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HUMAN ECOLOGY IN LONG TERM
RIVER BASIN PLANNING --
THE MEKONG CASE

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SUMMARY AND CONCLUSIONS

The desirability of achieving a steady state in human population and the consumption of renewable resources in the long run is self-evident. The only alternative is a series of unprecedented catastrophes along with a partial destruction of the overall carrying capacity of the environment. A major watershed appears to be a more suitable region for carrying out such planning than any other available.

The carrying capacity of the Mekong Basin was crudely estimated to be 123 million persons as compared to about 33 million population in 1974. The assumptions were that the Green Revolution methods of cultivation and ensuing yields would be raised to the highest obtainable regional averages today on all land presently cultivated, and extended to almost all the land in low-lying areas that can be irrigated. A several fold increase in the cultivation of plateaus and hilly lands that are more lightly yielding was also assumed. This degree of intensification and extension would probably be regarded as highly optimistic by agricultural scientists.

Yet the figure for the lowest population at which steady state could be reached is five to forty per cent greater (130-170 million) depending upon conditions in neighbouring basins where much less planning and development is being undertaken as yet. In this instance it was assumed that the acceptance of fertility controls proceeds as rapidly as any rates that have been experienced in recent Asian history, so that the demographic transition would be completed in record time.

The higher side of the range allows for the purchase of Mekong water by growing metropolitan areas just outside the Basin that are accommodating settlers from the Mekong and more densely settled basins nearby.

The likelihood of overshooting carrying capacity estimates suggests that unprecedented measures must be taken that would (a) enhance the carrying capacity and (b) accelerate acceptance of fertility limitation. In both instances it means depending upon knowledge that already exists and has been reduced to practice somewhere in Asia, but only on a very small scale. Thus twenty years or more would probably be required to fit them to the needs of the Mekong peoples after the studies and experiments were undertaken. The amounts of increase in effectiveness cannot yet be estimated. The successors to the Green Revolution could make a substantial contribution. A Dietary Plan needs to be prepared which would identify the periods and the dimensions of the prospective shortages; the appropriate region must be larger than the Mekong Basin.

More imaginative efforts must be addressed to hold down the growth of population. One feature neglected everywhere in the world should be looked into more carefully -- using the social changes effected by valley development to reinforce the acceptance of family planning and fertility control. There are four identifiable stages: (a) the resettlement of people now living in areas to be flooded, (b) the workers mobilized for large scale construction, (c) the population affected by the extension of the electrification of villages and towns, and (d) the agriculturists receiving the new water for irrigation. Feedback approaches like this are what stabilize the human community. We know from experience accumulated in many societies that family size

preferences do not change significantly until the climate of opinion and the flow of social communications have both changed. Control of population cannot be accomplished by mandate or through the use of police powers; the nations willing to take the strongest measures to promote either large or small families have not been able to achieve their ends, even over the middle run. However quite a few countries have been successful in influencing rates of change toward new family size norms.

The structural characteristics that can be deduced for the steady state at a minimum adequate level of living, maintaining a rural-urban equilibrium, suggests that the labor force would need to raise productivity several times over current levels. For the rural areas this means a labor force roughly equal to the present (with a total population somewhat less) but getting more crops from a larger area per worker. It also means that all added population henceforth can only find productive employment in urban areas. At steady state the population is expected to be 80-90% urban.

Intensive use of water and energy in the urbanized regions requires the introduction of recycling of water, fixed nitrogen, phosphorus, and scarce materials. The simplest solution is to produce the perishable foods within the extended metropolis. Energy saving can be accomplished with the aid of telecommunications, and electrified rail network, and a combination of light vehicles. The latter might be combined very effectively with canal transport in the largest foreseeable urban aggregations. Possible solutions for housing and other physical requirements that would be uniquely Asian can also be identified, but the options there seem to be very broad. No shortage of urbanizable space could be detected.

On the whole, perhaps because the Mekong has had a head start, the possibility of achieving a steady state without intervening massive catastrophe seems to exist, but there is likely to be either a close squeeze or an overshoot about three generations from now.

Recently a new kind of outcome for long range planning has become popular in concept -- even though it has yet to be embodied in basic plans for development. This approach aims at achieving a steady state in population size and in its relationships with the renewable resources in the territory it occupies, designing the projects so that they increase the likelihood of achieving a stable, balance set of flows instead of promoting maximal growth of domestic product. In order to assure that as much will be put into the supporting environment as is taken from it, a different set of social institutions operating within new policy constraints will need to evolve. What follows is an attempt to think through the implications of this change in objectives for a physically delineated region with large scale potentials for development and a good data base.

The new way of thinking is not shockingly novel, but much more a return to old precepts that need to be applied to a social order that has not yet been experienced, but whose dimensions, locations, and requirements can already be estimated through techniques made available in the life sciences and the social sciences. The ideas and principles are not very different from those introduced by the Tennessee Valley Authority in their visionary linkage of high technology to the delivery of human services, particularly through the establishment of stable communities. The outlook for the TVA, however, did not initially require plans for large scale urbanization; they started by serving an agricultural population quite thinly distributed

over the land, some of which might aggregate into towns and small cities.

In the past forty years the urban-rural ratio representing a balanced ecosystem has greatly shifted, more due to changes in agricultural technology and expectations regarding human services than to changes in the organization of cities. Sufficient food can be produced from the efforts of 5-15% of the population instead of 40-60%. Moreover the effectiveness of public health measures for reducing mortality without simultaneous effectiveness in fertility control has produced an unprecedented expansion of human population. In the watershed regions desiring to take advantage of high technology, the population has already doubled or trebled. In addition, the present youthful age structure and other characteristics suggest that population growth cannot be brought to a halt short of threefold or fourfold multiplication of present numbers. Thus the river basins in temperate and tropical areas of the world must henceforward be developed to support the surplus people from overcrowded villages who tend to accumulate in the urbanized areas. Indeed, because the rural densities in some places are so great, the extra people need not move at all -- they would produce densities that are regarded as urban and will require urban arrangements for providing services.

Despite the high priority given to irrigation agriculture, the net effect of valley development as carried out today and in the future will be the formation and continued survival of large urban settlements. Technologists cannot close their eyes to these consequences of their efforts, regardless of the degree to which they are deplored, because the institutions that might guide the human societies involved to other

conditions of life are not in existence, nor does anyone know how to design them for prompt introduction. The techniques of project and program appraisal have been polished and refined since the days of the TVA, but they are fitted to the needs of advanced societies that have almost completed the urban transition. What are the implications for the poorer societies following in their tracks? What strategies should be employed for developing the renewable resources under their control? We shall argue that they should bend every effort at achieving steady state conditions, and that this will require a non-Western, resource-conserving approach to large scale urbanization.

The steady state concept is grounded in ecological thinking. It assumes a relatively constant level of biomass capable of maintaining itself in the face of the previously experienced perturbations of the physical environment. As a principle for guiding the conservation of resources it applies strictly only to the Earth as a whole; special regions may remain out of balance so long as other regions are able to redress the deficiencies and exchange relationships have been worked out between them. The interdependencies cannot be projected on faith, hoping that the rest of the world will rescue a settled population in continuous or repeated unbalance, but only on the basis of negotiated exchanges that are rewarding to both parties. Those producing exportable surpluses capable of supporting the biomass that exceeded local capabilities will demand something of value in return.

The carrying capacity of a physical environment for biomass can be crudely estimated; it is expected to remain constant (or decline) for a given mix of technology. Within that limit human population may rise, but at the expense of other species. Thus, as the human

population increases, wildlife will decline, and eventually the populations of domesticated animals are also threatened. The tradeoffs are roughly gauged but nevertheless real. Appropriate technology can, of course, add to carrying capacity and increase the range of options, but it needs to be tested over a period of years in order to discover the cumulative effects of a chain of adjustments occurring in the living system.

From the point of view of future human participants it is highly desirable that the quantitative structure of the steady state should be determined well before the absolute biological carrying capacity has been reached. If the momentum of demographic growth causes it to overshoot carrying capacity for any bounded community in the ecosystem, that community becomes highly stressed and unstable. Catastrophic loss of life, and destruction of life supports normally follows. An overshoot outcome may also set up an oscillation involving repeated recoveries and catastrophes. Therefore a planned approach to steady state requires that estimates of the carrying capacity of a region be prepared before large scale investments are made there. Surprisingly, from a purely technical point of view, those estimates are not yet demanded by either the international agencies, the respective nations, or the planning profession as a feature of its responsibility to society.¹

¹It is less surprising, however, when one discovers the broad range of disagreement that exists regarding (a) the definition of capacity, and (b) the appropriate minimum average consumption for a human population. Colin Clark was one of the first to produce some rough estimates of the carrying capacity of Earth based upon established agricultural technologies (in a series of papers preceding Population Growth and Land Use, Macmillan, New York, 1968). He had to assume that climatic variability could be overcome through elaborate measures involving water storage, buffer stocks of food, and unfettered exchange of surpluses.

In the past carrying capacity was most often determined by the variability of the provision of essential inputs, whether for the biomass as a whole or for humans, the dominant predator species. But when investments have been made in a basin the water can be stored and many crops likewise, so that the population that can be carried will more nearly approximate the average yields obtained from the water, the soil, and the sunlight. From the overview of the Mekong basin region² three categories of food production, each involving different crops (for the most part), different cultures, and very different infrastructure for the support of agriculture can be identified (Table 1).

TABLE 1

CAPACITY OF THE MEKONG BASIN TO SUPPLY FOOD

	Gross area	Developable area	Fraction cultivated	Population supportable ^{ee} (millions)
	in millions of hectares			
Hills	16.0	3.0	19%	12
Plateau	41.6	30.0	73%	75
Flood plain	6.9	6.0	86%	36

(1974 population in basin is 32-33 million)

Total 123 million

The implications of the steady state for world population were analyzed by Tomas Frejka, The Future of Population Growth: Alternative Paths to Equilibrium, (New York; Wiley-Interscience, 1973), also more briefly in the Scientific American 228, March 1973, 15-23. Demographers apply the term "stationary" to a population with a net reproduction rate of 1.0; starting from present age structures it would drift, ever more slowly, towards a constant total. A population structure somewhere between that of Belgium and Hungary in the later 1960s should result.

²Committee for the Co-ordination of Investigations of the Lower Mekong Basin, Report on the Indicative Basin Plan, Bangkok, 1970. Chapter II, (table on current status is on p. 16).

Implicit in such a state of development is that agriculture would be pushed to, or even beyond, the degree it has been advanced in Japan and Taiwan, where the intent is to maximize output. The marginal costs would markedly exceed even the present high world market prices. The task set by such targets is extraordinarily difficult because second rate and third rate soils would have to be built up so that they reach the average productivity of the better soils already under cultivation, while the fertility of existing soils would need to be maintained. The amount of time allowed for installing the equipment and physical improvements, followed by acquiring the skill of management is only two human generations.

These basinwide estimates actually provide too narrow a base for calculations. Saigon, for example, is left out, even though it lies on one of the prehistoric channels of the old Mekong Delta, and should eventually draw upon its waters. Danang is also very close to some upstream development and could become dependent upon the surplus, arriving from it. At present such areas contain about 5,000,000 people, and their numbers are growing even more rapidly than the population which is resident within the basin.

The best strategy is to bring population growth to a halt at a level well under the carrying capacity. The leeway provides a measure of added security; it makes possible a wider range of options in achieving other ends beyond those of survival. What are the possibilities?

Characteristics of the Steady State

As already noted, the new steady state is a condition that has not yet been achieved anywhere in the world. In places where energy flow and commodity consumption seem to have reached a plateau (Cuba, Uruguay, Uganda) the population is still expanding, and where the population growth seems to have come to a halt (Czechoslovakia, Belgium, Hungary) the materials consumption is increasing notably. Nevertheless, through extrapolation and systems analysis procedures, it is possible to spell out what the achievement of a steady state means.

The birth rate should remain steady at about 13 per thousand of population. The surest way of reaching such a figure would be to have the birth rate drop to about 10 per thousand and then selectively permit an upward drift toward the equilibrium rate. The death rate is less now, but as the life expectancy approaches 77 years, which is just about the limit allowed by the present state of Western medicine, the mortality will increase again. The average number of live per woman births would be between 2.1 and 2.2, which means that the most common family size would be two children, and the next most likely either zero or one, but a few families may still be large. Family sizes of these dimensions imply complete control through contraception combined with early abortion. Coercive control of fertility has never been achieved, even in China where completion of the pregnancy is sometimes decided by the collective (according to translations of reports), so voluntary controls over fertility must be depended upon. Quite high levels of education, medical services and social services are required to obtain the 98-99% cooperation that is necessary. (The city state of Singapore has already gone about 80% of the way, while

a few cities in Japan may have advanced somewhat further. It is now becoming apparent that progress from 80% to 98% will require at least as much creativity, use of incentives, special education and social service as the advance from no control at all to 80%.)

Metropolitan areas can mount a full set of fertility control services well before the smaller cities and towns, because they can be grafted onto existing medical, educational, and social welfare facilities. For a given budgeted sum, a larger number of people can be served in a metropolis, because the density introduces economies of scale. Complete coverage, so that all residents become willing and able to hold family size to replacement levels, can be reached more quickly in metropolitan areas. In sociological terms, scarce specialists can reach a much larger number of people per unit of time, meeting total needs more quickly, when settlements are compact. Excessive crowding, however, can lead to frustrating congestion and the disintegration of public order, including fertility control services, so there will be upper limits to the concentration of population, even though these limits have not yet been discovered and specified.

As they are visualized now, steady state conditions make a number of other demands upon the social and economic system. For example, the ratio of animal populations to human population must be held roughly constant, but when stressful circumstances arise, the animal population will decline drastically before the human population is affected (in Southeast Asia, pigs, chickens and fish would be eaten, and the rats and vermin would be left with less to live on). Fuel for automotive vehicles would be increasingly obtained from vegetation as the fossil fuel supplies are depleted; so that populations

of automotive vehicles, airplanes, and ships will be competing directly with humans for the products of photosynthesis.³

Industry is not so important at steady state because it does not have to produce the equipment for building cities, but only the replacement parts. Hydroelectric power and geothermal energy are preferred sources for such industry, but breeder reactors could be used for many thousands of years before depletion of fissile materials sets in. Therefore manufacturing industry would selectively prefer basins with guaranteed power supplies and plentiful cooling water for power reactors. Inside those regions it will prefer sites that are relatively accessible to other concentrations of urbanization in the ECAFE region that are less well endowed. At steady state therefore, the Lower Mekong Basin is likely to provide a base for a disproportionately large share of the energy-intensive manufacturing. In the future, "energy intensive" also implies "capital intensive" to a much greater extent than in the present or past.

Note the fundamental importance of reliable supplies of fresh water in the functioning of the low fertility-low mortality ecosystem at steady state. The vegetation required to feed man and animal, and eventually to supply the bulk of the needs of vehicles, demands a

³In Planning for an Urban World (1974) I come to the conclusion that in Southeast Asian urbanization about 50-100 four-wheeled vehicles, on the average, may be operated for each thousand residents after the fossil fuels have been virtually exhausted. There will be a larger, but more variable, number of two-wheeled vehicles that are more resource-conserving. A few vehicles may be of the fly wheel type that depend upon the power grid.

tonnage of fresh water ten to a thousand times greater than that of the harvest.⁴ As the fossil fuels are depleted the supplies of fresh water become the most valuable resource in the world and the preferred locale for capital investment. Such areas would also support the greatest population densities for men, animals, vehicles, and stationary machines, when calculated on a regional scale.

One kind of growth is allowable at steady state. The accumulation of knowledge regarding opportunities, risks, challenges, resources, technologies, procedures, states of nature, structure of organizations, modes of communication, potential paths to further development, and the permissible directions for the evolution of the species that may continue in all these, and many other, directions, and yet not impose a significant drain upon scarce resources. Indeed, there is a real possibility that this knowledge, as it collects in a few unique points, will show the way to a new level of organization of the environment. Then the world could mobilize itself to undertake the transition to another steady state that cannot be visualized at present. Therefore the steady state that is described here is not an ultimate one, but merely the next stage in the successional development of the world ecosystem. It is the stage that would minimize the likelihood of large scale catastrophe triggered by drought, famine, and the epidemic disease that follows after dietary deficiency and disorganization.

⁴Fresh vegetables grown under optimum conditions require more than a hundred tons of water per ton of dry weight produced by photosynthesis, but the vegetables themselves are 90% water, so the minimum is achieved for fresh vegetables where virtually the whole plant is harvested. The ponds growing algae to be fermented into fuel are expected to require about a thousand tons of water to be evaporated per ton of fuel manufactured.

The Demographic Transition

The most recent evidence of the progress of the demographic transition, employing all of the known expediting techniques, is found in societies that are neighbours of those that occupy the Mekong Basin -- Japan, Korea, Taiwan, Hong Kong, the People's Republic of China, and Singapore. As compared to the historic process in Western countries, the rate of progress in all of them has been extraordinary.

Among the riparian countries Thailand started on this path the earliest. Its national programme began in 1970 and by 1974 has reached an estimated 15% of the fertile age group. However declines in the crude birth rate are barely noticeable as yet. Meanwhile the control of disease has advanced, so that mortality has declined. Therefore the rate of growth of the Thai population is as great as ever. Because infant mortality in particular is dropping, the age structure remains as youth-dominated as before.⁵

South Viet Nam instituted an official programme with plans for a vigorous diffusion of information and materials only in 1973, so there is insufficient time to discover the response of the public. The Khmer Republic and Laos, which together contain 30% of the population residing in the Basin, do not yet have comprehensive plans and coordinated actions. The programmes that exist are privately sponsored or represent pilot tests conducted on a local basis by government-supported institutions.

⁵The age structure is important because, if an unprecedented shock had miraculously and instantaneously reduced fertility to replacement levels, Frejka computes that underdeveloped area populations would still expand by about 65%. For the riparian countries, with still younger populations, the expansion would be somewhat greater.

In these three societies no more than 5% of the couples in the fertile age brackets will be using contraception or abortion as a means of controlling the size of their families.

The population living inside the Basin is probably no further advanced in the demographic transition than Taiwan and Korea were twenty years ago. In the intervening period these countries have reduced their crude birth rates to 24-30 per thousand and have found ways of persuading 40-50% of the couples to plan the size of their families. Unfortunately the traditional demand for having a son, sometimes even two sons, results in planned families (three to four children) that still produce an amount of population growth that cannot be tolerated over the long run. The Korean and Taiwanese societies have made the most rapid progress among all the recent starters along the road to the new steady state; fortunately, both have been open to the international social science and medical researchers for study over the whole period.⁶ The People's Republic of China, particularly in the eastern provinces, seems to have made remarkable progress over the past few years, but the origins of the programmes and the means of implementation are not available to us. The remainder of the developing countries (except for the urban societies of Hong Kong and Singapore) straggle far behind.

If the Mekong population were to progress through the demographic transition as rapidly as the pacemakers, it would contain 55-66,000,000 people twenty years hence. Then it still would have to cope with the

⁶These reports have been abstracted and summarized in the periodicals published by the Population Council. For the latest reports see S. M. Keeny, ed. "East Asia Review, 1973," Studies in Family Planning, Vol. 5, No. 5, May 1974; a more comprehensive analysis of Thailand's progress was reported by John Knodel and Pichit Pitakteksombati, "Thailand: Fertility and Family Planning among Rural and Urban Women," ibid., Vol. 4, Sept. 1973, 229-55.

dimensions of growth in prospect for those societies. If they found ways of reaching new contraceptors that make up as large a proportion of the population as was added in the previous period (say 40%) the crude birth rate will have been reduced almost to replacement levels, although due to the youthfulness of the population the growth would still be in the range of 0.5-0.7% per year. Thereafter growth would still continue to dwindle as the average age of the population shifted from the low-to-middle twenties to about 38-39 years. Before taking into account any of the prospects for migration to or from nearby watersheds (or greater distances) it is apparent that the indigenous population would expand to 110-140,000,000 people at steady state.

A similar exercise needs to be carried out for the Chao Phya Basin of Thailand, the Red River of North Viet Nam, and the minor watersheds of South Viet Nam. However the data base is even sketchier, and the precedents quoted are less applicable. Inspection of the maps shows that the Mekong may have its basin extended to serve an expanded Saigon and Danang. Thus a population now amounting to perhaps 5,000,000 could be drawn into Basin planning and would grow to at least 10,000,000. Wherever large cities have grown up they have warped the watersheds up to 500 kilometers away, and that tendency will increase rather than diminish. A megalopolis extending from Bangkok around the Gulf of Thailand may also find it economic to draw upon the waters of the Mekong for the eastern extensions.⁷ Thus the water may migrate along with the people. Much of the growth in

⁷ An exercise exploring the implications for accommodating the overspill from Bangkok was undertaken by John L. Taylor, "Elements in a Future Urbanization Strategy for Thailand," Universiti Sains Nasional, Penang, Malaysia, December 1972 (mimeo).

Bangkok might actually represent a preferred location for families originating in North Eastern Thailand.

The large scale capital investment will draw people engaging in the construction trades from great distances, often outside of the Basin, while the opportunities for construction in neighbouring basins are much less. Therefore, the construction of dams, industry, and major infrastructure will bring in new people, many of whom will stay. Thus, building up the high technology should create a net influx.

In addition, North Viet Nam is already a food deficit area where the gap tends to increase over time. Therefore strong pressure exists for North Vietnamese to move south and west; the Mekong Basin is encountered in both directions. It appears that an indefinite number of North Vietnamese may eventually need to be supported by the Mekong waters.

The total of migrants who are likely to find conditions in an enlarged Mekong superior to those at home and decide to stay (after all a river basin is not a sovereign state, and has no border guards or powers to resist), settling down to grow a family, could run from 10,000,000 to 30,000,000 persons, measured at steady state. The number who could settle overseas, or elsewhere, is likely to be trivial. Thus by making optimistic assumptions that put the riparian countries very quickly among the pacemakers in achieving fertility control, an estimate of the total population to be served, eventually runs from 130,000,000 to 170,000,000 people. This is a number noticeably larger than the estimated carrying capacity.

The Planning Dilemma

What has been encountered here is a worldwide dilemma that has been reduced to the regional scale. The Mekong Basin has always been regarded as one that presented few population-resource constraints. It is one of the most favorably endowed regions of the world, a territory that should produce surpluses that could be exported to more distressed regions. Therefore little has been done in the respective countries on the matters of social development, particularly techniques for the control of fertility, although plans for the investment of billions of dollars on physical equipment were readied. Yet the ecological, or living systems, analysis of outcomes suggests that the conceptions held in the respective governments (although Thailand and South Viet Nam are in the process of changing their outlook) are not born out in the long run. Even a doubly optimistic (the best possible average agricultural yields, based upon performance achieved in leading countries, matched against the best performance in the world in achieving human fertility control) approach produces a surplus human population that ranges up to 40-50 million people, and a potential overshoot that reaches 40% of the carrying capacity. An overshoot of this scale is expected to produce human tragedy and loss of life equal to or exceeding all the war and famine in South and Southeast Asia for the twentieth century until the present.

Planning documents all over the world, with exceedingly few exceptions, have avoided these issues, and those prepared by the Mekong Committee are no exception. Only the slightest, most generalized hints of social disequilibrium can be discovered in the programming of the underlying studies, yet it takes 10-15 years for studies to be converted

into physical developments and another ten or more years to realize the full capacity of the added facilities. In that period the total food output must reach more than twice the present levels. The carrying capacity at that time may well be exceeded by the population to be supported, but the overshoot should not be large and the uncertainties in estimation are much greater.

One reason for insufficient attention may be traced to the way in which planning theory has been taught in Western countries. The "planning horizon" (presently the year 2,000 A.D.) is set on the basis of the time required for the construction and amortization of the major projects, usually twenty-five to thirty years. Presumably all the foreseeable risks over this period are to be scrutinized and minimized through design before the capital investment is to be committed. The pressure of population upon resources in Western countries rarely becomes an issue over such a period, while in Asia it very frequently does. The succeeding decades in the West contain many imponderables that defy analysis, but the momentum of population growth as it occurs in Asia is a major variable that can be projected further into the future. Therefore in Asia the use of a one generation horizon (25-30 years) leads to a project that takes a far from adequate account of the social imbalances. Asian students in Western countries were taught this technique, so they use it as freely as the international lending agencies and the expatriate specialists Asian institutions have not yet developed a superior planning method. (Some specific improvements in project design based upon longer range considerations will be suggested later.)

Another reason no attention has been given to the overshoot problem is that other regions attempting coordinated development have much poorer prospects than the Mekong Basin, and the prospective inadequacy of the resources is repeatedly discovered by informal (i.e. unpublished) calculations of the aggregated impact of the currently planned projects. The overshoot in demand occurs sooner and the dimensions of the apparent gap between the supply of food and energy and the total requirements for this group of commodities is greater. Therefore the disasters threatening the Mekong population before it reaches steady state are not unique; they are likely to occur elsewhere in Asia and Africa, perhaps also in Latin America, quite a bit earlier. Some of this earlier overshoot of carrying capacity seems likely to occur in adjacent watersheds, and it was that likelihood that exacerbated the stresses upon the Mekong region. Therefore parallel planning should be carried out for a larger region than the Basin itself; the Mekong Committee would be one of several participants. This can be done quite easily in the formal sense, because the adjacent watersheds are incorporated wholly in one or another of the participating riparian countries, but grants for assistance are much less readily obtainable. The logic behind such studies is unassailable, but unfortunately the planning that needs to be done is not yet under way.

Another reason for the delay is that environmental thinking which does try to cope with the longer run -- the conservation of forests, erosion prevention, preservation of unique landscapes, and prevention of the extinction of wildlife species -- has been popular for less than a decade, and during that time it often concentrated public attention upon many less fundamental problems. Among well-informed Asians

environmental arguments have taken root only in the past three years. Therefore there has been insufficient time to incorporate the ecological perspective into plans. The concepts of carrying capacity and of steady state require a broader and more systematic foundation in theory and in data acquisition than those of pollution. Probably the earliest that even single individuals could arise in this milieu who might have started these arguments regarding steady state outlooks would have been in 1973. The Population Council computer models for estimating population size at stationary state would have been available only then, and probably only in New York.

Other reasons can be adduced, but all the evidence still shows that we are witnessing a worldwide change in perspective which now, for the first time, can begin to affect plans for development like those for the Mekong. There has been an enhanced understanding of what are the "limits to growth" and now these limits will affect plans.

The search for reasons that these ideas have not been expressed earlier has not revealed any interest group or dogma that has suppressed public discussion of this approach to valley development. There seems to be no basic conflict in values that needs to be worked out. The battles that have been going on in the region are about who shall govern, not about different ecological philosophies. If the facilities are designed properly it is the human population that benefits, and all the ideologies are willing to take the credit. Thus the new rationale becomes much more an issue for professional planners. What kinds of action can be taken, given the prospects for too many people, that would alleviate the difficulties that are anticipated?

It is possible to deal with the transmigration issue (as it is labeled in neighbouring Indonesia), or the export of surplus people to the empty

regions of the world, rather quickly. Those that are nearby have been pre-empted for settlement of Javanese, where the pressure has reached the point where over half of the rural population is already landless, with conditions growing worse each year. Yet the programs for resettlement of Javanese, -- all the formulas so far tried -- have consistently failed. The expenditures by the State would have accomplished more if the people were allowed to remain where they were. If a new formula succeeds the Javanese would reach the empty areas first; if no good formula is found, people from the Mekong would be unable to make the transfer either, since their skills in working these lands are no more relevant than those of the Javanese.

The alternative that remains is to question the assumptions that underlie the calculation of carrying capacity and those upon which the estimated demand for food was based. Perhaps the accumulating body of knowledge allows us to do things differently in the future from the best of recent precedents, such as were used in the first estimates arrived at here. If so, that knowledge should be recognized in the subsequent studies and project designs, so that the preferred strategy can be adopted in time.

It is conventional for economists to separate the analysis into a "supply side" and a "demand side" in order to achieve a judgment of the balance that can be struck. Ecological thinking requires further identification of feedback systems affecting both supply and demand in such a way as to enhance capacity at the steady state. These modes of thinking will be taken up in that order.

Carrying Capacity Considerations

The estimates of carrying capacity arrived at in Table I, which reached a level of 123,000,000 people, are more optimistic than normally estimated by agriculturists. The high figures presume that the Green Revolution will become universal in the region. This means not only the standard high yielding wheat, rice, and maize strains would be grown, and extended into marginal soils, but also oil palm and sugar cane. Sorghum is beginning to move through the experiment stations and seed farms, and should add a very significant amount to yields from soils that are presumably sub-marginal, so its contribution has been included. It presumes that the quality of agricultural practice would match that of the Japanese today -- the best comparing with the best and the poorest with the poorest. For the people in the field stations this will appear incredible, yet many equivalent transitions have been made in two generations in Asia. Even such achievements are obviously insufficient, because the population is highly likely to exceed that capacity estimate, and the world cannot afford another food importing region.

One set of possibilities has been neglected in estimating carrying capacity. It includes those that exist outside agriculture. Standard methods neglect non-agricultural sources because, except for fisheries in some districts, their contribution has been trivial in the past. However, the prospective shortfall in food production forces the planners to review the growing body of knowledge in this area.

Studies have already been directed to the declining productivity of fish in Tonle Sap, and to the fish populations in reservoirs. In

effect, a high productivity of fish from paddy rice cultivation, an enriched Tonle Sap, and careful cultivation in reservoirs was implicit in the carrying capacity estimates already given, because the Green Revolution varieties of grain, sugar, and oil, consistently skimp on protein content, so that it needs to be made up with protein-rich by-products in order to obtain adequate nutrition. Thus far the research on the soy bean and the ground nut has not yielded any "miracle strains," but only varieties adapted to an increasing range of tropical soils. Thus increased production of protein and oil from them will mean reduced overall output of calories. Therefore the fish in the impoundments are needed to make up the difference. With yields amounting to several hundred kilograms per hectare of water surface, of carp and tilapia predominantly, the future population would still not have a very rich diet.

The fish population in the South China Sea indirectly induced by the mixing of the Mekong waters has not been taken into account. Coastal fisheries are normally handled by different agencies, so the reports are registered in a different column. Most of the technologies are different also. However this fishery is ecologically part of the Mekong Basin, and it will be noticeably enriched in biomass supported by the development of heavily fertilized agriculture upstream, particularly in the Delta. Since the perspective urban growth is in this immediate vicinity, the demand will also be great and the off-shore fisheries will be exploited to full capacity and will need to be carefully regulated. Although the yield of the coastal fisheries may expand five fold or more, based upon biological considerations, it would not keep

up with demand. Nor would it support more than a few million people, based upon the caloric contribution to the total dietary intake.

It appears that the best hope for supporting the extra population lies in the new science and technologies that lie beyond the Green Revolution. If they have already been tested in pilot plants it will take ten years to get into serious production and twenty to forty years to expand to the limits upon capacity set by natural resources. If they have reached the stage of small industries somewhere with a climate and culture similar to the Mekong perhaps about five years can be shaved off that estimate.

At the basic science level an important discovery has been made over the past several years which is being rapidly expanded. An alternate pathway of photosynthesis has been detected in a few plants which is increasingly efficient in the temperature range of 35-47^o (unshaded) and uses up the last traces of carbon dioxide in the air immediately adjacent. This is to be compared with normal plants which gradually shut down as the temperature keeps on rising above 25^o, and stops altogether when two-thirds of the carbon dioxide has been exhausted.⁸ Sugar cane and maize are two of the few crop plants that presently use this "four carbon intermediate" pathway for photosynthesis; that is the reason such extraordinary yields per unit area can be obtained from these crop plants under ideal conditions. This means that wild plants having this property need to be domesticated for use as human food, or

⁸The four-carbon pathway to the fixation of carbon dioxide in photosynthesis was first analyzed by I. Zelitsch, Photosynthesis, Photorespiration, and Plant Productivity, (New York: Academic Press, 1971). Jean L. Marx provides an easily accessible review of implications in "Photorespiration: Key to Increasing Plant Productivity?", Science 179, 1973, 365-7. Genetic experiments are described by Olle Bjorkman and Joseph Barry in Scientific American, 229, October 1973, 80-93.

that existing crop plants must be crossed with them (a more difficult challenge). Successful crosses would produce more than rice and other major crops. The growing conditions in the Mekong Basin are highly appropriate to this kind of development, but the institutions are not advanced enough to contribute to the scientific work that needs to be done. The Mekong investigators must watch carefully, wait, and hope; they must be willing to change the engineering of the irrigation systems so as to take the best advantage of the opportunities as soon as they become evident. Whenever it can be applied, utilization of this mode of photosynthesis could add 30-50% to output.

Another approach to the optimization of conditions of photosynthesis has been pioneered in Japan and Taiwan with very little publicity perhaps because some trade secrets are involved. They produce a crop of uni-cellular algae (*Chlorella* spp.) at a rate of 6-8 tons, dry weight, per hectare per year with 50-55% protein content. The inputs are synthetic fertilizer, water, sunlight and power for stirring and harvesting. The yields are likely to be raised to ten tons per hectare per year since higher yields of feed grade Chlorella can be produced from sewage.⁹ About 500 hectares was scheduled to be operating in 1974; much of the product is used for producing a green yogurt. The most suitable locations, low lying land or swamp, are not likely to be useful for crops. In this instance significant increases in output of

⁹Advanced work on this technology had been launched at the Asian Institute of Technology, Bangkok, and a number of students from the riparian countries were trained in the underlying techniques. However, the North American sponsor did not understand the significance of the approach and the grant was discontinued. In the future much more research needs to be undertaken for the substitution of Chlorella protein for soybean meal. An incomplete account of the technology was reported by Takachi Yoshiro, Chlorella: Fundamental Knowledge and Application, (Tokyo: Gakushukenkyosha, 1971) (in Japanese).

protein foodstuffs could be obtained in perhaps twenty years. The preferred locations would be in the vicinity of growing cities with food processing industries and also mariculture facilities (for the growing of marine finfish, shellfish, shrimp, and seaweed), since the algae could be a cheap fish food. Whatever is produced represents a pure gain in carrying capacity.

One aspect ignored in the calculations are the losses incurred inside the plant as it converts the products of photosynthesis in the leaf into a seed that can be stored and marketed. More food can be obtained from the soil if the leaf, the fruit, or the root is consumed. The increase can be a factor of three or more, using methods already applied in Taiwan, Singapore, and China (including Hong Kong's New Territories). The difficulty is spoilage, because the product is 80-92% water. Transport and distribution facilities need to be very efficient. Since these conditions are most likely to exist in the vicinity of cities, the discussion of the solutions will be taken up in the proposals for the proper design of cities in environments like that of the Mekong Basin. The difference, as compared to rice and sugar cane, represents an addition to carrying capacity.

Another improvement arises from the inefficiency of the humans in converting traditional foods into nutrition. Many local customs and habits prevent mothers, children, sometimes even workers, from getting the proper mix of nutrients. Dietary planning will obviously be essential for the support of the Mekong peoples, but thus far virtually none has been done. Carefully selected food processing industries must fit fortified foods to the tastes of the residents. The cuisines of the local cultures are highly elaborated, so that straight forward

borrowing from the rest of the world is not likely to be sufficient. Even after good solutions have been found, a full generation of education and advertising will be needed to take advantage of the opportunity to add to carrying capacity. Virtually none of these programmes is under way (although I note in passing that the last addition to the MIT faculty responsible for this technology was a young, female Thai biochemist).

To summarize, there are short range, middle range, and long range possibilities for enhancing the carrying capacity of the Mekong. Very little is being done to insure that the explicit possibilities in view will be applied in time within the four riparian countries. In part this is because they are banded together as a Mekong Commission only to influence the supply of power and water; the link-up with demand has been left open. The delivery system for the benefits to be derived from the development of the Basin remains to be worked out. The aim of achieving a steady state below the actual carrying capacity of the Basin makes it possible to produce at least an outline nutritional plan which should allow all residents sufficient food for work and active participation in society. Such a goal is basic enough to be agreed upon by all members of the Commission and donors that assist in the development of the programme. Obviously similar plans should be prepared for neighboring basins. (Apparently a committee has been called together from ECAFE countries and agencies at the initiative of TROPMED to consider monitoring the status of nutrition.)

Controls Over the Growth of Demand

As soon as an infant is born into the world and acquires a name, he has a claim upon the social services of the society. These include provisions for health, suitable foods for nutrition, a place in a school, a seat in the transport system, a bit of private living space, opportunities for productive employment, and a chance for recreation, at a minimum. Moreover, as societies become more modern, an increasing number of services will expand proportionally to the total population. Therefore, when carrying capacity is in sight, so that the available resources are insufficient to meet the needs of the new claimants, the highest priority must be given to fertility reduction.

These are concerns first of prospective parents, second of households, third of communities, and finally of nations. The requisite information and opportunities for control of fertility need to be transmitted at each level. Behavior in riparian countries is very much influenced by the leadership, so national programmes with national examples are absolutely necessary. At the community level sources of contraceptives and clinics should be organized. Households should make specific decisions regarding family size, rather than fatalistically adapting to the number of children that arrive, and young adults will need to have reliable information. Techniques can be borrowed from neighbouring countries that have advanced the furthest in birth control.

In none of those countries however, has fertility control been directly integrated into a valley development programme. There are four ways that such a programme directly affects the lives of households and communities, bringing about social changes, so that the likelihood

of voluntary acceptance of fertility control is enhanced. In the order of impact they include: (a) the major construction sites, (b) the displacement of populations from the reservoir, (c) the electrification of villages, towns, and the poorest sections of cities, and (d) the resettlement and land reform associated with the use of irrigation water.

At the construction site after dark there is time for films, slides, and other informational material. It should include health, accident prevention, improved cultivation, better house building, organization of cooperatives, and the maintenance of machines, along with various approaches to birth control and family planning. For each lesson there should be examples installed in or near the camp. Videotapes and slides are now so inexpensive, they can easily link the films to onsite examples and generate enough curiosity to get visits on the day off. Construction camps have been informal "schools of hard knocks" for the surplus young men of the villages, so that a large fraction are enabled to make their way in and around the cities thereafter while the remainder take their skills and accumulated capital back to the villages and modernize the surroundings there. Only in rare instances has the necessity of building a camp been used as a means of social development in a region. The fertility control messages have very little significance for the men assembled to work unless they are put into the context of better living through modern methods, so they must be imbedded in a comprehensive description of the new life style and its requirements.¹⁰

¹⁰The Planned Parenthood Federation of Korea has been developing materials for the same kind of surplus population when it is recruited into the military and later when it returns for refresher training. The local link-up is handled through discussion. Of course, arrangements are made for subsidized contraceptive materials to be made through health services and commercial channels. PPFK Activity Report (Seoul), Jan.-Feb. 1974.

Among the people forced to move there is much stress. Films and slides are of little value then. Postponement of the age of marriage may be a more appropriate argument. Personal contacts between knowledgeable individuals and uprooted persons would be far more influential. The resettlement in the future will be more thoroughly planned, but the implementation of such plans for a minority that is disconnected from its original networks of interdependency and has not yet synthesized new relationships has always been fumbling. This has been the experience in an orderly society like Switzerland, an enterprise-oriented society like the United States, or a socialist society, like the U.S.S.R. Usually the people are handed what is legally necessary under contracts drawn up many years earlier, and not what they want or really need. Under stress the community bonds dissolve, and households shift much more for themselves, either in a designated resettlement area or in an accessible metropolis. (This is for valley-dwelling agrarian settlements; tribal groups in forests and hillside villages exhibit different responses to stress.) Therefore the kind of family planning that might be of interest includes methods of achieving short range adaptation. For example, safe procedures for terminating pregnancy might be of considerable importance to households not ready for an addition to the family. Without access to such a service, the people who bear the highest social costs in valley development would have to pay a still higher price. It would be most advantageous to make the move out of the valley floor behind the dams a social learning and community development process, where fertility control becomes one of the techniques to be learned, but that will require some creative social planning followed

by innovative organization-building. Fortunately, the early work on improvement-through-displacement is under way, sponsored by the Mekong Committee.¹¹

The electrification programmes set into motion once the power is generated bring a wave of modernization with them. Lights, television, water pumps and purification systems, refrigerators, fans, air conditioners, sewing machines, and cooking stoves are put on sale, and their respective advantages are discussed. In the ferment of change there is greater likelihood that family limitation will be seen as

¹¹A reconnaissance of conditions in the Thai portion of the Mekong Basin, as well as the area adjacent to Saigon, suggests that in both countries the displaced population may be most strongly influenced by the lowest level personnel in medical and other services (i.e. nurses, midwives, the contact persons in social welfare, and -- in Viet Nam -- family services). However the relatively new persons at the lowest level of the professional hierarchy do not feel free enough or sufficiently knowledgeable until the middle level professionals supervising operations away from the capital have not only indicated their enthusiasm for family planning but have taken the time to enter into a mutual education program on techniques for introducing information and materials and a joint learning experience regarding what kind of efforts produce responses in the resettled population. The official family planning program in Thailand has already transmitted basic information to the present resettlement wives but contraceptives are rarely available as yet. Some information has been distributed by word of mouth in Viet Nam, the official program awaits the passage of legislation now under discussion and already delayed for a year.

In Thailand the agricultural extension service is not extended directly to resettled families (for whom the Welfare Department has sole responsibility but inadequate capacities due to budget and personnel problems). Therefore any linkup of improved agricultural practices with family planning for the resettlement from flooded out areas behind dams will encounter major difficulties due to the division of responsibilities in the field between the respective agencies. In Laos there is little administration at all, so the families are dependent upon their headmen. In Viet Nam resettlement of land is becoming highly organized due to a program for the resettlement of refugees in urban camps back on abandoned land. Hopefully this experience can be extended to land reclamation programs in the Delta.

The principal difficulty in Laos and Thailand, and increasingly so in Viet Nam, is that there is a strong tendency for family units to take care of themselves, particularly if compensation is paid promptly (about 75% until now in Thailand), which means that they drift out of

valuable by the leading groups in the population. Family planning teams should be ready to move with the salesmen and the distributors who follow the extension of the highlines into new territory. These changes can already be observed in communities energized by the dams on the tributaries, so the techniques of linking the location and special strategies of family planning promotion facilities to electrification could start at any time. It would appear a very appropriate kind of collaborative project for a group dedicated to comprehensive basin planning.¹²

contact with the first agency offering family planning information and materials and are likely to move into isolated areas where service is not easily renewed.

The minority that remains at a resettlement estate and relatively dependent upon the Welfare Department (in Thailand, at least) is made up of families that are less educated, and slower to take up the kind of longer range rational calculations associated with planning small families. The estates are relatively isolated, equipped with a second level health center at best, to which the staff often does not arrive at the few scheduled hours of opening. Service at that level would not prevent pregnancies, even if there were acceptance of contraceptive techniques. It is important that a serious effort be made in this stratum of the population, because their complete cooperation is needed to achieve steady state and they are normally the slowest to employ fertility control effectively. The less educated, rural, traditionalist poor require more ingenuity, effort, and time than either the progressive rural or the urban immigrant populations.

To sum, the social science models used to plan fertility control programs suggest that gaining widespread acceptance from resettled families will be slow, but the historic division of responsibilities between agencies prevents the mounting of the kind of integrated program that might make valuable contributions to reaching a stationary population.

¹²The introduction of electrification in rural Thailand does not seem to be bringing about the pace of social change that it has elsewhere. This may be accidental, in that farmers and shopkeepers cannot afford the electrical connection plus television and refrigerator (locally the most popular domestic appliances) until they sell a good crop at a high price, or it may be attributed to the structure of the rural electrification program itself as viewed by townspeople and villagers. Even then Thailand is years ahead of Viet Nam and Laos, so that the exploratory studies on integrating family planning services with modernization through electricity should be initiated in that part of the Basin. An extra feature of rural change that may get linked with electrification is the buildup of cottage industries, particularly Thai silk and cotton spinning, dyeing, and weaving, for which an expanding market seems to exist.

On the matter of planning irrigation agriculture made possible through the provision of water, the Mekong Basin is more fortunate than most other basins to have available the evaluation by the staff of the Resources for the Future.¹³ It addresses itself to the fundamental causes for failure identified in previous irrigation programmes, and argues for a number of approaches whereby these can be minimized. Although it identifies the population growth problem, and places great emphasis upon both human resources and institution building, so that the priorities are noted, no hint of a strategy for developing institutions in newly irrigated or newly double cropped areas that cope with overpopulation is offered. It is not even incorporated in the note on improving the health services, even though the implications of public health investment in the Basin (3% population growth per year) were clearly understood. The gap in their otherwise admirably presented ecological thinking will need to be rectified very quickly.

The planning, construction and management of irrigation is left to the respective governments and may require five to twelve years before a reasonably efficient use of the water is achieved. A national family planning programme could set up a special group to coordinate studies and facilities with the department of agriculture. Little is known as yet how to take advantage of the transition to more intensive, disciplined agriculture for installing the small family norm.

¹³ Resources for the Future, Agricultural Development in the Mekong Basin: Goals, Priorities, and Strategies, (Baltimore: Johns Hopkins Press, 1971). There is some internal evidence that the treatment of fertility limitation issue was made extremely oblique in order to enhance acceptability of the remainder of the report.

The proper procedure under such circumstances is to learn by trying a number of different approaches.¹⁴

Another procedure for reducing the demands placed upon scarce resources at a time when the carrying capacity is being approached is that of developing substitutes for the commodities that are resource-intensive. Further increases in meat eating, for example, will be a drain on resources. Livestock that consume leftovers should be encouraged while those that are grain-fed, as in Japan and North America, should be discouraged. The preparation of meat substitutes in the form of textured vegetable protein and to-fu equivalents was introduced earlier.

Matters like this are again matters of life style, so that meat is associated with Western bathrooms, automobiles, large houses, and European style furnishings. The drain upon resources such as energy, water convenient living space, and materials may reach five or more times than is needed for comfort and convenience. As a student of the Asian Institute of Technology put it, there needs to be a number of devices invented for persuading leaders and followers that "small is beautiful." It represents the kind of civilization that the Mekong countries can safely move toward, and could still be the envy of much of the world. This is a matter which intellectuals must take up; it could evolve from the rising interest in the environmental thinking in this stratum of the population.

¹⁴The organization of irrigation districts usually involves complicated land adjustment procedures that take time to work out and require extra cooperation and capital to implement. Once the canals have been built and sluice gates installed people are very reluctant to see a plot subdivided. Thus in Thailand it would be highly desirable to have only one daughter to inherit the property, and quite small families would be associated with intensive use of irrigation water. Similar hypotheses would have to be tested for the other riparian cultures, and fertility control programs designed to fit land tenure customs and laws.

Urban Growth in the Region

The cities serving the Mekong region, some of which still do not depend directly upon its flow, have been growing as rapidly as any in Asia. All the counts are inadequate, so the present growth rates can be crudely estimated at best. An important feature of a number of these cities is their seasonal variation in population. On the whole, however, the cities are believed to be growing currently at about 5-10% per year. Of this about 3% is natural growth and the remainder represents migrations of various kinds.

Because of endemic warfare in the region it has been widely believed that the cities are being expanded by "forced draft" urbanization.¹⁵ A study conducted in the last half of 1972 in Saigon shows that none of the expected relationships based upon urban migration elsewhere in the world actually held up enough to account for the local immigration. Yet refugees likely to return to their homes at the end of hostilities seemed to be no more than 10-15% of the total influx over the previous dozen years.¹⁶ The picture that emerges (for 1972) is one of a population that largely would have appeared in the metropolis regardless of war, and now finds prospects difficult both at home and in the city,

¹⁵The term is Samuel Huntington's. The conclusion is that T.G. McGee in "Beachheads and Enclaves: The Urban Debate and the Urbanization Process in Southeast Asia since 1945," Working Paper, Centre for Asian Studies, Hong Kong University, 1972. It has been widely believed due to a series of press reports from Saigon and Phnom Penh, but appears to be contradicted by the findings from the more recent study discussed here.

¹⁶Allan E. Goodman and Lawrence M. Franks, "Between War and Peace: A Profile of Migrants to Saigon," SEADAG Paper 74-1, New York, 1974.

yet not desperate. The fact that more than half of those that arrived between 1970 and 1972 did not feel threatened by the war itself (they had learned to live with the fighting) but were responding to other pressures makes the growth appear almost normal. The high frequency of recent immigrants lacking relatives suggests that, if they actually find niches in the city, there will be a strong flow of followers from the more distant provinces in the future. The personal histories of the migrants in Saigon resemble much more the experiences of peacetime migrants than those of refugees during World War II. An influx from the Delta region into extensions of Saigon is likely to begin as soon as the opportunities arise. Recognizing that a troubled peace which gradually stabilizes will bring new immigrants as well as emigrants from the city, it is apparent that Greater Saigon will continue to expand from a base of about 4,000,000 people in 1974, and Phnom Penh from more than 1,000,000 and Vientiane about 200,000.

Projection into the future in this part of the world is more hazardous than almost any other place. Yet dams with an expected life time of much more than a half century are being built. Similarly, despite the violence, the mortality rates are running only a minor fraction of the birth rates. These features, when combined with the lack of abnormal population structure for Saigon discussed above, suggest that long term projections should be carried out for the Mekong much the same as these tasks are handled elsewhere.

There are three kinds of urban centres that attract strong flows of immigrants from the countryside. The strongest in this part of the world is the primate capital city. The reason is that government grows much faster than the economy at large, and the preferred government

posts are in the city. The quality of education and the higher services, such as health and cultural activity, will be superior to other centres. These tendencies toward concentration have been more dominant in the riparian countries than anywhere else in the world.

The second kind of attraction is to the coastal metropolises. They are connected by both sea and land with other metropolises of the world, and they have readier access to raw materials and semi-manufactures. They can pick up coastal industries of a type that cannot be fitted into Japan, Hong Kong, and Singapore due to full employment in those locales. Very likely a superport will be installed in the Gulf of Thailand and off South Viet Nam to match the superports off Taiwan and Korea, and a large aggregation of medium to heavy industry would form on the shoreline behind. It would be powered by Mekong hydroelectric generation, nuclear energy and imported petroleum and coke. Any oil and gas pools found offshore (the likelihood seems to be quite high that at least several moderate size fields will be found) will substitute for part of the imports. Thus the advanced stages of electro-metallurgy and electrochemicals production can be mixed with petrochemicals plant, and other features of moderate to heavy industry.

The third variety of attractive location is on a transport intersection in a region with quite dense agricultural settlement. The sites of the bridges to be built over the Mekong are excellent candidates for rapid development.¹⁷ Food processing industries and services provide

¹⁷ Although a dam provides a crossing, it rarely supports a metropolis. The reason is the kind of terrain needed to anchor the dam is not conducive to efficient urbanization. Power-intensive industries provide few jobs.

major sources of future employment, while many such agricultural districts nearby will be unable to find a productive use for as much as half of the new generation of young people. The push and the pull are exerted together, resulting in quite rapid growth of new centres.

There is a fourth kind of centre that can be imagined for the long run and it might acquire a very considerable population. It would begin, as Los Angeles (the second city in America) did, with an attractive climate -- a place where educated and moneyed people would prefer to live. They tend to bring high technology enterprises (i.e. electronics, pharmaceuticals, fine arts, film-making) along with them, thus building up employment for ordinary workers. It is possible that one of the reservoirs of the Mekong could evolve this role, particularly since modern designs are being invented for houseboats. So many difficulties, such as reservoir drawdown, can be foreseen that it does not seem proper as yet to plan for such a development. However, as soon as the necessary technical solutions are found, such a centre would have a high growth potential. Because it could reduce the stresses of expansion elsewhere, a serious review should be undertaken of the potentially accessible urbanizable land at the edge of the large reservoirs that are projected, recognizing that one of the future attractions would be the possibility of developing an aquatic habitat integrated with the more traditional kind on land.

Ecosystem of the Steady State Urban Community

Of the minimum 130-170 million people that the Mekong Basin would have to plan for, about 110-150 million would have to live in cities.

The rural population in the territory not covered by urbanization would remain about the same, but their productivity would be increased enough to allow them to enjoy a minimum adequate standard of living. This would constitute a quality of life high enough to attract as many people away from the cities as are drawn to them. Such equilibria (at a more affluent level than the minimum adequate standard) have only been reached in the United Kingdom and in most parts of North America at this time. Japan is also very close to that stage due to a higher rate of subsidization of agriculture.

A large share of the Basin-born population moving to the cities, probably well over half, is likely to seek niches in Bangkok, Saigon, and Phnom Penh. A possible allocation is 20 million to Greater Bangkok (which could receive 30-50 million from elsewhere), 30-40 million to a megalopolis that arcs around from the South China Sea through Saigon, and extends beyond Can Tho in the Delta. Phnom Penh may take ten million and Cam Ranh and Kampot perhaps five million apiece. That leaves 40-60 million to find homes along the river or at other places along the coastline that can be guaranteed sufficient water. These guesses are made on the basis of requirements for the achievement of the steady state.

Water is the lifeblood of urbanism. As urban populations increase it will have to be reused and reprocessed at increasing cost. Great care will need to be exercised to keep the sea water from intruding and contaminating the aquifers. Therefore the cities will not be able to pump unlimited amounts from strata immediately under their facilities. This means that the sewage and industrial waste of the urban settlements that is usually carried by water must also be recycled. Thus intensive gardens and fish ponds that recycle water, fixed nitrogen,

nitrogen, and phosphorus become an integral part of the new urbanism that must be created for Southeast Asia, where the Mekong supplies the largest share of this most essential input. The balances will change according to the amounts of direct sunlight received, but first approximations suggest that about half of the water would be lost from transpiration in gardens and trees, and the remainder through processing losses and evaporation. Coastal cities may be required to do what Hong Kong has already done -- place large rubber bags at the mouths of small streams, which inflate with run-off and can be pumped into low level reservoirs after the storm.

Some interesting consequences follow from the need for conservation and steady state technology. Perhaps half the area of the city would be given over to intensive, multi-crop gardens, which in turn provide part of the addition to carrying capacity that is needed to keep the population alive. As much as 80% of the tonnage of the food supply (but only 20-30% of the calories required) could be produced within the interstices of the urban settlement, using methods already developed for this climate and soil types. Only about a quarter of the surface would be devoted to residences, the remainder to public services, commerce and industry. This means a population density for most portions of the urban area that ranges between 4,000-12,000 per square kilometer, which is quite a bit less than occurs today, except in residential districts dominated by the automobile.

The areas with the best soils adjacent to Saigon and Bangkok are already evolving in this direction. One can see rice paddy being displaced by vegetables wherever the transport is adequate. Fruit is grown on higher ground close to the settlements of growers. The textile

mills, knitting factories, and wood working shops have located within commuting distance, and electronics plants are settling down next to the airport which is available to some of these mixed settlements.

It should be remembered that the really elaborate, carefully designed adjustments to steady state must be made in the third generation during a period between 50-85 years from now.¹⁸ That is when the full benefits from the Mekong development should be attainable, based on the sequential development of its programme. It is a time when the prospective world supplies of petroleum will be running down, with only the shale, tar sands, tar belts, and the coalplexes producing strongly and steadily. Prices for liquid fuels may be trending slowly toward limits that are set by the synthesis from sunlight via a microbiological cycle or the synthesis from limestone via nuclear power. Thus a reversal of present conditions is forecast: electrical power will be priced lower than refined liquid fuels used in transportation on a delivered joule for joule basis, calculated before taxes.

Thus the future cities of Asia, and those of the Mekong are included, must economize upon hydrocarbon fuels in their operation as much as possible. The growing of heavy, perishable vegetables and some fruits within the urban settlement does this quite admirably. The movement of heavy freight and passenger flows by electric railways would also help. Everything must be done in the other features of the design of the cities to economize on the continuing use of all energy, but particularly the imported sources. Therefore special provisions must be

¹⁸The length of a generation in a young population is about 25 years, but age at marriage is likely to increase simultaneously with the adoption of family planning. Although these changes tend to work in opposite directions, the length of the generation is expected to increase.

made for the use of very light vehicles -- bicycles, tricycles, quadricycles, mo-peds, Hondas, scooters, and small water craft -- with their own carefully engineered networks of light roads, parking, flyovers, bridges, signals, rental organizations, legal regulations, and vehicle manufacture. To a large extent they must displace the automobiles that we are now taking for granted. The buses will remain economic during the first generation of settlement, but after that many will be displaced by both the cycle system and by electrically powered mass transit.¹⁹ Even more economical would be dependence upon the telephone for transacting business; the telephone network could be used by many other telecommunications devices which consistently save 80-95% of the energy required to make visits or deliveries. Thus we must expect a much larger capacity for telecommunications and computing than is found anywhere in the world at the moment. Fortunately this is one kind of service that is expected to get cheaper over the three generations required to approach steady state.

The prospective energy-conserving solutions for constructing a steady state urban ecosystem do not seem to conflict in any way with the water-conserving or materials-conserving features that appear to be required for the Mekong Region. A useful estimate of domestic energy requirements for tropical countries is about three to four

¹⁹ Interestingly, it can be shown that some kind of leveraged or powered assistance is needed for transportation in order for all people to have the opportunity to reach a minimum adequate standard of living. A city designed around pedestrian and/or beasts of burden reduces productivity to such an extent that only a small minority could reach consumption levels equal to adequate standards.

times the energy value of the food consumed by men and beast.²⁰ To this must be added the requirements for manufacturing (which will depend upon the competitiveness of regional energy costs as compared to the rest of the world), for civil aviation (which is determined by trade and also the extent to which local peoples are able to be exchanged with other regions of the world) and the military or other emergency needs.

It is interesting to note that in a number of places in the world the amount of flat, well-drained, accessible land suitable for urbanization is scarce, so that problems of land conservation are encountered. It is true that much of the urban land for the Mekong may have to be poldered or similarly reclaimed, and those costs will need to be carefully compared to the alternative locations, yet the prospects do not appear to present the kind of limitations encountered in places like Bombay and Java. There seems to be sufficient room to accommodate any density between 4,000-12,000 per square kilometer in the urban areas, depending upon the preferences of the settlers.

One other option with respect to space remains open to the population. They could retain the same amount of space in a house but insulate and ventilate it so that it remains more comfortable. Crowding is reduced because the household at steady state typically contains three to four persons instead of five to six at present. A constant size dwelling unit means retaining light oriental furniture and simple sleeping arrangements. It also means that most of urban life will go on in public and commercial spaces.

A Westernization and privatization of family life, using beds and bulky furniture, would require larger dwelling units that reduce the

²⁰ Many alternative systems were designed in the preparation of two

dimensions of public services, and probably would result in an overall residential density at the lower end of the range. It would also require two or three times as much materials of construction and transportation during the period when the cities are being built. The standard lumber, tile, bamboo, and kenaf used for construction are expected to become scarce when city building approaches its peak rate (about two generations hence if major catastrophes are averted) so a number of substitutes need to be introduced, based upon modern technology which is best applied to reinforcing Asian life styles.²¹ There appear to be no difficult problems to be solved, merely a lot of details to be pulled together.

One interesting innovation may be desirable in coping with the major concentrations of population. Drainage will be important and canals are necessary. The costs of bridging could be very high if a more traditional kind of city is built. However, the canals could be

books: R.L. Meier, Science and Economic Development - New Patterns of Living (Cambridge, MIT Press, 1966), 2nd ed., and Planning for an Urban World - The Design of Resource-Conserving Cities, (Cambridge: MIT Press, Nov. 1974). The first of these books assumed apparently feasible technology, while the second assumed that the best tested technology could be borrowed. Due to the difference in dates the results are very similar.

²¹For example, fabrics made with synthetic fibers have already penetrated village society quite thoroughly, and so have the polymer-based paints. Folding sleeping pads based upon flexible polyurethane foam are becoming popular; they can also be used for seating pads at low tables. Fluorescent lights are already used, but places to read or study are uncommon. Small handy electric kitchen units are now on the market, but refrigerated cooperative food lockers are still rare. Building systems for putting up self-help housing with modern components are known but not yet applied. Methods of combining such water uses as drinking water supply, bathing, washing clothes, food preparation and sewage transmission into a neighbourhood recycling system are understood in schools of public health and environmental engineering, but the prototypes have yet to be built. Pocket radios already on hand will make it easy to introduce Asian designed portable telephones, which are arriving this year.

used as ferry routes, similar to buses, the vaporetto of Venice, or the services already established on the Phao Phrya in Bangkok. The basic elements of a metropolitan transit system have been worked out for Honolulu, linking with ferries to other islands, by the Ocean Engineering Department of the University of Hawaii.²² Most bridges could then be restricted to very light transport, thus saving markedly on capital investment at a time when the demand for infrastructure development is high, and also reinforcing a system that works conveniently at low energy. The technique of combining two systems could be advantageous in other parts of the world (e.g. Bangladesh, Egypt, Venezuela and Florida) but the greatest gains would be reaped among three of the four riparian nations.

In a steady state situation the gross domestic product accounts are no longer very useful for a society. Instead it is necessary to have an accounting system for each element of human welfare that could become critical and a human services delivery system that uses the accounts in its planning and administration. Thus the dietary planning shown to be needed well before steady state is reached would continue; it would program the supply and demand of calories and protein. Land accounting is already carried out by urban and regional planners. Energy accounting has just now become important, and will become more so. The human time accounts, which indicate the amount of freedom people have to choose what they wish to learn or experience (discretionary time) are now being studied. One interesting form of accounts yet to be developed are based upon the supply and demand for water;

²²Published reports were not yet available in 1973. I saw several internal reports and proposals in Honolulu in May 1973.

for cities, and populations in drought-prone areas, the allocation procedures for water will become critical long before the steady state is reached. The Mekong Committee may be in a position to pioneer in this respect, because it is responsible for a precious commodity.

The present method of categorizing productive activity would also become almost meaningless. The jobs that are clearly primary (agriculture, mining) would shrink to around 10%, as would those that were predominantly engaged in manufacturing, which means that the steady state ecosystem becomes primarily a "service society" (also called "post-industrial"), so that most people are engaged in making sure that everyone gets his share of necessities and an opportunity to participate in cultural activity.