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THE OPTIMUM POPULATION OF THE UNITED KINGDOM

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ABSTRACT

The current population of the U.K. need not necessarily be considered the best population level for the country's future well-being. This paper examines this country's degree of self-sufficiency in energy, food, forestry and other related resources which contribute to its economic output and, in particular, the quality of life of the British people. Different population levels of between 10 to 57 million are considered. A clear attempt is made to persuade the reader that there is scientific evidence to support an optimum population of the U.K. less than the current population of 57 million. This paper gives various time scales for population reductions without incurring possible economic hardship. Environmental and population policy recommendations are also discussed.

KEYWORDS

Optimum population levels, U.K. optimum of between 15 - 30 million, resource management, environmental and population policy recommendations.

INTRODUCTION

Definition & Aims

The optimum population of the U.K. is defined as the level of population which is most likely to produce a sustainable 'high quality of life' for its inhabitants without adversely affecting the quality of life of people in other countries. It should not adversely upset the ecological balance of its natural wildlife. Figure 1, schematically represents the simple model which is used in order to calculate the best optimum population band.

The aim of this paper is to prove that there is enough evidence to support the claim that the U.K. is overpopulated. It also aims to identify the most important areas on which to concentrate future research effort in order to enable changes in government policy and ensure a long term reduction in population.

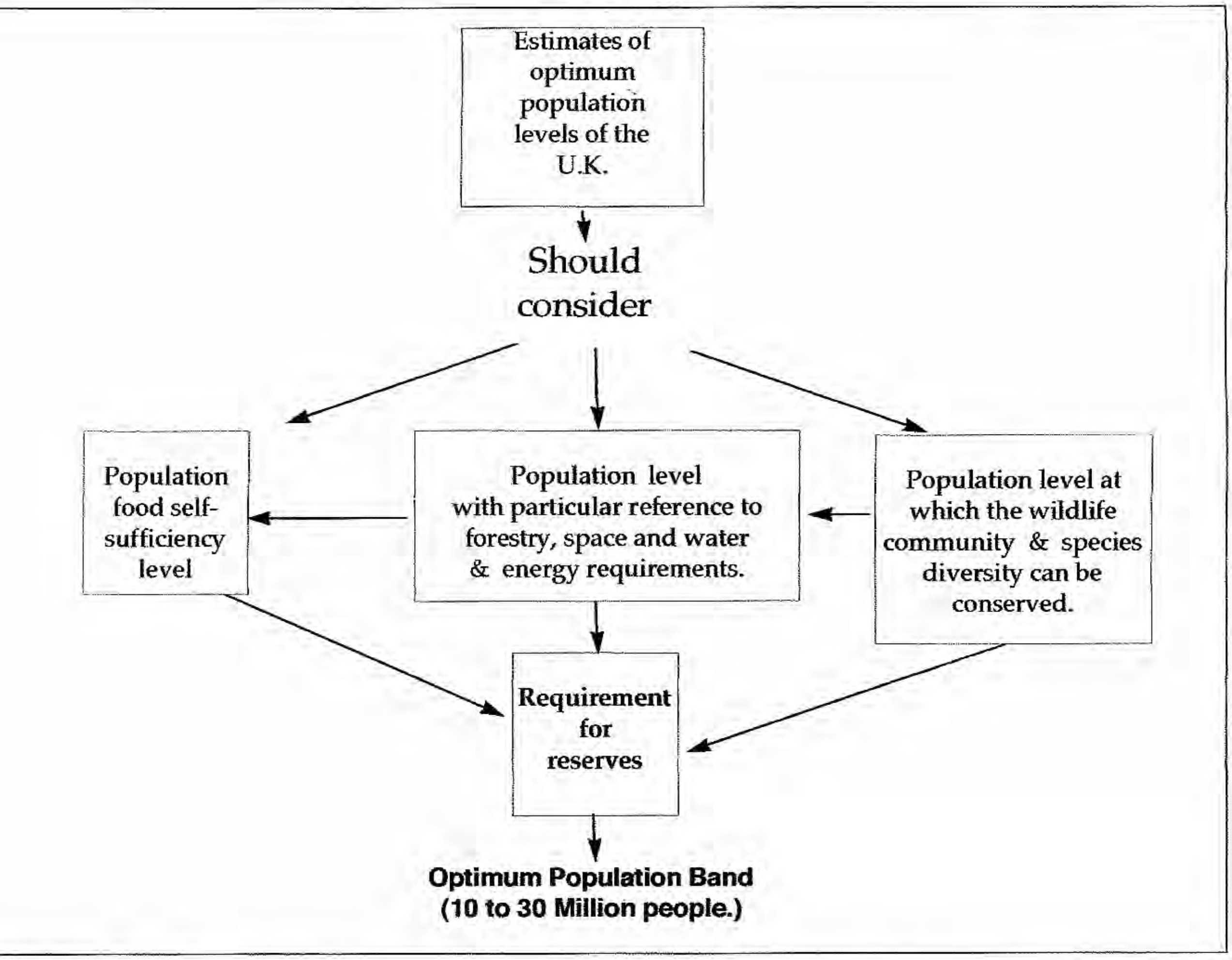


Figure 1: Model of the Optimum Population Calculation.

Methodology

Calculations of optimum population should encompass the following:

1) population preferences versus availability for natural resources such as, water, energy, wood, food, precious and semi precious minerals;

2) estimates of the by-products of human population such as carbon dioxide and other pollutants;

3) optional demographic projections, population specific recreational and aesthetic preferences;

4) realistic time scales involved in attaining these population levels given careful planning;

Earlier estimates of optimum population tended to be dismissed as guess work and were therefore considered unreliable. This could be partly attributed to the lack of firm scientific evidence. Advances in science and its perception of the environment over the last ten years could now significantly improve the quality of data used in the determination of optimum population.

The realistic assessment of optimum population has only recently been made possible as a result of the emergence of modern technologies such as accurate scientific instrumentation, up to date population census and data sampling techniques, satellite remote sensing technology, high speed numerical computing power, immense advances in data storage capabilities and faster communications.

This paper links natural resources to life quality preferences of the British population in an attempt to assess best estimates of optimum population levels. Four optimum populations levels are considered in more detail; self-sufficiency in food production, wood production, energy requirements and wildlife conservation. The accurate linkage of estimates for optimum population levels to quality of life for transport, tourism, housing and recreation is considered of secondary importance to the above and is therefore discussed in less detail.

Table 1 summarises the upper optimum population level for the U.K. for various resources. Only those levels which are written in '**bold, marked with an asterisk and numbered**' are scientifically examined in this paper. These levels are considered the most important natural resources for the U.K. on which to base calculations of optimum population.

Background Information

Copious references in the literature refer to optimum population. Many studies are also available which set out to measure carrying capacity based on food, water, availability and energy throughput. Zabia, 92, Ehrlich , 90 ., note that it is usually impossible to formalise the carrying capacity calculations in the popular literature but there seems to be a tendency to choose a 'tolerable' mortality level, evaluate the consumption standard this implies, calculate a notional maximum population size by considering the productivity of the environment and its resource base, and then to state whether observed population growth lies on the trajectory required by this choice.

The economy of the U.K. is an open system in as much as it can import essential raw materials which it lacks. There are few restraints, at the present time, on its population other than its long term economic survival which constrains the population size.

The fact that a population can afford to maintain its existing lifestyle does not

Table 1. This table gives some optimum population estimates for the U.K.
(* means that the estimate is the basis of further supportive scientific evidence)

	Present Population	57	Million
1.	**Maximum Population Level** **Self sufficient in food** **under intensive agricultural conditions**	**41**	**Million***
2.	**Re-introduction of** **Vanished Species i.e. Wolf/Bear** **Increase stock of endangered species.**	**40 - 45**	**Million**
3.	**Self-Sufficiency in the less intensive** **crop rotation**	**35**	**Million***
	Transport Maximum Numbers of cars possible 10 million. Given the Car ratio of 3 person to 1Car	30	Million
	Walking Maximum population level which can maintain uneroded and pleasant walks.	25	Million
4.	**Self -sufficiency in** **Forestry and Wood requirements**	**15-25**	**Million***
5.	**Self-sufficiency in renewable** **energy**	**15 - 20**	**Million***
	Tourism Adequate space for tourism.	20	Million
	Housing	10 - 20	Million
	Social Life Historic Optimum Population not a problem Provided other countries had similar related population levels then would permit global tourism for all i.e. high altitude trecking and sites of global historic and natural interest.	7	Million

mean, necessarily, that the lifestyle reflects the highest quality of life for that population. It is assumed that most people will prefer to live in an environment where there are adequate natural resources and space although it can be observed in London, Hong Kong, and Singapore, there are many who may positively enjoy a high population density (Slesser., King, 92.). Bright et al (1970), based upon an important survey in Buckinghamshire showed that 74% the people interviewed indicated that they thought the U.K. to be overpopulated. This is an area of research which needs expanding. A nationwide survey which interprets accurately the publics interest in population, space and other related issues needs to be carried out.

Food Self sufficiency Population Level 35 Million

Refer to Table 1. (levels 1 & 3).

The U.K. is able to import sufficient food stuffs in order to feed itself, hence the normal Malthusian welfare checks do not apply. However it is possible to calculate the best level of population which could be sustained on locally grown produce. The reader must be aware that any calculation of food self sufficiency is fraught with problems because of the simplistic assumptions which need to be made. High agricultural outputs cannot be sustainable over the long term because of two main reasons;

1) the levels of energy, fertilizer and pesticide needed to sustain this continued high agricultural output would be too great to be maintained indefinitely and

2) because intensive agriculture increases soil erosion with resultant loss in soil nutrient fertility.

The U.K. is only 73 % self sufficient in indigenous type food and feed, even with an intensive high input agricultural regime (Evans, 93). If the Britain was to be self sufficient in food at this high level of intensive agriculture then this would be equivalent to supporting a population of 41 million people.

The demand for increased agricultural production started early on in British history when there was a need to meet the burgeoning population. This demand for food resulted in an increase in the arable land during the 18th and 19th centuries in England and Wales, which is not always entirely suited for agriculture. Also more importantly, since the second world war the U.K. has entered its second agricultural revolution. There has been a massive increase in artificial fertilizer use, and very intensive agriculture. Yields for many crops have more than doubled but farmers are now on a treadmill. These increases in production were stimulated by both the U.K. Government Policy, which needed to assure itself that there was enough food in times of crisis, and then also by

EEC policy which paid farmers for all they could produce. Areas of agricultural land used for winter wheat and winter barley tripled inside a decade.

An agricultural regime which would minimise soil erosion and maintain the long term fertility of the soil must be a deciding factor when considering what would be the best level of population which could be supported by a more rational and sustainable agriculture policy. Evans (1993) writes that erosion is more widespread now in the U.K. than it has even been, in and attempt to grow more food and wood, and also cut down our import bills. This soil erosion is, in part, due to the increase in growing of winter cereals which incur greater soil erosion that the planting of spring ones. As the manufacturing base declines so there will be greater pressure to become as self-sufficient as possible. If our exports do not pay for imports, it is more likely that soil erosion will become more severe. Furthermore, if these changes are accompanied by a warming climate, which could result in large changes in the way we use our land, introducing erosion-prone maize for instance, or changing grassland to arable, so the incidence of erosion will increase (Boardman et al 1990) and 46 % of England and Wales, will become at moderate or higher risk of erosion(Evans 1990b)[figure 2].

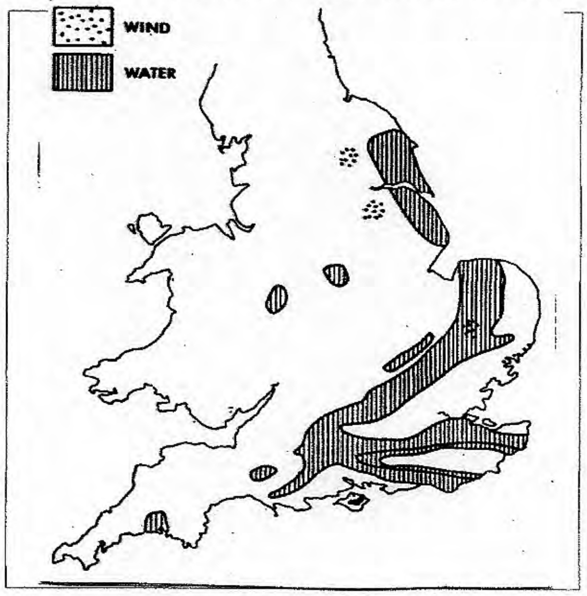


Figure 2. Areas at risk of soil erosion in England and Wales. Evans (90) Boardman (88).

If crops were to be grown in a rotational basis so as to reduce soil erosion and maintain soil fertility then such an agricultural regime could only provide 62% of the nation's needs which is equivalent to feeding a population of 35 million. Using agricultural yields data taken over a long period of time (Johnston 1992, Grigg 1989,), Evans reached this population figure by two different methods. Even at this lower figure of 35 million soil nutrients would have to be replaced with fertilizer.

Evans' lucid description leaves us with little doubt that historically poor agricultural practices and the introduction of new crops, potato and sugar beat, brought about as a result of the urgency to feed out burgeoning population was the main cause for the initial increase in soil erosion.

A historic marker which is worthy of attention is the Repeal of the Corn Laws of 1846. The Act of Parliament allowed imports into the U.K. in order to feed the the industrial workers. There were between 15.9 (Wrigley and Schofield) and about 20 million inhabitants in England [21.1 million in 1851 (CSO 1992)]. From then on the population of the U.K. was fed more and more by imports paid for by exporting industrial goods (Figure 3).

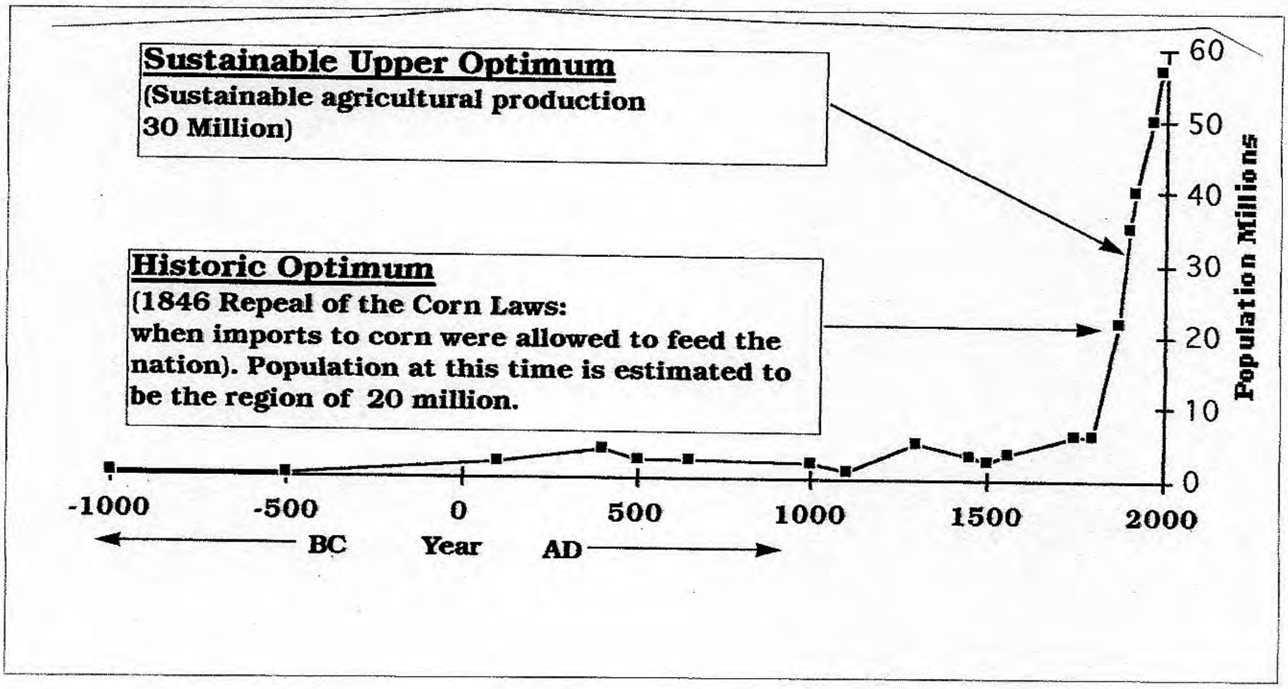


Figure 3. **Graphical representation of the U.K. population since 1000 BC to AD 1993.**

Lampkin (1988), points out that the carrying capacity is critically determined by the composition of the diet. A shift to a lower meat diet, particularly less pig and poultry meat, would dramatically increase the carrying capacity of the land. He estimates that a reduction in population of 50% to achieve food self-sufficiency would not be required for a non chemical agriculture but does admit that the range of products which the U.K. could produce under this regime and in quantities approaching self sufficiency is relatively limited. In his view this would gives us a diet which would not be particularly exciting.

Given that the population limit which could be fed, in the long term, with locally grown food is in the region of of 35 million coupled with the fact there needs to be a built in reserve then it does not seem unreasonable to assume an agricultural optimum population level approximately in the region of 30 million.

Refer to Table 1. (pp4), (Level 4).

About 4000 years ago prehistoric humans came from the continent and started to colonise the British Isles. It was then that the process of cutting down of trees began. Prior to this time Britain was cloaked in forest. Even the early records dating from Roman times described Britain's landscape as one great forest. However these forests were cut down over the centuries to such an extent that by the year 1900 only 5% of Britain remained wooded.

Country	% Area Forestry	% Area Agriculture	% Area Urban & Other	T otal Land Area Million of hectares.
Ireland	5	82	13	6.9
Netherlands	9	59	32	3.4
United Kingdom	10	77	13	22.7
Denmark	12	66	22	4.2
Greece	20	70	10	13.1
Belgium/ Luxembourg	21	46	33	3.3
Italy	23	58	19	29.4
EEC Average	25	60	15	222.9
Norway	27	3	70	30.7
USA	29	47	24	916.7
France	27	57	16	55.0
Spain	31	62	7	49.9
Canada	38	8	54	922.1
Portugal	40	36	24	9.2
USSR	42	27	31	2227.2
Japan	67	14	19	37.7
Sweden	68	9	23	41.2
Finland	76	8	16	30.5

Taken from Forestry Facts & Figures pamphlet 1990-92

Table 2. Percentage area of forestry cover /country comparison

It was not until the end of the First World War that Lloyd George, the British Prime Minister at the time, remarked that Britain nearly lost the war more for lack of timber than lack of food. From then on the government finally recognised that forestry was a valuable resource.

The realisation that the nation needed to invest in its forestry was emphasised by Acland Report. This report stated that Britain could not run the risk of future wars without safeguarding supplies of timber and embarked on a policy of afforestation. Other European countries had enforced woodland conservation policies since the sixteenth century (Miller, 1991). Since the publishing of the Acland report there has been a continued programme of afforestation. The area of land under forest has increased to 2.3 million hectares or 10% of the total area of the country. However, even if there was maximum utilisation of forestry resources, Britain would be unlikely to produce more than 15 % of the current wood requirements [Table 3. & Figure 4.] and still ranks amongst the lowest of the comparable countries in the world percentage forest cover league tables [Table 2].

Figure 4. Forecast of the United Kingdom roundwood supply and wood product demand 1987 - 2050

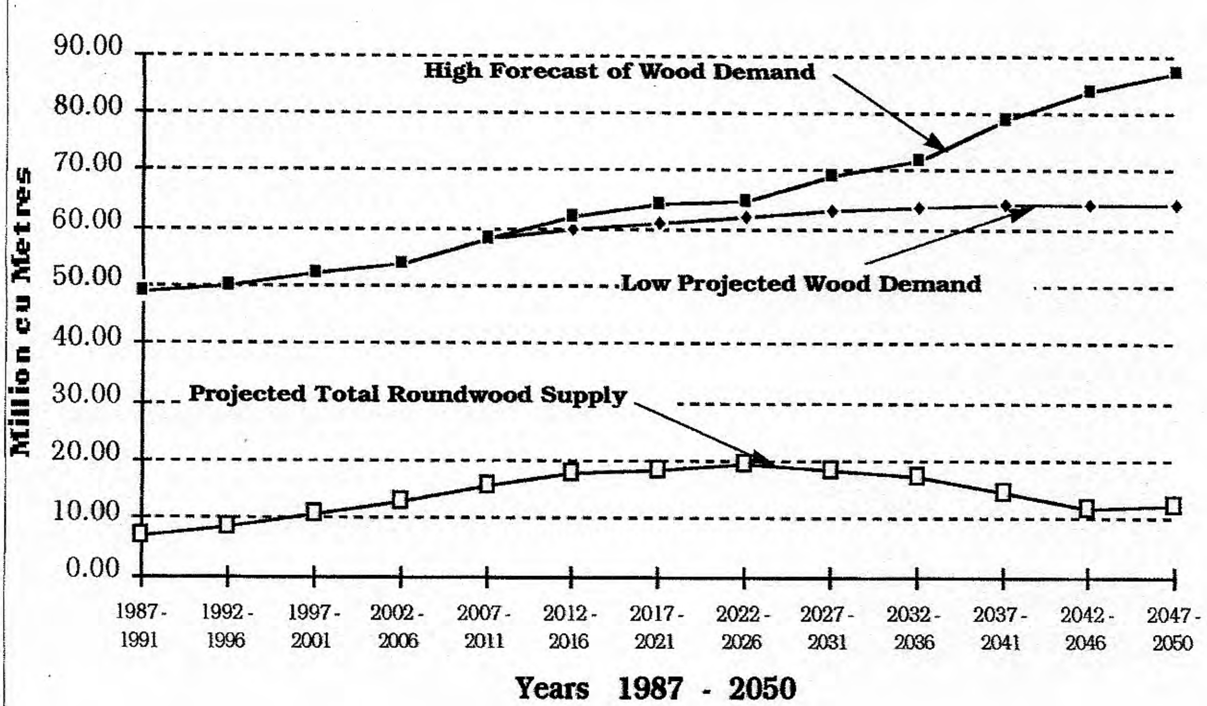


Table 3 : Volume of U.K. imports, production and apparent consumption of wood and wood products, in millions of cubic metres of wood, raw material equivalents.

Year	Imports: Wood	Pulp	Panel Products	Paper	Total	U.K. Production	Apparent Consumption	Percentage Home Produced (%)
1986	14.6	8.3	4.3	13.0	40.2	5.2	43.0	12.9
1987	19.1	8.5	4.5	15.4	47.6	5.4	49.9	10.82
1989	18.6	9.6	6.8	13.9	48.5	6.0	50.7	11.83

An exhaustive set of reports commissioned by the 'Forestry Commission' in 1989 highlighted how especially important the U.K. forestry is to improving the quality of life. Research carried out by the National Survey of Countryside Recreation (NSCR [1]) pointed out that there were recreational advantages to forests (Benson et al., 1989). The report's findings indicate that 1 - 2 billion trips are made into the country each year within the U.K. and the Forestry Commission's forests are estimated to receive about 50 million visitors a year. So important has this issue now become that the Government has announced that it would form a forest in Central Scotland and eleven community woodlands around English cities. This radical change in thinking by the government is especially welcome because it is now clear that the government had acknowledged that there must be a recreational value attached to forests near cities and town.

Future recreational forestry needs to be carefully planned. The NSCR[1] research indicated that over one third of trips away from home for recreational purpose have a round trip distance of less than 10 miles, and a further one half of journeys are a distance of less than 20 miles. There would be major advantages to the city dwellers if forests were located close to towns and cities so that distance does not become a major obstacle to potential visitors. This study also noted that these visits fluctuated with the fortunes of the national economy.

Future forestry developments depends very much on whether government policies can successfully turn areas of farmland over to forestry. Historically, overriding priority has been given to safeguarding fertile land for food production. This effectively pushed new forest developments into land of marginal agricultural value. However, as a result of set aside CAP[2] policies there is now good reason to expect forestry developments to expand not only into to areas of marginal agricultural value but also into lowland areas. Some lowland grassland in the Midlands and the north of England have already being taken out of agriculture. However, such land would be more likely to be released in small parcels than in large tracts (Cunningham, I., 1990). The withdrawal of 1 million hectares of land from agriculture should not cause major problems for U.K. agricultural production. Estimates from various studies indicate that 2-4 million ha will become surplus to farm production requirements by the year 2000. The countryside will change dramatically if these changes come about (Harvey, D. 1990). However, continued forest expansion will depend on the public perception of the balance between land used for agricultural production against the alternative potential service benefits which newly created forests would provide.

Miller (1991) writes that 'Already forests are being much modified to ensure conservation of fauna, floral, physiographic and archeological features'. Interestingly, it is often found that the landscape modifications can serve more than one function; 'for example, leaving an archeological site unplanted may provide a deer lawn, will increase habitat diversity and can create a feature with both landscape and recreational interest. The design of forests to optimise these factors is one of the great challenges facing management.'

Pearce (1991), carries out a comprehensive cost analysis and benefits which takes into account the financial value to recreational and carbon storage. Using the theory that absorbed CO_2 is locked up, on average, in forests for 100 years and that applying the speculative research results of Bordahus (1990), and Ayres (1990) he estimated the cost benefit of reducing the green house CO_2 as £ 8 per tonnes of CO2 fixed. Knowing the fixing rates of different types of forestry, the distribution of different woodland type, and allowing for decay of wood Pearce was able to calculate the carbon credit as between £ 527 - 554 per hectare of forest. The overall financial conclusion showed that the community forests, along with mixed conifer, broadleaved forests in lowlands and upland margins have the highest value to society (Table 4.).

Forest type	I.R.R.
Community Forests	5-7%
Native broadleaves, Lowland	4-5%
Lowland Conifer	6%
Conifer Upland	6%
Semi -natural Pinewoods	4%
Mixed conifer/broadleaved forests in lowland/upland margins where low amenity value	8%

Table 4. **Estimates of the Internal Rate of Return from different types of woodland. (Note high value of community forests)**

<u>Wildlife habitat</u> <u>Arbitrary Population Level for the Reintroduction of Vanished Species 40 - 50 Million</u>
Refer to Table 1. (pp 4), (Level 2).

The future of forests relates very closely to wildlife. Historically, as man cut down the forests to make way for agriculture, so species were hunted to extinction. The list of extinct species (some listed in Tables 5 & 6) is well catalogued.

Britain now has a growing tradition for its interest in wildlife. Public opinion now understands the need to preserve the wild life sites. Wild life conservation is very closely linked to a programme of afforestation. In many regions species can be conserved without major changes in land use. However if everybody in Britain is to take advantage of wildlife then there needs to be a substantial reduction in population in the future.

Species	Extinct
Mammals	9
Birds	14
Amphibians & Reptiles	0
Insects	2
Vascular Plants	18

Table 5. Species which are known to have vanished from the U.K.

Good et al (1991), described how National Nature Reserves and Sites of Special Scientific Interest now protect some 8% of Britain. They also pointed out that there are now many dedicated conservationists in the country. This will give credence to the national interest in planting new forests in areas where woodland have become fragmented. By linking these pockets of forest together. Larger woods tend to contain more species than smaller woods of the same kind because their populations are generally bigger and species in danger of local extinction are likely to be less vulnerable.

Now that the pressure is off the utilisation of land for agricultural purposes, perhaps it is an appropriate moment in British history for the reintroduction of certain vanished wildlife species back into the United Kingdom.

Yeldon, Morris, 1986, suggest that the Isle of Rhum might be one suitable location which could be used for the trials for the reintroduction of wildlife species. Other possible areas which should be considered are the Cairngorm mountains between Aberdeen and Inverness. Large areas could be successfully fenced in for experimental releases of species such as bears and other vanished species etc, providing that supplementary feeding is given initially to support the species.

Recent literature highlights the difficulty with protecting wildlife in the U.K.. Not even the Wildlife and Countryside Act of 1979 and the Bern Convention for the protection of European Habitats (1979) is sufficient to protect the remaining colonies of Otters, *Lutra lutra* (Tickell, 1993). Any reintroduction of species would, in future, need proper and full and unrelinquishing government protection.

Table 6. **Species which have vanished from the British Isles.**

Mammal species that have been made extinct as a result of conflict with man.

Wolf	Canis lupus	Extinct: England late C15th/Scotland 1743.
Brown Bear	Ursus arctos	Extinct in C10th - habitat destructionhunting.
Wild boar	Sus scrofa	Extinct by end C17th - hunting, habitat destruction.
Beaver	Castor fiber	Extinct by end of C10th - habitat destruction.
Auroch	Bos primigenius	Extinct by C10th - habitat destruction.
Lynx	Felis lynx	Survival to mesolithic times - habitat loss.

Conclusion

A reduction in population to 40 to 45 million would relieve the pressure on land for agriculture, human industrial or town developments. This could trigger a major afforestation programme, safeguard existing stocks of protected species and stimulate the reintroduction of wildlfe back into areas of low population density. The most probable sequence for this process is summerised in Figures 6 - 8.

It will be noted that areas of low population density (i.e. less than 100 inhabitants per sq km coincides [Figure 6.] with the largest areas of land of marginal agricultural importance (Hornung et al, 1991) [see Figure 5.] and major areas of forestry commission and grant aided forests of Britain. It seems therefore obvious that any pattern of afforestation and reintroduction of certain vanished species would follow a pattern as simulated in the hypothetical set aside land as portrayed in Figure 8.

The careful reintroduction of certain vanished species, especially some of the mammals and birds would improve the species diversity of these area and could boost tourism in the future.

Figure 5. Distribution of upland land(heavy stipple) & upland margin agriculturally marginal lands (medium stipple) (Taken from Hornung et al 91)

Energy Self Sufficiency in the long term through renewable Energy
15 - 25 Million

Refer to Table 1. (pp 4), (Level 5.)

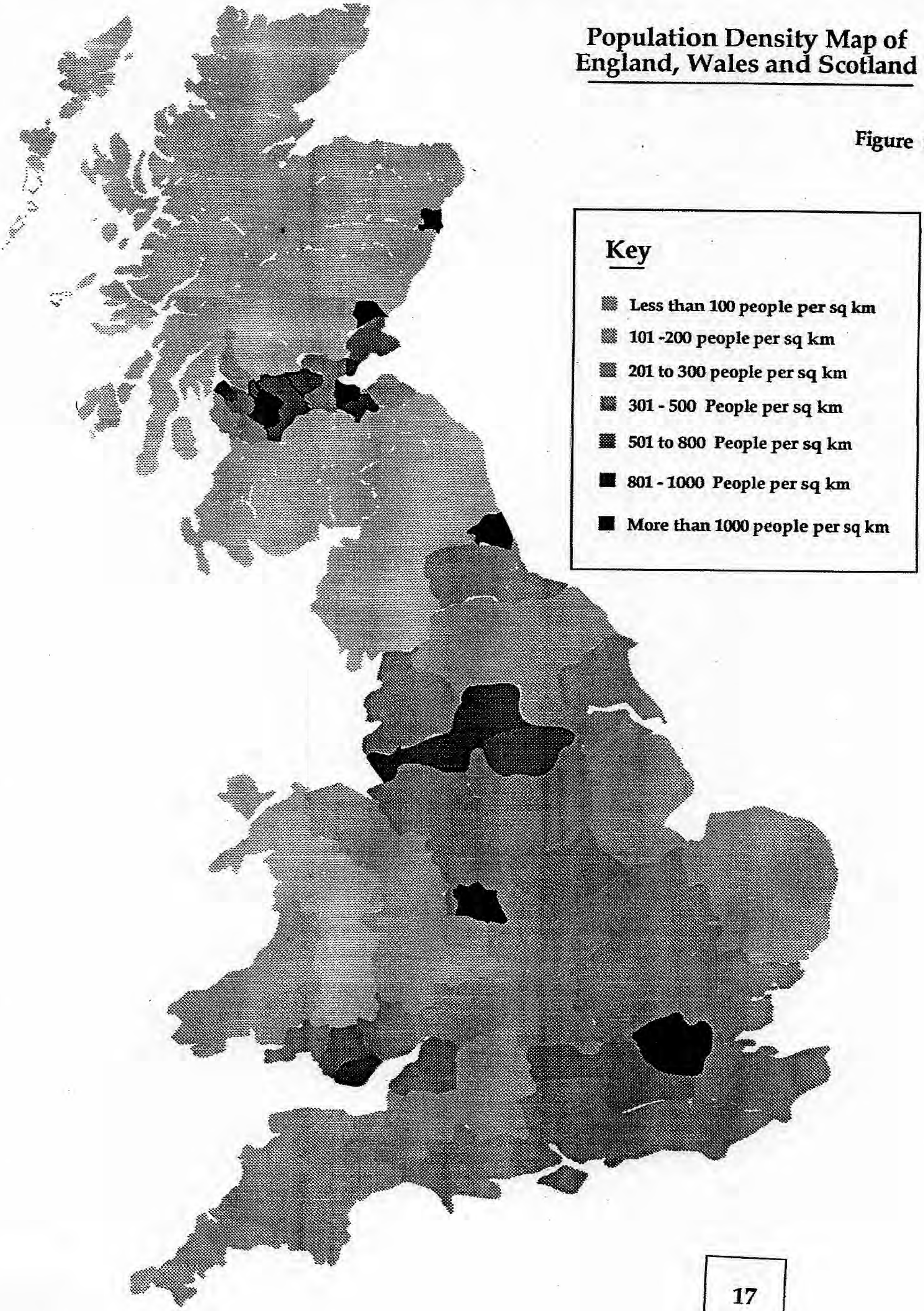
The energy issue is continuously under debate, both in the scientific and public domain. There is increasing public and governmental concern at the prospect of real adverse changes in climate from global warming. Organisations such as the IPCC[3] and the NFFO[4] are urging governments to pursue policies which use renewable energy.

If global warming is to be avoided then the annual carbon load released into the earth's atmosphere from burning biogas, wood and fossil fuels must not exceed 1 billion tonnes (IPSEP[5] report). The IPSEP[5] report suggested that this should be the target for the year 2100. If this estimate is accurate and the world population was to stabilise at 10 billion then the mean annual global per capita carbon ration would have to be 0.2 tonnes if global warming is to be prevented. At present the USA average is 5.8 tonnes of per capita carbon emission; the UK average is 2.92 tonnes and even India is 0.23 tonnes, Smith (1992). In order to reach this target there would have to be a 75% mean reduction in CO_2 emissions against the 1985 baseline by the year 2030. That is a tough goal when the U.K. shows no sign of achieving the rather feeble target set by the EC of stabilising at 1990 levels by 2005 (Smith, 1992).

On paper Sayigh estimates that the UK could supply 3 times its current present

Population Density Map of England, Wales and Scotland

Figure 6.



energy demand. Wind energy alone could supply 340 TWh/y (onshore) and 380 TWh/y (offshore) for less than 10p/kWhr in 1991 prices with an 8% discount rate (EP, No**60**). Tidal potential energy could add an extra 50 TWh/y of electricity with the Severn Barrage, if built, supplying 17 TWh/y of electricity at less than 10p/kWh (1991 prices) using an 8% discount (EP, No**60**). The total potential renewable energy supply from these two sources alone of 770 TWh/yr electricity far exceeds the current U.K. electricity demand of 300 TWh/y.

Exploitation of all these renewable energy resources is impractical and unlikely to be desirable as it would require large areas of the country to be covered in wind turbines & many estuaries to be barraged. Some of the most optimistic calculations predict that 50% of the U.K. energy requirements could come form renewable energy. However it is more realistic to assume that a prediction of 25 to 30 % could come from renewables over the next 50 to 100 years. Currently most of the renewable energy in the U.K. is in the form of Hydro electricity which currently supplies 2% of the nation's electricity needs. Two major potential sources of renewable energy are examined in more detail in the following paragraphs:

1) Wind Energy

The UK's potential is one of the best countries in the world for wind energy potential. The supply of wind can be divided into three regions: Scotland has wind speeds of more than 9 m/s, the Central part of England has wind speeds between 6-8 m/s and the rest of England and Wales has wind speed between 8-9 m/s.

The installed capacity in 1993 of wind power is approximately 130 MW which would be the equivalent to about 4.5 MW continuous supply of electricity. Multiplying this figure over 24 hours and 365 days year yields an expected annual wind generation of 0.4 TW/yr. This represents only 0.15 % of the current total annual electricity demand of 300 TWhr/yr (HMSO Paper No 55). It can therefore be concluded that: 1). the total supply electricity from wind energy is miniscule in comparison to the total supply and 2). there needs to be further substantial investment in wind power if the UK is to reduce its reliance upon fossil or nuclear fuels (Table 7).

Installed expected Power Capacity	Percentage % Electricty Supply	Year Prediction Wind Gerenerted Electricity	Approx Numbers of Wind Turbines
130 MW	0.2 (Musgrove, 92)	1993	1300
1000 MW		2000	10,000
2020 MW	20.0 (Musgrove, 92)	2020	20,000

Table 7: Potential for wind energy electricity supply.

2) Scope for further Tidal power projects.

The scope for extending the application of large scale hydro power in Britain is limited since most suitable sites have already been developed. However there is a huge potential for the untapped electricity from tidal schemes. The UK has a favorable tidal regime where an estimated 54 TWh/y (equivalent to approximately 18 % of the current electricity UK requirements) could be supplied from this natural resource. About 90% of this would come from eight large sites and the remainder from 34 sites.

Wave energy, which is the least developed of the renewable energy resources, could possibly be exploited. However, initial investment and maintenance still makes it look the least attractive option although some calculations predict that it would be possible to produce all our energy from wave and tidal energy at an average cost of 6p/kWh (as compared to 4 p for coal) (Sayigh pers comm).

Summary

Further substantial energy savings could be made through better insulation and with switchable windows, having selective coating for specific wave bands to heat and cool buildings. Also a significant proportion of a smaller population would be able to use wood for heating energy.

Combine these energy savings with potential electricity production (38 % of current equivalent electricity supply) coming from wind and tidal energy then the possibility of supplying 25 to 40 % of current total equivalent energy from renewable energy sources does appear to be possible.

When discussing energy, a reduction in population would be advantageous for three reasons:

1) safeguard the highly useful stock of fossil fuels.

2) Reduce pollution from acid rain

3) reduce the effect of global warming

Equally the source of energy is inextricably linked to population. If a population optimum of 20 million was supplied with renewable energy (possible from the above estimate) then, given the current consumption pattern of electricity per capita, then the saving would be approximately 26.5 million tonnes of Carbon, 79 to 106 million tonnes of Carbon dioxide and 1.3 million tonnes of SO_2 and .5 million tonnes of NOX.

The price considerations are an all important factor when choosing an energy source. Musgrove (1993)[pers communication] now reports that the current prices of installed wind energy is a mere1p/kw hr dearer than coal and gas (3p per kw/hr). If appropriate taxes were to be applied for carbon, sulphur dioxide and nitrogen oxide emissions from fossil fuels then the price of wind energy becomes extremely competitive. Future technological improvements could make wind energy even more economic than current gas and coal. Sayigh argues that nuclear industry is riddled with problems and expensive. Certainly the problems of the disposal of nuclear waste and the long catalogue of global disasters does favor alternative forms of energy. Also the expense of decommissioning was not accounted for until1989. When allowances are made for this factor then nuclear generated electricity becomes more expensive than other forms of energy. Further more, of all the energy sources, nuclear power is the most controversial and the most likely to arouse political opposition (Cross, 1993).

To conclude, if one is to assume that renewable energy could supply between 25 to 40 % of the UK current energy needs on a self sustainable basis then this would be equivalent to an energy sustaining optimum population of approximately between 15 to 25 million.

Housing **10 - 40 Million**

Space in the UK is a premium. Precise analysis of space requirements await further scientific prognosis. Odum E. (1970) analyses the minimum area requirements for a quality environment for a citizen of the USA.

Food-producing land	0.6 hectares
Fibre-producing land	0.4 hectares
Natural use areas (watershed, airbed etc)	0.8 hectares
Artificial systems	0.2 hectares
Total	2.0 hectares

The average UK citizen only has 0.42 hectares per person and in England, where population density is highest, the average area available per person is down to 0.27 hectares. Obviously the definition of space requirements will depend on many factors and could vary from generation to generation. There is also substance in the idea that people are getting used to being condensed into smaller and smaller spaces (Milligan, S. ,1991).

However the boom in population coupled with the necessity to provide a higher standard of living for everybody has created a building boom. Figure 9. shows the plan of new Towns in Britain. Most were built on largely green field sites an owe their origins to the 1946 New Towns Act. New Towns provided spacious homes for people in a clean rural setting and modern locations for industry. Today more than 1.5 million people live in New Towns. However, although they are considerably better than the slum housing areas and tower housing blocks they have been found to lack community spirit, bustle and the variety of styles found in established blocks.

The prospect of 2 million new houses before the year 2000 is an awesesome statistic when there is already a lack of space for their location. This problem of housing has been recently aggravated by the increasing numbers of single parent families.

The relationship between land supply and house prices is a complex one involving the interrelationship of four elements:

- the planning system
- the land market
-the new housing production; and
-the housing market

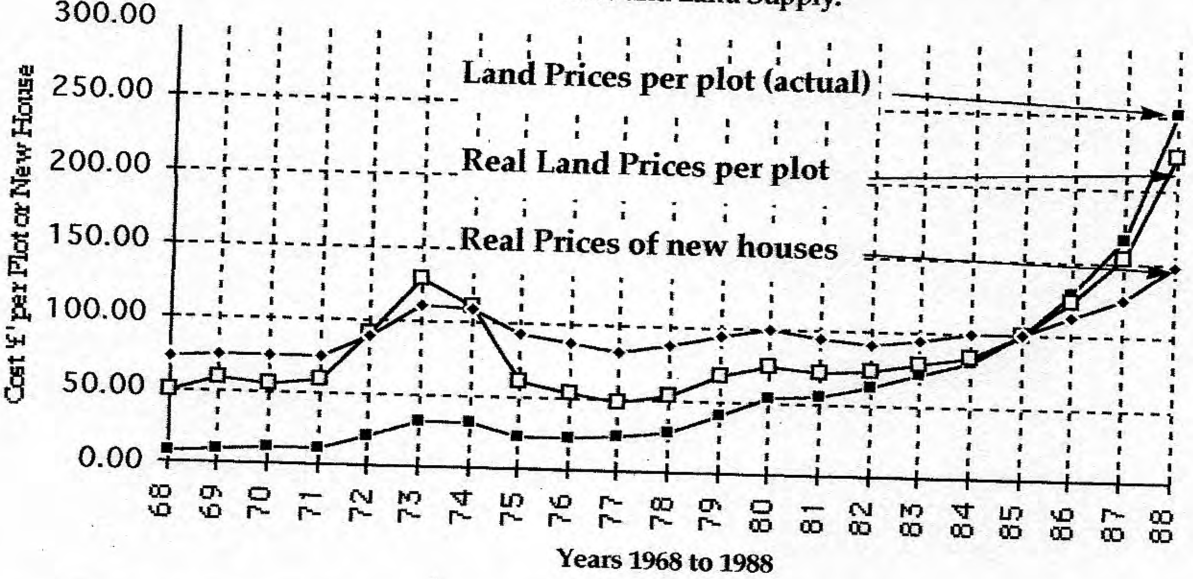
Obviously, providing the economy is resilient enough, any increase in population or increase in single families will increase the demand for new housing. If space is at a premium then land prices would be expected to increase faster than house prices. This is exactly what happens and is well illustrated in Figure 10 HMSO[9]. Here the real price of land is separated from the real price of the housing. This indicator shows that land is in short supply and indicative that population pressure causing land prices to rise faster than house prices. However the problem of space for housing has been known in the UK since the middle of the 19th century. Because of this pressure on space the Parker-Morris standards were issued as guidlines to good practice of area spacing for

Map Showing the location of some of the New Towns in Britain. Most of these were built on largely green-field sites.

architects in the 1960's. However, space has become such a premium that the standards have not been strictly adhered to. As a result there has been a predicted fall in building standards in the public sector. Also the private developers were not able to build sufficiently down market to replace the lack of council houses without an unacceptable decline in standards (Goodchild 1986). Here is clearer evidence that population pressure is having an adverse effect on housing and hence decreasing the quality of life for their inhabitants.

Figure 10 **House land prices and price of new houses - England and Wales: 1968 -1988.**

HMSO, Dept of the Environment, The Relationshop Between house Prices and Land Supply.



The pressure for new developments to be built in the country side has become so great that new housing development plans are met with local resistance of the indigenous people, environmental groups and now even from local government (Hampshire County Structure Plan 1990).

The question therefore still remains 'What sort of upper optimum population for housing would delineate the highest standard of living?' Certainly a house with a garden, a view and access to the country would qualify as a high quality of life. For this a guess estimate of of 10 million population is made (Willey 91).

The pressure on housing has become so great that the government free market economy could not advocate a policy of 2 houses per family.

Transportation (30 million)   Walking 25Million,   Tourism 20 million.

Table 1

These figures equate to very crude approximations with little scientific basis but should be used simply as a thought provoking concepts for future research possibilities.

Car congestion in towns and cities has become so great that the average speed be reduced to a crawl. Surely the total number of cars required depends on the number of people per car. The Car associations predict that the total number of vehicles that this country can take without yet further destruction of the countryside is 30 million. Although, to be free of traffic jams, pollution etc the figure should be nearer 10 million. Given a car ration of 3 people to 1 car (UK average) then this would give an upper optimal population of 30 million people for UK.

Similarly the same non scientific approach can be applied to tourism and walking in the UK (Table 1). The Pennine way has been so frequented by walkers (20 million annually) that it has now been renamed the Pennine Motorway and has had to be paved, in order to protect it from further erosion. Tourism has become a nightmare in certain parts of the UK with the number of tourists far exceeding the capacity of the site to deliver both its service and present a historic peaceful image (Willey 91).

Demographic Projections

Background

The dramatic fall in fertility in the UK along with the rest of Europe is well documented. The UK fertility rate fell to 1.66 in 1977 and subsequently rose to the 1.82 and since then has hovered around the 1.8 mark. Whether the UK will follow the example of Italy, with the lowest TPFR[6] in Europe at 1.29, is open to some speculation [(Hill, 1993)(King 1993)].

This decline in fertility coincides with the growth to maturity of the post-Second World War generations. These generations have become increasingly better educated; they have experienced rising standards of living and, perhaps equally important, changes in contraceptive technology. A whole host social changes, not least the desire for women to remain in the labour force have contributed to a great change in the attitude to child bearing.

The benefits of the concomitant reduced mortality and increased life span of the demographic changes are beyond question.It seems unlikely that that fertility will rise very much, unless a wide range of public measures is introduced to help parenthood with paid work (Hall 1993).

Migration More Problematic in the Future.

The UK along with the rest of Europe could be swamped by a wave of migration from the East and South. The views on television of Albanians trying to land by the shipload in Italy and the massive flights of many Bosnians in order to escape their civil war bring home the future reality of Eastern Europe on the move. Now that the Cold Wall no longer lifts the barrier between east and west, so many people will attempt to migrate, stimulated by the economic, social crises, high unemployment, ethnic tension and environmental degradation so they will tend to migrate to the west. The numbers of potential migrants from the USSR may be anything from 3 to 20 million alone (Salt, 1991). Migrational controls, rapid economic development of the east, and prolonged periods of peace making diplomacy could control such measures.

The Prospect of a Reduction in Population.

Providing the predicted massive wave of migrations into Europe are prevented, then the population of Europe is projected to decline early next century. The whole issue as to whether this positive reduction in population should be publically allowed, encouraged, discouraged or simply ignored has become the hotly debated.

Pros

The findings of this paper conclude that a halving in the current population would, in the long term, improve the quality of life for all the citizens of the UK and restore some environmental harmony. Certainly the fears are that the present level of affluence cannot be maintained indefinitely and that if the outcome of the above debate was to discourage a drop in population then there would be disastrous environmental consequences with resultant rapid fall in the quality of life.

Cons

However many government bodies fear that if the population was allowed to fall then the ageing population raises the spectre of another kind of 'demographic time-bomb':

1). the shortage of new recruits to the labour force and,
2). the problems of smaller active population supporting a large dependent population.

Certainly there have already been many calls both from within the EEC governing body and also many individual governments within the community to resist the fall in population

Author's Conclusions

Any resistance to the reduction in population would delay any relief in the UK's congested cities and frustrate any progress towards a fairer, more balanced society which has access to recreation, a share in work and brighter prospects in life.

With proper planning the population could also decline without adversely affecting the pensions to the elderly. The argument about the predicted shortage the labour force should be regarded as unimportant. The high rate of unemployment is a testimony this. For countries who do not plan then unfunded pensions, population trends does suggests a fiscal crisis. The rich European states (UK included) may adapt remarkably well to the shock of falling numbers. Dwindling work forces and savings rates may turn out to stimulate innovation, refinement and application of technologies and business techniques. This is an uncertain area of economics; but most studies suggest that advances in knowledge account for just over half of total growth (Economist[4]).

If governments adopt policies to ease the shock of an ageing, by including later

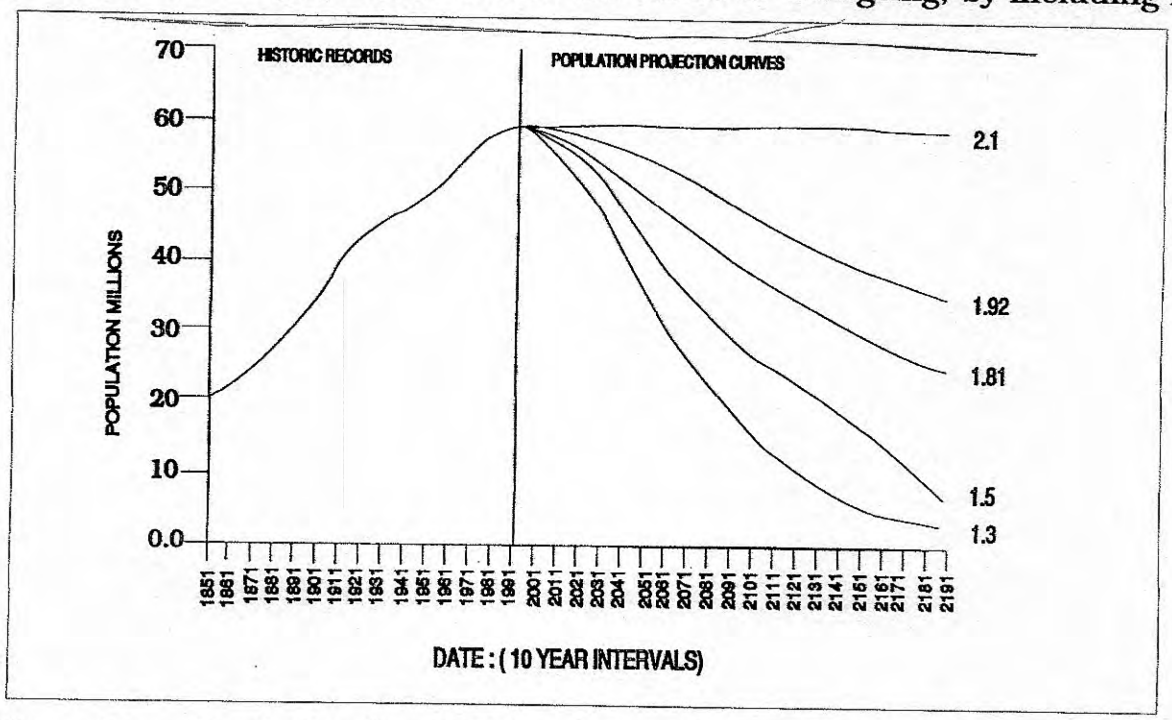


Figure 10: Graph showing the Historical and Projected Population Trends for the next 200 years at various fertility rate.

retirement, workers may actually find themselves better off. Improved health care and self help housing for the elderly could help relieve this shortage.

A 30 Million UK

The publicity of a population target which is generally accepted by all makes the task of education, taxing, policy and planning much more straight forward. It would save wasting money, time and energy.

Figure 10 graphically projects changes in UK population with different fertility rates (Kinzett, 1993)] If the current fertility rate of 1.8 was to be maintained then the 30 million target could be reached within 150 years. Every year there are an estimated 850,000 pregnancies in the UK. Of these, it is estimated that 280,000 are unwanted. (Some 180,000 are aborted). If all the unwanted pregnancies could be avoided, the fertility rate could be reduced to 1.5 which could mean that a 30 million target could be reached by the year 2085 (Kinzett, S. 1993).

The development of a Population Policy could be also helpful for the less developed Countries.

Europe is likely to be the demographic precursor to the rest of world, and the UK with its very close ties with the Commonwealth could send a very positive message to a very significant proportion of the worlds population. Just as the theory of demographic transition is based on what happened in Europe in the nineteenth and twentieth centuries, so what is happening now to Europe's population may well indicate future trends for other regions of the the world(Hall, R. (1993)).

Discussion

The Concept of Optimum Population

A realistic estimate of optimum population should significantly simplify our lives. A major scientific challenge of the nineteen nineties should be to convince the public that the concept of optimum population has real practical value.

The calculation of optimum population is complex and is also partially dependent on how well informed a researcher is on a wide number of subjects and his or her perception of the definition of optimum population. These calculations are further complicated by changes in expected quality of life and social attitudes. Future estimates of optimum population will also have to take into account the fact that the world is shrinking with whole organisations becoming redundant as the speed of technological development overtakes them.

This estimate of optimum population are based upon estimates of resources such as energy, forestry agricultural output and recreation (particularly in relation to wildlife). These figures need further refinement when taking into account space, redevelopments, and aesthetic requirements.

Findings

The results of this research concluded that it would not be unreasonable to consider an optimum population figure for the UK in the region of 30 million.

The concept of choosing an optimum population has countless advantages. It enables research to be undertaken on subjects from resources available per head to a visual depiction of a future landscape (BBC 'Set Aside' Panorama[8]).

Recommendations

1). Open debate and discussion on optimum population, in relation to quality of life and population related environmental impact should be encouraged.

2). Education on optimum population levels should be introduced into the school national curriculum. The study of computer projections inter relating with fertility changes should enhance the students understanding of demographic consequences of government policy.

Optimum population studies should be linked to studies on family planning. Students should understand what is meant by a high or low quality of life and how their perception that this could be achieved both for themselves, as individuals, and for the country as a whole.

3). A better understanding of optimum population could help government plan for the future. The setting up of a nation wide land management scheme using a use computer data base such as the one used in (SILSO[6]) would help optimise land use.

6). The concept of a target optimum population for the UK less than the current would help the less developed countries tackle more effectively their own population problem.

7). The research on optimum population should be multi-disciplinary.

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FOOTNOTES

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2. (CAP[2]): **Common Agricultural Policy** of the European Economic Community.
3. (IPPC[3]) : The working group for the **'Intergovernmental Panel on Climate Change'**.
4. (IPSEP[4]) Report: **International Panel for Sustainable energy Paths.**
5. (NFFO[5]): **'Non Fossil Fuel Obligation'**
6. (TPFR [6]): **Total Period Fertility Rate** : Equivalent to the Total Number of children which a woman will have in her lifetime.
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