Principle of Environmental Energy Matching for Estimating Potential Economic Value, A Rebuttal

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Our energy analysis group was not involved in the paper by J. Gosselink, E. P. Odum, and R. Pope, but because one of our 1970 methods was quoted, we were asked to comment on the critique by Shabman and Batie. Rather than discuss others' descriptions of our method, the concept and its application as we would do it is given as follows:

1. The total embodied energy of the environment is calculated, including that in sun, land, wind, and water. (Embodied energy means energy previously used in work transformations to develop the flow of concern or its storage.) As various types of energy flow have different embodied energies per calorie, all are expressed as equivalents of the same type for comparison (i.e., coal equivalents or solar equivalents). Calories are kilocalories.
2. The embodied energy of the environmental system, such as marsh (storage and annual flow), is the basis for attracting economic activity, which is competitive so long as the ratio of free embodied energy embodied in purchased inputs (goods, services, fuels) is greater than that of competitors. Thus, the potential economic value related to free external embodied energy may be estimated from the ratio prevailing in the U.S. economy. In 1975 this was about 6.3×10^{-8} dollars/calorie of solar equivalents (1.25×10^{-4} dollars/calorie of coal equivalent).

The embodied energy in marshes is shown in Fig. 1, where actual calories are shown first. Then calories of each type of energy are converted to solar equivalents by multiplying by quality factors. The potential value yielded is $500 per acre/year.

If the wetland depends on a convergence of waters from a 10 times larger area, the embodied energy is larger, and the energy value, which is potentially attracted, involves matching by $4,000 per acre/year.

The procedure permits estimates of economic values before they have been incorporated into the economy. It gives the potential economic effect on the basis of the concept that flows with high embodied energy will be used for large amplifying effects, and the system in the long run will reorganize so that the combined power of environment and the economy interacting symbiotically maximizes the power of both. More complete discussions are given in references 1–3.

The dollar-to-energy ratio derived in this procedure is only used for the feedback of high-quality goods and human services from the final demand sector in which all the energy of the economy is embodied. The ratio used is the total fuels + solar energy, both in coal equivalents divided by the GNP. This is about 20,000 kilocalories of coal equivalents per dollar in 1975.

Energy sources are the externalities. The buying power of money depends on the externalities (e.g., fuels, environmental resources, land) Except when externalities are constant, it is not possible to determine in advance whether or not an activity is economic from the economic situation. The externalities must be evaluated and energy expressed in calorie equivalents of the same quality and the ratio of money to externality calculated as in Fig. 1.

An environmental system may be the basis for a good economy without anyone in the economic system being aware of it or without th prices reflecting the free environmental services of greenbelt action Such services include development of soils, peats, cleansing waters recycling, development of nurseries and outputs of fisheries; seedin offshore fisheries; providing air cleaning; recreation services; greenbelt and more that we probably don't even recognize yet. After the environmental system is removed, the increased costs of the economy and i poor position in economic competition shows afterward some of th ecnomic subsidy that was unrecognized before. The embodied energ method allows one to calculate these in advance.

The stored energy value in capital assets in a marsh is estimated

the energy flow required to replace the marsh. If the peat and landforms are not disturbed, a marsh can be restored in 10 years. Thus the annual energy flow can be multiplied by 10 years and then multiplied by 6.3×10^{-8} to get the potential dollar value of the stored soil and vegetation as $5,000. A marsh, however, includes the tapering channel tidal distributary assets and other landforms. If landforms and peat bases have to be rebuilt at rates about 1 mm/year, a thousand years may be required to restore a relief of 1 m, making embodied energy equivalents in support of the economy of $500,000 possible in some cases.

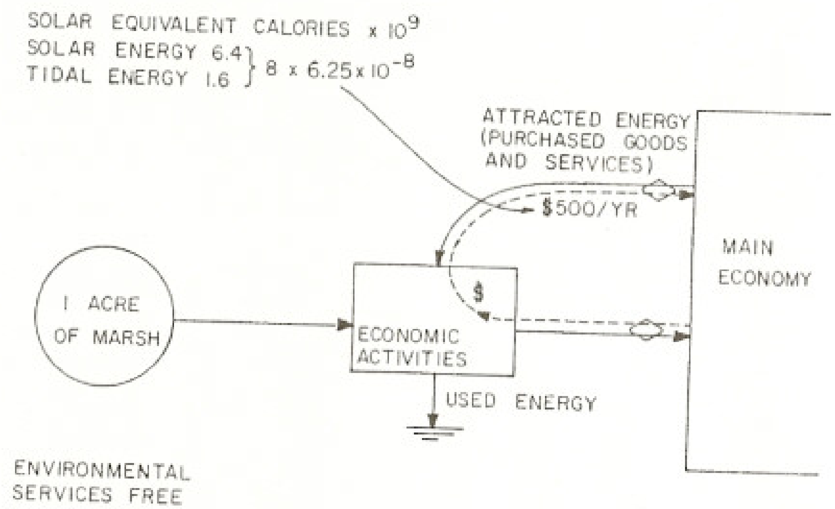

Figure 1. Summary of relation of free embodied energy of an acre of marsh supporting an economic activity that brings in energy and money of the external economy on a ratio. Tide included was 1.3 m. Tidal energy converted to solar equivalents using factor of 3,400. See Odum et al. (1977).

Notes

1. Odum, H.T. 1976. Energy Basis of Man and Nature, McGraw-Hill 297 pp.
2. Odum, H.T., W. Kemp, M. Sell, W. Boynton and M. Lehman. 1977. Energy analysis and the coupling of man and estuaries. Environmental Management. 1:297–315.
3. Odum, H.T. 1978. Energy analysis, energy quality, and environment. pp. 55–87 *in* AAAS Symposium #9, ed. by M. Gilliland. Westview Press.