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PRESIDENTIAL ADDRESS

Water Resources and the Population Explosion

When we talk about population estimates, it is a well-accepted fact that the past is a poor indicator of the future. However, beyond our imagination, we have to rely on recorded facts to get some idea of population trends. The only real known fact is that to date most population forecasts have underestimated the increase, and this should make us realize that demographic doomsday prophets may have a point. I believe that many are aware of the population explosion (which started after the Second World War with the cure of major infectious diseases and the general improvement in public health measures) but that few are considering the implications seriously.

The current world population increases by 2 percent per annum, and at this rate of growth doubles itself every 35 years. Simple calculations show that a continuation of this growth rate may make a mockery of rational human behaviour. We have now one person for every 40 000 m^2 of the land surface of the earth. A continuation of the 2 percent growth rate will give us one person per 5000 m^2 in 100 years, four persons per m^2 in 500 years, 30 000 persons per m^2 in 1000 years – and it has been said that in 3000 to 4000 years all visible objects in the universe will have been converted into people and the population will expand in space at the rate of the speed of light!

Ridiculous, perhaps, but it is sobering to realize that even with zero population growth now (a seemingly impossible objective at present), the world population will continue to grow at the present rate for a further 70 years and so quadruple itself.

On the home front things appear quite calm. The present population of 2.9 million is expected to rise to 5 million by the year 2000 at the present growth rate of 1.9 percent. However, urban growth and the drift to the north must be considered. The North Island now has 71 percent of the population – but this is expected to rise to 78 percent by the year 2000, and the population north of and including Hamilton is expected to be 3 million by then.

Apart from a small population we also have more water resources per unit area or per capita than any other country. The annual runoff for New Zealand has been estimated as 392.8 km^3 (Toebes, 1972), with some 55 percent running off during flood time, leaving a dependable flow of 177 km^3. We could not use all of this, since we need to leave water in streams and rivers for hydro-electric use, fisheries, river maintenance, recreation, as a wild life habitat, and for carrying away pollutants; about 25 percent of the total flow, or 98 km^3, would be a satisfactory volume. This leaves $177-98=79$ km^3 for use, which is considerable, since even with a population of 5 million by the year 2000 we will still have some 40 000 litres per capita per day.

In the United States the present water use is 5000 litres per capita per day, and this is expected to rise to 8000 litres by the year 2000. On this basis we could support some 25 million people in New Zealand, at least from the water point of view. However, we have not taken into account the distribution of water in time and space, and because of this the calculation is not a very practical one.

Some idea of problems that could arise may be obtained by looking at the area north of and including Hamilton. The annual runoff (including the entire flow of the Waikato River) for that area is 35.7 km^3, and using the same calculations as before we arrive at a water availability of 7000 litres per capita per day by the year 2000. This is somewhat less than the estimated use per capita in the United States by the year 2000, and it optimistically presumes a utilization of virtually all streams and rivers and of the dynamic groundwater resource.

The problem is not very great, however, compared with similar problems elsewhere. It is difficult to produce meaningful figures on a worldwide basis, but taking the figure of 15 000 km^3 for the dependable world runoff as given by Llovitch (1972), and assuming a similar requirement as before to leave 25 percent of the average annual runoff of 38 000 km^3 in rivers and streams, we arrive at a usable runoff of 5500 km^3. This is equivalent to 4000 litres per capita per day with the present world population and 2000 litres per capita per day for the projected world population of 7×10^9 by the year 2000. This is 25 percent of the estimated United States per capita requirements and would not be unreasonable if the water were available where the population is. This is, of course, not the case.

Let us take, for instance, the Ganges Basin in India. The basin has an area of 950 000 km^2, a population of 191 million, and an average annual runoff of 17.2 km^3, giving 36 litres per capita per day at present and 18 litres per capita per day in the year 2000, 0.25 percent of the estimated United States requirements.

Of course one could argue that the entire water resource could be used in such an emergency situation, and this is already happening in southern India where, for instance, the Cauvery River in its lower reaches is dry throughout the year. In the case of the Ganges it would give the people only some 123 litres per day, still not a particularly large quantity if one considers that this is to be used for domestic, industrial and agricultural purposes, including irrigation.

The examples indicate that water availability must be of considerable concern in the near future. Of course, water is not the only problem that is coming upon us because of the population explosion. Others are space, heat accumulation, pollution, food shortage, energy production, and the non-availability of certain mineral resources. Of these the shortage of water and mineral resources will be the more important limiting factors. Space and heat accumulation are not short-term problems. Pollution, in spite of dire predictions by the Club of Rome (Meadows *et al.*, 1972) will without doubt be controlled within tolerable limits, and it is generally conceded that production of energy and food is feasible on a relatively unlimited scale, albeit by as yet unconventional methods, since the continued use of present agricultural methods, for example, will be automatically limited because of the shortage of water for irrigation.

The shortage of water (and of certain mineral resources) will affect us sooner than we would like. Of course, water is a renewable resource and recycling (as for minerals) is entirely feasible, as is also the conversion of salt water to fresh water. But the energy requirements for conversion are immense, because of the high entropy of salt water and polluted water, and to envisage such methods for the developing nations is entirely illusory. Neither could towing icebergs or exporting water from New Zealand assist the requirements of such nations. And the large-scale use of static groundwater could have consequences more severe than those it might solve.

One could argue that people have survived so far and will continue to do so. But one would miss an important point. The simple fact is that developing nations want to become developed nations, and quickly. One of the requirements is water, and this is just not available in sufficient quantities. Ehrlich and Ehrlich (1972) talk about the "never-to-be-developed nations", and from the water point of view this is the correct terminology to use in many cases.

What will be the outcome? Will people be happy with large-scale and severe rationing of water, a fact already common in some countries? What is likely to happen is that developing nations will become sufficiently developed to realize that there is an upper limit to their development, and that – in the case of water requirements – this upper limit is reached sooner rather than later.

No doubt the exponential population growth curve will change into one of a sinusoidal form, but at the high population levels mass unrest and the desire for mass emigration to other areas may increase at alarming rates. This statement is not designed to establish a panic situation. Sir Arthur Bryant said in 1971 that "a liberal, democratic and tolerant system of government [as we have here] is inefficient in the short run, but efficient in the long because by delegating responsibility it trains and educates men for it". This might be interpreted as saying that we will cope somehow. Nevertheless, changes are occurring at a pace never perceived before, and training and educating men to solve the problems as outlined here is an immense task.

I believe it to be our responsibility to educate politicians and administrators on the likelihood of water shortages, and the implications in New Zealand with continuing population growth, and – more important – of the possible immense consequences of an increasing water shortage in densely populated developing nations.

I use the word "educate" deliberately since, to use Goethe's words in *Faust*: "Normally man believes when he hears words; it pays him also to think about those words".

CORNELIS TOEBES

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