half-life would be about 40 times as great as it was in 1970.* The global assimilation half-life was about 1.5 years in 1970.

DYNAMO equations:

A   AHL.K = AHL70 × AHLM.K
C   AHL70 = 1.5
A   AHLM.K = TABHL(AHLMT,PPOLX.K,1,1001,250)
T   AHLMT = 1/11/21/31/41
C   PPOL70 = 1.36E8
A   PPOLX.K = PPOL.K/PPOL70

Our information about the real world's current and potential assimilation capacity is based primarily on intuitive impressions, scattered data, and case studies. The interval-scale statement is closer to our current level of understanding than the ratio-scale statement. Existing information is not precise enough to connect absolute pollution levels directly with absolute values for the assimilation half-life AHL. However, there is some basis for guessing the percentage increase in the assimilation half-life that would be produced by different increases in PPOL. In the interval formulation one may easily change the value of the assimilation half-life in 1970, the value of persistent pollution in 1970, or the rate at which the assimilation half-life would increase with increases in the persistent pollution levels. Both DYNAMO expressions are numerically identical and would lead to the same model behavior, but the first equation does not clearly exhibit the components of the judgment that lead to the assessment of pollution's influence on AHL. We therefore chose the interval formulation. If more comprehensive and accurate information were available, the ratio expression would be preferred.

Since the assumptions underlying our formulation of AHL refer to the situation in 1970, the normalizing constant PPOL70 must always be equal to the value computed in World3 for persistent pollution PPOL in 1970. If any change is introduced in World3 that directly or indirectly influences the persistent pollution generation rate PPGR, transmission delay PPTD, or assimilation rate PPASR, and thereby the value of persistent pollution PPOL in 1970, the constant PPOL70 will have to be changed so that PPOLX will still retain the value of 1.0 in 1970. The standard value for PPOL70 was determined by simply simulating the standard version of World3 and setting PPOL70 to the value of PPOL observed in 1970. Since PPOL70 has a slight and indirect influence on the level of persistent pollution through AHL, several iterations were required to find the precise value of PPOL70 that caused PPOLX to be 1.0 in 1970.

Although current information is insufficient to make any accurate estimates of the effective assimilation half-life of global persistent pollution in 1970 AHL70, there are data that indicate the half-lives of individual persistent materials present in the environment in 1970. Figure 6-23 summarizes the estimates of the half-lives in soil of ten insecticides made by Nash and Woolson (1967). The estimated half-lives range from 4 to 13 years. It should be noted that these figures are not accurate estimates of the half-lives of these materials in the global environment, for disappear-

*To obtain equally spaced table intervals, DYNAMO programming conventions force the use of 1,001 instead of 1,000 as the upper bound of the AHLM table. Obviously, this difference has no effect on the model's behavior.

Insecticide	Half-life in Soil (years)
Aldrin	11
Chlordane	11
Endrin	11
Heptachlor	5
Dilan	6
Isodrin	5
Benzene hexachloride	4
Toxaphene	12
Dieldrin	9
DDT	13

Figure 6-23 Disappearance half-lives for ten insecticides in soil
Source: Data from Nash and Woolson 1967.

ance from the soil is a necessary but not a sufficient condition for disappearance from the global environment. Some fraction of the pesticides that vanished from the soil in Nash's tests must have been degraded and thus fully assimilated. The remainder may have simply evaporated and moved to other sectors of the global environment.

The difference between disappearance from only one sector and full assimilation by the global environment is illustrated by the simulation of our DDT model (Randers 1973), in which we followed the disappearance of the insecticide from the various sectors of the global environment after an initial pulse application in year 10 of the simulation (Figure 6-15). The residence half-life of DDT in the soil is seen to be about 2 years.* However, it takes fully 17 years to achieve a 50 percent reduction in the total amount of the chemical present in the environment: the air, soil, stream, ocean, and fish sectors of the model.

Figure 6-24 provides data on the half-lives of radioisotopes released in the liquid wastes of conventional pressurized water reactor nuclear power stations. The half-lives range from 20 hours to about 28 years. The concentration of these materials in the liquid effluents of reactors was extremely small in 1970, so they did not play a significant role in determining the effective assimilation half-life of the total global persistent material burden. However, both the growth in reactor usage and the tendency of longer-lived materials to increase in importance because of changes in the composition of persistent materials will increase the contribution of many elements listed in Figure 6-24 to the global pollution burden.

As a final illustration of the half-lives that characterize current components of the global persistent material burden, we refer again to our simulation of the mercury model (Figure 6-16). In the model's projection, only a small fraction of the total metal initially added to the environment disappears from the air, soil, mud, ocean, and fish sectors of the model after 140 years have elapsed. This long delay is likely to

*The discrepancy between our simulated estimate of half-life in soil and the larger figure obtained by Nash and Woolson (1967) is due to the higher rate of evaporation in the simulated system. Nash placed his DDT evenly throughout several inches of soil. Thus evaporation was less important in his test than in the real world.