Culture.* London: Flamingo, Fontana Paperbacks.

Capra, F. 1989. *Uncommon Wisdom: Conversation with Remarkable People.* London: Flamingo.

Capra, F. 2002. *The Hidden Connections: A Science for Sustainable Living.* London: Harper Collins.

Cuomo, C. J. 1994. Ecofeminism, Deep Ecology, and Human Population. In *Ecological Feminism*, ed. K. J. Warren. London and New York: Routledge.

Curtin, D. 1997. Womenôs Knowledge as Expert Knowledge: Indian Women and Eco-development. In *Ecofeminism: Women, Culture, Nature*, ed. K. J. Warren. Bloomington and Indianapolis: Indiana University Press.

Dankelman, I. and J. Davidson. 1988. *Women and Environment in the Third World: Alliance for the Future.* London: Earthscan.

Des Jardins, J. R. 2001. *Environmental Ethics: An Introduction to Environmental Philosophy*. Ontario: Wadsworth.

Dr. George P. C. *Historical Earthquakes in China* http://www.drgeorgepc.com/EarthquakesChina.html (accessed January 26, 2011).

Eisler, R. 1990. The Gaia Tradition and the Partnership Future: An Ecofeminist Manifesto. In *Reweaving the World: The Emergence of Ecofeminism*, ed. I. Diamond and G. Orenstein. San Francisco: Sierra Club Books.

Ekins, P. 1992. *A New World Order: Grassroots Movements for Global Change.* London: Routledge.

Ekins, P., M. Hillman, and R. Hutchison. 1992. *Wealth beyond Measure: An Atlas of New Economics.* London: Gaia Books Ltd.

Elliott, J. A. 1994. *An Introduction to Sustainable Development.* London and New York: Routledge.

FAO. 2009. *1.02 Billion People Hungry. One Sixth of Humanity Undernourished - More than Ever* Before http://www.fao.org/news/story/0/item/20568/icode/en/ (accessed January 19, 2011).

Friends of River Narmada. *A Brief Introduction to the Narmada Issue.* http://www.narmada.org/introduction.html
The Sardar Sarovar Dam http://www.narmada.org/sardarsarovar.html
Who pays Who Profits? http://www.narmada.org/sardar-sarovar/faq/whopays.html (accessed January 15, 16, 17, 2011).

Friends of River Narmada on Alternatives. *Water Harvesting: Addressing the Problem of Drinking Water* http://www.narmada.org/ALTERNATIVES/water.harvesting.html *Alternative Solutions to the Narmada Valley Project* http://www.narmada.org/ALTERNATIVES/index.html (accessed January 18, 2011).

Good Planet.info *Dams* http://www.goodplanet.info/eng/Economy/Dams/Dams/%28theme%29/2717 (accessed January 24, 2011).

Greenpeace. 2011. *Solar Power on Brink of Breakthrough* http://www.timeslive.co.za/local/article892574.ece/Solar-power-on-brink-of-breakthrough--Greenpeace (accessed February 9, 2011).

Gujarat Solar Power Transmission Project. 2011. http://www2.adb.org/Documents/IEES/IND/44431/44431-013-ind-iee-01.pdf (accessed August 8, 2012).

Henderson, H. 1978. *Creating Alternative Futures: The End of Economics.* New York: Berkeley Publishing Corporation.

Houghton, J. 1994. *Global Warming: The Complete Briefing.* Oxford: Lion Publishing plc.

Inhabitat.com. 2010. *China Building Biggest Solar Energy Production Base in the World* http://inhabitat.com/china-building-the-biggest-solar-energy-production-base-in-the-whole-world/ (accessed January 20, 2011).

International Rivers. 2008. *Sichuan Earthquake Damages Dams, May Be Dam-Induced* http://www.internationalrivers.org/resources/sichuan-earthquake-damages-dams-may-be-dam-induced-3619 (accessed January 2, 2011 and August 8, 2012).

Kelly, P. 1997. Women and Power. In *Ecofeminism: Women, Culture, Nature*, ed. K. J. Warren. Bloomington and Indianapolis: Indiana University Press.

Kothari, A. 1999. *A Village Reborn. Bhaonta: A Village Wildlife Sanctuary* http://www.narmada.org/ALTERNATIVES/alwar/bhaonta.hin.html (accessed January 18, 2011).

Merchant, C. 1980. *The Death of Nature: Women, Ecology, and the Scientific Revolution.* New York: Harper and Row.

Mies, M. and V. Shiva. 1993. *Ecofeminism.* London: Zed Books.

Practical Action. 2010. *"Poor People's Energy Outlook"* Rugby, UK http://practicalaction.org/docs/energy/poor-peoples-energy-outlook.pdf (accessed February 5, 2011).

Practical Action on East Africa Energy. *Energy Programme.* http://practicalaction.org/east-africa/region_east_africa_energy (accessed February 5, 2011).

Practical Action on Energy Poverty. *Energy poverty* http://practicalaction.org/access-to-energy-1 http://practicalaction.org/decentralised-energy-2 (accessed August 7, 2012).

Practical Action on Micro-hydropower. *Micro-hydropower.* http://practicalaction.org/energy/micro_hydro_expertise (accessed February 5, 2011).

Practical Action on Solar Lantern. 2010. *Energy programme* http://practicalaction.org/energy-5 and Lighting for Rural Homes Using a Solar Lantern http://practicalaction.org/energy/docs/energy/EnergyBooklet4.pdf (accessed August 7, 2012).

Radford Ruether, R. 1993. Ecofeminism: Symbolic and Social Connections of the Oppression of Women and the Domination of Nature. In *Ecofeminism and the Sacred*, ed. C. J. Adams. New York: Continuum.

Rist, G. 1997. *The History of Development: From Western Origins to Global Faith.* London and New York: Zed Books.

Robertson, J. 1998. *Transforming Economic Life: A Millennial Challenge.* Devon: Green Books.

Rosenthal, E. 2010. *African Huts far From the Grid Glow with Renewable Power* http://www.nytimes.com/2010/12/25/science/earth/25fossil.html?_r=1&ref=elisabethrosenthal (accessed February 10, 2011).

Rowe, D. 1997. *The Real Meaning of Money.* London: Harper Collins.

Schumacher, E. F. 1993. *Small Is Beautiful: A Study of Economics as If People Mattered.* London: Vintage.

Scientific American. 2008. *China's Three Gorges Dam: An Environmental Catastrophe?* http://www.scientificamerican.com/article.cfm?id=chinas-three-gorges-dam-disaster (accessed January 20, 2011).

Shiva, V. 1989. *Staying Alive: Women, Ecology, and Development.* London: Zed Books.

Shiva, V. 1990. Development as a New Project of Western Patriarchy. In *Reweaving the World: The Emergence of Ecofeminism* eds. I. Diamond and G. Orenstein. San Francisco: Sierra Club Books.

Simmons, P. 1997. Women in Development: A Threat to Liberation. In *The Post-development Reader*, eds. M. Rahnema and V. Bawtree. London and New Jersey: Zed Books.

Shresth, S. 1999. *Forest Conservation and Water Harvesting in Bhaonta-Kolyala Villages, Rajasthan, India.* http://www.narmada.org/ALTERNATIVES/alwar/bhaontalecture.html (accessed January 18, 2011).

Small Hydropower Systems. 2001. *Energy Efficiency and Renewable Energy.* Brochure created by the US Government no. DOE/GO-102001-1173 FS217 July 2001.

Survival International. 2010. *Background Briefing Dams* http://www.survivalinternational.org/about/dams and *"Serious Damage" a Survival International Report* http://assets.survivalinternational.org/documents/373/Serious_Damage_final.pdf (accessed January 25, 2011).

Trainer, T. 1997. A Rejection of the Brundtland Report. In *Perspectives on Development: Development Theory: Urban and Rural Issues* eds. P.D.S. Steward and H. Swanepoel. Pretoria: University of South Africa.

Treehugger.com 2010. *Global Solar Energy Could Hit 980 GW in under 10 Years* http://www.treehugger.com/files/2010/12/global-solar-energy-could-hit-980-gigawatts-10-years.php (accessed January 25, 2011).

UNIDO 2009. *Scaling up Renewable Energy in Africa.* 12th Ordinary Session of Heads of State and Governments of the AFRICAN UNION Addis Ababa, Ethiopia. http://www.unido.org/fileadmin/user_media/Services/Energy_and_Climate_Change/Renewable_Energy/Publications/Scaling%20Up%20web.pdf (accessed April 19, 2013).

United Nations. 2007. *United Nations Declaration on the Rights of Indigenous Peoples* http://www.un.org/ga/search/view_doc.asp?symbol=a/res/61/295 (accessed August 7, 2012).

United Nations, AGECC. 2010. *Summary Report from the UN Secretary-General's Advisory Group on Energy and Climate Change (AGECC) "Energy for a Sustainable Future"* http://www.un.org/wcm/webdav/site/climatechange/shared/Documents/AGECC%20summary%20report%5B1%5D.pdf (accessed April 2010).

Warren, K. J. 1997. Taking Empirical Data Seriously: An Ecofeminist Philosophical Perspective. In *Ecofeminism: Women, Culture, Nature*, ed. K. J. Warren. Bloomington and Indianapolis: Indiana University Press.

Warren, K. J. 2000. *Ecofeminist Philosophy: A Western Perspective on What It Is and Why It Matters.* Lanham: Rowman and Littlefield.

Washington Post. 2010. *With Solar Valley project, China embarks on bold green technology mission* http://news-summary.blogspot.com/2010/05/with-solar-valley-project-china-embarks.html (accessed February 5, 2011 and August 8, 2012).

Water Technology.net. *South-to-North Water Diversion Project, China* http://www.water-technology.net/projects/south_north/ (accessed January 26, 2011).

Wikipedia on Banqiao Dam. 2011. *Banqiao Dam* http://en.wikipedia.org/wiki/Banqiao_Dam (accessed January 24, 2011).

Wikipedia on Charanka Solar Park. 2011. *Charanka Solar Park* http://en.wikipedia.org/wiki/Charanka_Solar_Park (accessed January 20, 2011).

Wikipedia on Geothermal Energy. 2011. *Geothermal Energy* http://en.wikipedia.org/wiki/Geothermal_energy (accessed February 24, 2011).

Wikipedia on Germany. 2011. *Germany* http://en.wikipedia.org/wiki/Germany (accessed January 21, 2011).

Wikipedia on Gujarat Solar Park. 2012. *Gujarat Solar Park* http://en.wikipedia.org/wiki/Gujarat_Solar_Park (accessed August 8, 2012).

Wikipedia on Renewable Energy in Africa. 2011. *Renewable Energy in Africa* http://en.wikipedia.org/wiki/Renewable_energy_in_Africa (accessed January 20, 2011).
Wikipedia on Sardar Sarovar Dam. 2011. *Sardar Sarovar Dam* http://en.wikipedia.org/wiki/Sardar_Sarovar_Dam (accessed January 20, 2011).
Wikipedia on Three Gorges Dam. 2011. *Three Gorges Dam* http://en.wikipedia.org/wiki/Three_Gorges_Dam (accessed January 20, 2011).
World Bank. 2010. *World Bank updates Poverty Estimates for the Developing World* http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:21882162~pagePK:64165401~piPK:64165026~theSitePK:469382,00.html (accessed January 19, 2011).

Explanations of Concepts

1) A kilowatt (kW) is equal to one thousand (10^3) watt or 3.6 mega joules or 1.34 horsepower
A megawatt (MW) is equal to one million (10^6) watts or one thousand kilowatts
A gigawatt (GW) is equal to one billion (10^9) watts or one thousand megawatts.

Observe: some figures used here have been changed and updated over time; new figures may therefore differ from those stated in this article. However, those stated were the figures at the time of writing this article.