I. G. Simmons: Changing the face of the Earth
Basil Blackwell, Oxford, U.K. 1989.

Environmental influence on culture: Thomas Malthus (1760-1834): Influence of different environments & limitations imposed on social development. Carl Ritter (1779-1859): Physical environment was capable of determining the course of human development. Charles Darwin: Origin of species 1859: Relationship of organisms & habitats & pressures of natural selection. Huntington (1876-1947): Climate as an important influence on human behaviour. Best climates were those in which temperatures varied within a certain range & made people industrious (UK & New England).

The French Geographer Paul Vidal de La Blache (1845-1918) saw in the physical environment a series of possibilities for human development, the culture of the people concerned taking advantage of these possibilities. Historian Lucien Febvre (1878-1956) emphasized initiative & mobility of man & his interactions with other groups of people. H. J. Fleure (1877-1969) divided the world into regions of effort, & of hunger & of industrialization. He also recognised regions of lasting difficulty & debilitation & i.e. recognised the influence of physical environment.

The name of H. H. Barrows (1877-1960) became associated with idea of human ecology - relationship between human & physical factors. 18th century was considered to be a watershed of biological regimes when much of the world was still a "Jungle Book".

The environmentalist movement started in 1960s has shown quite distinctly that there is an overall limit to certain kinds of human activity in terms of the biophysical persistence & resilience of the planet's system. So there is a physical a physical or ecological envelope, but within this, human technology & knowledge allow a variety of adjustments to the resources of the planet. Nevertheless, the technological achievements of man are such that we can now perhaps contemplate the replacement of some of the biophysical systems of the planet with man-made ones, providing that enough energy is available, thus escaping forever the possibility of determinism's being correct. On the other hand, knowledge of the biospheric envelope might make us even more intent upon living within it. This is the new determinism of the environmentalist.

There is another view which sees man as modifying nature & nature in turn affects the perceptions of human societies. G. P. Marsh (1801-1882) highlighted man's role in upsetting natural balance through his unwise acts. He was a predecessor of today's environmentalists & his influence culminated in the formation of EPA in the US & the requirement of EIA for all technological projects.

In the East traditions emphasized quietism & non-interference & rejected western dualism of man & nature. But the results in operational terms were similar in both east & west. Deforestation continued under Buddhism & Taoism; conservation of forest as sacred groves & forest sanctuaries was practised in east & west & particular societies achieved delicately balanced relationships with their surroundings in both cultures.

Now Technology has come to dominate both east & west & that makes "the story of western civilization now the story of mankind".

When human beings are active agents in ecosystems, then the field of study is sometimes called human ecology & the resulting systems have been given a variety of labels such as anthropo systems, socio-natural systems & agroecosystems.

The flow of radiant energy from the sun forms the foundation of most life in its familiar forms, so the capture of energy by the process of photosynthesis and the subsequent fate of the chemical energy thus 'fixed' is of considerable importance. Photosynthesis is rather inefficient but by way of perspective we might think that it is remarkable that it exists at all, & that we are unable to replicate it in the laboratory, let alone improve upon it.

There are other limitations too. All forms of energy on the earth end up as heat which can do no work. Only oxygen & hydrogen are freely available in large quantities, the others circulate between reservoirs (pools) on varying scales. The pools usually include a non-living stage which has a very slow turnover & involves a very large pool of the element stored in the atmosphere or in the earth's crust.

The effect of mankind globally is to reduce NPP, even though the lower levels are culturally more acceptable than the pristine states. The physical & biological systems of the planet are evaluated by culture & turned into resources, which are then transformed into energy, goods & services. All human activities, in the long run, increase the quantity of entropy in the Universe, and can only be sustained while there is low entropy upon which to feed: e.g. fossil fuels, the atomic nucleus and sunlight though each of these has concomitant problems. As more energy becomes available, to a society, control over it becomes disproportionately concentrated in a few hands. The effective use of solar energy as an alternative to fossil fuels, might require technological and demographic decentralization, on the other hand, nuclear fusion based on hydrogen might require even greater technological & population concentration.

If we consider the relationship of non-human energy flows to those controlled via technology, we can see that the latter flows are used to diminish the energy flowing through the former,

Changing the face of the Earth (contd.)

Since the transformations of fossil & nuclear energy place stresses upon natural and semi-natural eco-systems which in turn lower their biological productivity. This situation is the outcome of millennia of social change in which the physical environment has been progressively absorbed into the cultural world of perception & cognition, with an increasing use of technology to satisfy the ever larger human populations with their increasing demands for comfort, wealth & nutrition.

The ~~b~~ biological success of the human species now means that they have the highest biomass of any animal; and a population growth rate of nearly 2 p.c. per annum is fast, although longevity makes for slow turnover of the biomass. We now manipulate or appropriate some 40% of the continental NPP with the consequence that many of the earth's eco-systems now depend for their continuing function upon the integrity of human societies. Man has increased the area of biologically inert places.

Technology of Primitive Man

After 0.5 m.y. a. man had control of fire which made glacial winters more palatable. Choppers were the earliest stone tools. Then came hand axes, cleavers, chisels, scrapers, awls, hammers etc. Bones were used. Group hunting was practised. Forests were cleared. Fire was used to sharpen & harden tools (Antler tip). Fire favours herbs & grasses, animals to perennials, organic matter mineralized, rich in protein

plant toxins are reduced. Bacteria & fungi reduced.
Fire creates diversification & a mosaic of habitats.

Where the energy ratios of hunters have been measured, the combination of food collecting skills and environment seemed normally to provide an adequate surplus of input to output to feed not only the collectors but those dependent on them. The Kung food systems appeared to provide an adequate diet for the whole group on 2-4 days per week with more surplus devoted to feed dogs, accumulating fat against lean season etc.

In an exchange economy more calories have to be expended in gathering the product to be exchanged. In general, it appears that ending of isolation for hunters due to trade & exchange meant that either their resources were greatly reduced in quantity & that this led to demise or to the adaptations of agriculture or horticulture or wage labour. Heavy investment of time & effort which goes into hunting militates against selective killing & rational management.

Fire has the advantage that it raises the value & nutritional quality of food for ungulates by a factor of ten, since it increases the quality of browse as well as improves protein content of leaves.

Impact of Agriculture

Horticulture came first. Human beings altered the genetic composition of plants by influencing their breeding. Planting of harvested & selected seed brings about multiplication of chromosome numbers of the plant which produces an increase in size & robustness. Bitterness toxicity, thorns are lost. The plant may lose its ability to disseminate & becomes annual. In animals neoteny is encouraged. Scavengers & weeds increased around habitations.

Continuous agri. changed soil chemistry & salt tolerant crops had to be introduced. Domestication increased use of milk & milk products leading to earlier menarch in women & with cereal grain as instant food led to population increase.

Pastoralism beyond irrigated zone led to vegetation loss, erosion & choking of channels. Loss of habitat & hunting affected wild animals & predators whose nos. declined, e.g. Lion, Leopard. Grazing changed species composition. In shifting cultivation burning loses N & K & builds up P & Ca. Even terracing does not eliminate soil loss.

Grazing animals turn cellulose into milk, meat & blood & also provide dung, horn & hide. Even repeated light grazing produces shifts in plants composition with inedible plants dominating. Eroded soil builds up river terraces which increase flood losses

Old irrigation systems were revived & improved upon creating a new agricultural season. Enclosure movement in England & elsewhere promoted innovation & varied use of land. Certain heath, moor, fen, saltings were reclaimed when some were changed to woodland or parkland. Four course rotation of crops introduced & cattle & sheep were specially bred for milk & meat or wool or mutton

Low fertility of tropical soils is circumvented through water-borne nutrients brought into the terrace, fixation of nitrogen by blue-green algae & release of nutrients & minerals by the decay of stubble. Farmer may add manure of pigs & buffalo, ashes, soot, straw, green compost etc.

The mean NPP of cultivated lands is 650 g/m²/yr. For shifting agriculture weeds comprised of 5.6 & 12.8% of above ground plant productivity in 1st & 2nd year. The crop production declines from 146.5 g/m² to 119.5 g/m². A nearby plot allowed to go back to forest had lower NPP in first year but much higher in the 2nd year. In New Guinea shifting cultivation in highlands with hunting, pig herding & collecting wild food leads to a input-output ratio of 1:3.8. Maring fence their fields, control erosion, & species succession, keep pigs giving a ratio of 1:10.2. The Enga cultivate sweet potato to feed pigs. If value of cut down forest is included, the ratio becomes negative.

In permanent agri where some irrigation & animal labour were involved, ratio was 1:0.64 in China. Maize with only human labour in Mexico yielded 1:12.5 while in China with tools & horse drawn implements it yielded 1:2.44. Similarly with bullock power in U.P. yielded 1:0.96. Rice with gravity irrigation yielded 1:9.8 in Philippines. Where a great deal of crop energy goes to feed animals & dung not put back in the field, ratio declines significantly.

A preindustrial farm in Britain managed a ratio of 1:40 with only 5% fossil fuel use, production of bread, beer & bacon for own consumption but 78% of crops & mutton sent out. This farm employed 32 persons & 98 dependents without any fossil-fuel use. The total area was 460 ha.

Socialism to be a genuinely radical enterprise must dissociate itself from the styles & mores of life which capitalism tries to perpetuate and self-consciously create those which accentuate the humanity in man & at the same time avoid violating the delicate balance of nature.

It is better to recognize that large quanta of non-metabolic power per se could never be available to more than an extremely small minority of mankind & that for purely transitorily. Bicycle not only symbolizes but embodies just that dose of technology, which would engender a human environment for people to work & live in, not a maze of highways & flyovers for robots to commute over. Authentic social progress, then, would be contingent upon man's ability to switch over from a want-based economy, as C.T. Kurien has designated it, to one that is primarily need based. Plateau should replace pyramid. The pyramid of today is vastly more effective both at regimentation & destruction. Those at the top exclude the majority from a participatory existence & at the same time lobotomize the incorporated minority through sales promotion & gadget multiplication.

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Kamal Nayan Kabra

Structural Adjustment Programme operating in India. Implementing liberalization. Poor & counter productive results due to weak states & their poor governance. Injecting morality in globalization. Special attention to rural & farm sectors. Giving reforms a human face.

Electoral rout of reforming regimes. Dismantling of interventionist regime produced: High cost, industries depending on imports, producing high income goods. Growing debt, huge trade deficit, concentration of wealth, low agri. growth, growing unemployment, tax evasion, large fiscal deficit, hyper growth of service sector, black economy, regional imbalances, poor response of corporate investment, unsold food stocks, farmer suicide, foreign exchange reserves invested in US bonds with low int. rates, rise in no. of poor. Reforms increased the misery & woes of the people at large.

Denial by the electorate. Neo-liberalism never preferred social equity, democratization of the economic sphere, partnership of the people, growth of national product with indigenous & foreign capital is the prime goal. Trickle down continues. Some transfers of wealth to welfare measures. Foreign aid givers became critical players. Indian & foreign capital joined hands. Continuously rise of prices. Even before reforms India had massive inequalities. A large part of population excluded from market. Increasing the flow of marketable goods & services increase inequalities. The main ~~costs~~ sufferers were farm workers & small land holders (80% of total)

State-market co-operation. Inter-state disparities increased. Primary sector's share decreased from 33% to 24%. Higher income classes increased from 20 to 26%. Cut in indirect taxes not passed on to consumers. All forms of labour incomes are taxed. Big borrowers' bad debts increased. 24 stock exchanges. Their turnover is enormous. Casino economy. Large imports of gold.

Changing the Face of the Earth (contd.)

The energy input/output ratio of modern farmers was 1 : 0.553. The old Amish produced 1 : ·009 without any energy subsidy & conservative Amish 1 : ·058. Thus labour intensive farming can compete with modern one in terms of productivity.

In Himalayas where wheat is grown, it yields 1:14 but when vegetables are grown with fertilizer & manure, it is 1 : 0.46. The requirements of fuel & fodder come from forest & dung is used as fertilizer. In East India, compared to shifting agri & valley cultivation, terracing becomes inefficient as it requires additional efforts to construct & maintain & heavy inputs of fertilizer. Paris also provided an example of energy efficient agri based on horse dung & city's sewage. If dependents are taken into account, the ratio declines for all systems. In low-technology systems yields vary from season to season & problems of storage, processing & preservation are ~~a~~ seldom adequate. It was perhaps best-suited to an environment ~~whatever~~ when surrounding nature provided a buffer & life-styles were simpler.

Pastoralism. Pastoralists had to keep peaceful or violent contact with agricultural civilizations. They always require fresh sources of water & food. Grazing always encourages weeds, thorns & toxic many plants.

Early Technology Wind was harnessed to pump water up from waterlogged lands. In Netherlands wetlands were drained in early AD. The control of rivers had mediaeval beginnings: weirs on the Thames in 13th century & sluices & locks in 14th century Europe. Between 3500 & 1300 BC flint mining was practiced in Europe. Environment was changed to a cratered terrain. Mining for gold & marble was practised in Greece. Clay & limestone were mined also.

Mining clogged streams & poisoned surface & ground water by lead, mercury & arsenic. Romans extracted silver & lead from old slags. Small-scale metal working was prevalent in all societies. Use of coal was known since Roman times.

Peat mining changed many areas. Peat was used as a fuel to fire salt-pans. Digging peat left depressions then filled with water. Industries like sugar refining, cotton printing, brewing & distilling, oilseed processing, paper-making, tanning created waste disposal problem.

Cities & towns had their own flora of weeds & fauna of rats, cats & dogs & their parasites. The smoke caused by burning coal, high in soot & sulphur created problems in 13th century. Sewage & waste was discharged into nearest watercourses.

War in effect depleted a region's energy sources: Crops, forests, wildlife, pastures.

Land near the sea was reclaimed by building walls. By 1880 whales had been severely decimated.

Industrial Technology

Energy has to be invested before there is any surplus. But concentrated energy in fossil fuels produces a very large surplus. These sources of energy are finite. Energy transformed into knowledge & which is used to build machines. Chemical industry produces compounds hitherto unknown in nature. The capacity to change nature has increased 100fold, both in situ & removing them to another place to transform them into artefacts.

Some use of coal & natural gas was made during Roman times & in China. In 17 & 18th century labour cost of extracting coal was lower than making charcoal.

The first oil well was drilled in 1859. The per capita consumption of energy in terms of equivalent tonnes of coal per head went up in England from 1.7 in 1850 to 4 in 1919. Sites of mines & forges were places of heat & smoke & toxic wastes discharged into streams or built up into unvegetated piles. From mines & factories ran roads, canals & railways & settlements grew around them altering the landscape.

Industrialised countries did not depend on tropics for materials initially. But population growth & rising expectations created a huge demand by the end of 19th Century. Wheat, Meat & Wool were the main products from temperate lands. From tropics came rubber, cotton, silk, jute, hides, oil seeds, sugar, tea, coffee & cocoa. By 1960 U.K. France, Germany & USA collectively taking 29% of their supplies from tropics. Many forest areas were converted to plantations. Irrigation systems were set up to provide water.

Energy Use

The energy throughput as food of hunter-gatherers was 2000 Kcal per head per day.

Agriculturists using draught animals, irrigation, use of wind & water power may have a throughput of 10-20,000 Kcal per head per day

In industrial societies it goes up to 70,000 in earlier phases and 1,20,000 Kcal per head, per day in modern times.

Each citizen of USA becomes the owner of 73 slaves well-fed.

Open pit mining uses 17 litres of water per tonne of coal in USA, underground mining uses 63-120 litres per tonne. Refineries demand 195 litres of water per barrel of oil produced. Effluents & wastes released are unknown to nature.

The urban areas represent an almost total transformation of land surface, aquatic & ecological systems and alterations in lower atmosphere. For its energy the city is parasitic upon other areas. It will suck in sand, stone, gravel & brick. Each year Hongkong imports 2.37×10^6 kg of nutrients of which 74% reaches consumers. A lot of phosphorus is discarded & also nitrogen.

The energy use of industry is enormous. The Bougainville Copper Co. uses 21% of the entire energy flow of Papua New Guinea. The overburden & spoil of an open pit mine occupies an area 3-5 times larger than the mine. A lead mine may accelerate sedimentation rate by a factor of 3.5. Effects of industry on flow of materials & their environmental linkages are serious.

1000 new chemicals enter the market every year. Wastes are diverse & some have to be destroyed by high temperature combustion. Land & energy have to be devoted to separation of toxins.

Industrial Agriculture

Mechanised agri. started in late 19th century. Production of machinery & fertilizers, packaging & delivery are all energy intensive.

Changing the Face of the Earth (contd.)

In the 1820s energy expended per ha was 140 MJ, in the 1970s it was 21869 MJ. Modern farms are vulnerable to outside economic processes. Iron plough, reaper & crop varieties tolerant of cold or drought extended agri. to dry & cold lands. Proportion of energy devoted to irrigation is higher. China & India seem to require 900 to 6500 MJ/ha of energy input for irrigation schemes. In USA irrigated corn silage for beef production needed fossil fuel inputs of 318 GJ per ha. of which 178 GJ were for irrigation.

Most cropping systems are subject to energy subsidy in developed countries. In LDCs draught animals consume a lot of energy. In India the consumption of commercial energy in agri. increased by 387 p.c. between 1965-1980. The use of rice straw to yield energy will obviate the need for 60×10^6 tonnes of oil. Cash crop agri. on flat lands pushes food crops to hill lands & decreases area under forest and grassland. Intensive agri produces soil losses from 2 t/ha/yr to 8 t/ha/yr. Irrigation brings in salinity & water-logging. Shallow storage reservoirs allows explosive growth of bottom-feeding fish in the early life of the lake. Less silt in water downstream leads to greater photosynthesis & algal blooms.

Industrialisation brings in standardisation. Genetic uniformity results in crop failure. There is a grave imbalance in protein, raw materials, fertilizer & energy consumption while the extent of grassland & ocean in the world is finite.

Pastoralism

Population growth, demand for meat, more permanent wells on one hand & rise in animal no.s but no improvement in the quality of ranges on the other.

This 35 % of the area of the world is prone to drought. Mechanical energy is necessary to control bush & weed, reseeding, fertilizer use & irrigation. Even in Lapland road, dams, logging, tourism have reduced & disrupted reindeer.

The creation of derelict land today exceeds reclamation.

Consumption of water in Karachi 90 li./day, in London 263 li/day, in the US 635 li/day.

1 kg. of rainfed wheat requires 500 li. of water

1 kg. " irrigated rice requires 1822 li.

1 tonne of bread industrially produced requires 2100-4200 li.

1000 li. of beer requires 600-10,000 li. water in U.K.

" " " " " 15,200 " " in USA.

1 tonne of steel may need 8000-12000 li. of water

1 Car requires 38000 li. at the factory.

Through dam building chemical changes in soils & vegetation of the drowned area may affect water quality & fish for many years.

Inter basin transfer of water may change river systems if conditions in receiving systems in terms of temperature, silt load, nutrients & effluent-control are quite different.

Many waste disposal practices affect ground water system.

Aquifers can be recharged with waste water on the assumption that rocks will purify water. But dissolved substances such as nitrates will be difficult to be absorbed.

In altered habitats exotics & fish species may compete with indigenous sp.

The engineering works have changed flows, velocities, silt loads, channel morphology, substrates, benthic & fish populations

Asia shows the greatest ecological effect of aquaculture. Many times it is for luxury production than as a protein source.

Efficient guns & all terrain vehicles have decimated species of prey & predators.

Agri. encourages secondary vegetation leading to larger deer populations.

Between 1600-1700 every 4 yrs. 1 species became extinct
1950-2000 " 1 " 1 " " "

Habitat destruction & competition with exotics are causes.

When growing plantations tend to release more nutrients than natural forests & accumulate more surface organic matter, at harvest time significant nutrient losses from the site occur due to cropping.

Impacts on the Sea

Marine populations started collapsing since late 19th century. A fish species may not be able to recover if in the food chain it is displaced by a competitor.

Whaling provides an example of an irreversible impact. Fish stocks have been depleted as far away as New Zealand. If whaling continued in Antarctic the phytoplankton - krill - mammal chain may shift to a phytoplankton - Copepod - fish chain. Dependent populations of birds, seals, fish and squid may decline. Marine mining increases turbidity & affects productivity especially on continental shelves.

Contamination of oceans is far more signi-ficant at local or regional level. Long-lived substances may accumulate in food chains or sediments & prove to be time-bombs.

War where technology shows its greatest perfection, brings about fundamental changes. In Viet Nam the delivery of 587 kg/ha of explosives pro-duced 350×10^6 craters, displacing 3×10^9 m soil. Some 325×10^3 of the forest area (2%) was cleared mechanically. On 10% of its area 72×10^6 litres of herbicides were dropped.

Tourism

It has an expected rate of 4 p.c. per annum growth. Tourists travel to remote places but expect urban levels of food, shelter & hygiene. Construction activity, waste disposal, traffic all have impacts on the location as well as surroundings. Soil & Vegetation are gravely affected. Rare species, ground nesting birds are most affected. Coast-lines suffer the greatest impact. Ground water table

Changing the Face of the Earth (contd.)

may be severely affected. Airport noise, water contamination are other problems.

Waste disposal is a pervasive problem with 1-2 kg/cap/day waste produced by individuals in DCs & 0.5 kg in LDCs. Plus waste is created on his behalf in farm, factory, road and shop. There is always a time lag in disposal & discovery of environmental consequences.

Global warming has effects on phytoplankton photosynthesis which is a major constituent in hydrological cycle & may affect rainfall patterns.

Global population rate of increase is close to 1.7 p.c. per annum i.e. doubling in 41 yrs. Rise in GNP & GDP means people have access to more materials & more energy. Manipulation of environment to extract resources & absorb waste -es is profound. Forest clearing, pastoralism, agri., mining & quarrying, roads & railways & urban expansion are the causes for manipulation. Algeria, Morocco, Tunisia, Tanzania, Zambia, Iran, Israel, India, Nepal, Syria suffer from greatest harm. Local economies dependent on local resour-ces & transport are suddenly changed & thus more often. The effects on linkages are devastating.

The Nuclear Age

It began with first controlled fission of atomic nuclei in a chain reaction in Dec. 1942 by Enrico Fermi. The fusion of nuclei light elements was achieved for military purposes by the development of hydrogen bomb in 1953 & 1954. Nuclear energy in the form of electricity developed from uranium 235 & by 1985 there were 374 power stations in the world & 157 under construction. But their performance was poor, economics bad & rate of accidents deep. Scientists are now after fusion power.

Enrichment of uranium is highly energy intensive. The fission of 1 tonne of fuel generates 5 m^3 of high level wastes. The plant-life is 25 years. It is then to be dismantled or completely sealed off. These plants are sited where large volumes of cooling water are easily obtained.

Radio-nuclides formed during extraction & fission of uranium are major hazards. Waste at mining is 1300t. per 1 t. of uranium product. Slow & constant leaching of radium-226 & radon gas continues. Reprocessing plants release heat & radionuclides are emitted to air & water or sea. High level wastes are at present stored above ground. If radionuclides can be dispersed by circulating water, it will be safer.

The Hiroshima bomb besides killing people, affected genetic make-up. The device detonated at Bikini in 1946 showed its effects in land crabs & fresh water in 1978. Incidence of radio activity dangers. There is high incidence of cancer among workers of nuclear plants.

There are significant effects in simple eco-systems where radioactive particles are channelled with nutrients into a narrow array of species & a relatively small biomass.

The benefits of biotechnology have to be weighed against our need to conserve genetic resources.

Among softer paths geothermal energy & tidal power have great env. impacts. Biomass energy may rob the soil of that much material in nutrient cycling. Food crop land may be diverted to produce biomass. Again conservation of genetic variety should have priority. Algae, methane out of animal & plant wastes are other sources of energy as also some dry area plants & water hyacinth. Decentralised power for rural areas is better. Windmills, solar pumps & biogas powered pumps might allow Indian irrigation systems to be run on renewable sources.

Organic agri. implies change in dietary styles. Alternative energy flows and land-use patterns include fuel wood production, conservation forestry, intensive gardening for food, subsistence level agro-forestry systems, composting of city wastes, planting of fruit trees in an urban area.

Much of the vegetation composition is changed by grazing herds. Many times conservation measures result in accumulated organic matter which encourages fires.

It is best to limit the per capita energy use.