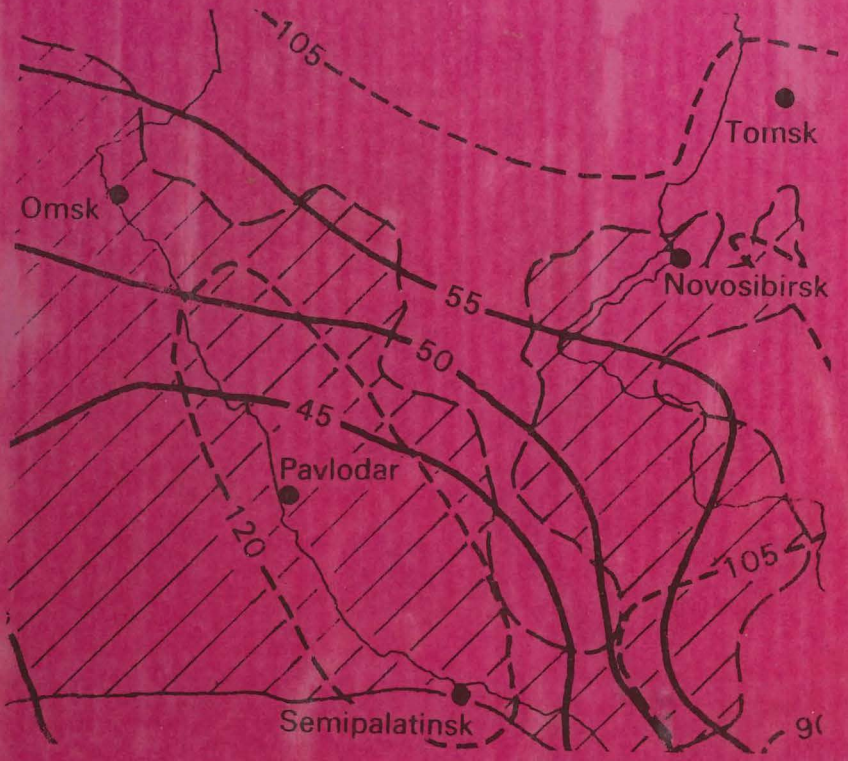
Leslie Symons

The Land-Use Challenge: Eastern and Western Responses



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THE LAND USE CHALLENGE

EASTERN AND WESTERN RESPONSES

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by

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Land is a resource which is neither homogeneous nor finite. The truth of the first part of this proposition is self-evident since the surface of the land varies from swamp to desert and from alluvial plain to high mountain. The truth of the second part is barely less obvious to natural scientists who are aware of the fluctuation of relative levels of land and sea, the mobility of surface strata and the movement in geological times of the continents - phenomena admirably discussed in recent inaugural lectures in this College. (Stephens, 1980: Owen, 1979). For the practical purposes, however, of supporting the human population and land-based fauna and flora, the land area is virtually of fixed dimensions. Reclamation of land from the sea has been one of the most notable achievements of engineers in the Netherlands during several centuries, and their skills have aided similar, though less extensive, reclamation schemes in Britain. Sea and lake margins elsewhere in the world have been pushed back by careful planning and hard work, and modern techniques ensure that such gains shall more than offset marine encroachments. Yet such increases of land area are truly marginal in areal as well as locational terms.

While the land area is almost fixed, the world's human population increases rapidly and, though brought almost to a position of stability in the more developed countries through the operation of birth control practices, elsewhere it soars virtually without check. Every improvement in medicine and hygiene and its dissemination throughout the world, every improvement in the safety of work and travel, every dearly-sought victory for peace in a troubled and violent world, speeds this increase

in the numbers of mankind to be fed and supplied with products derived ultimately from the resources of this planet and its associated envelopes of air and water.

Modification of the familiar graph of population increases and projections for the future produces the picture, shown in Figure 1, of the declining area of land available on average to the individual on a world basis. If population is related to the cultivated land on which we depend for most of the world's food and agriculturally-derived raw materials, we obtain Figure 2. I do not propose to develop a neo-Malthusian thesis (Malthus, 1797) but it is clear that there is no room for complacency on the subject of man's relationship with the

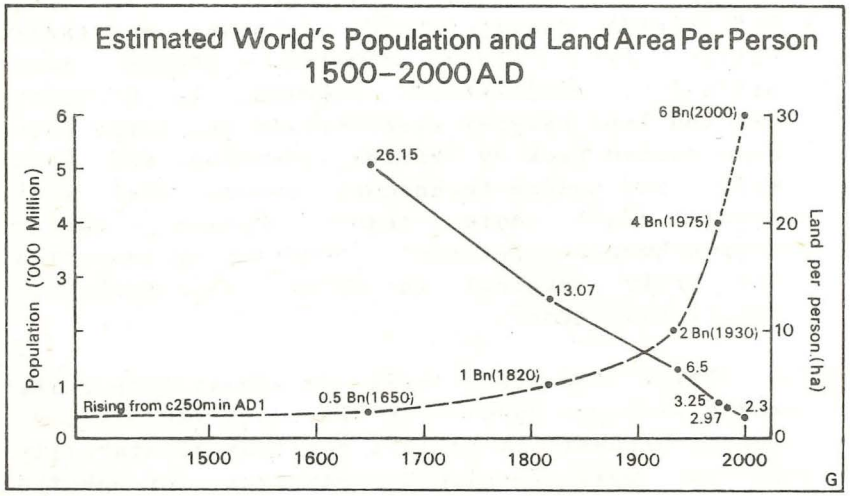

Figure 1
World population and land area(total) per person
Sources: Population: U N Statistical Yearbooks, Borrie, 1970
Land areas: FAO Production Yearbook, Vol.34 1981

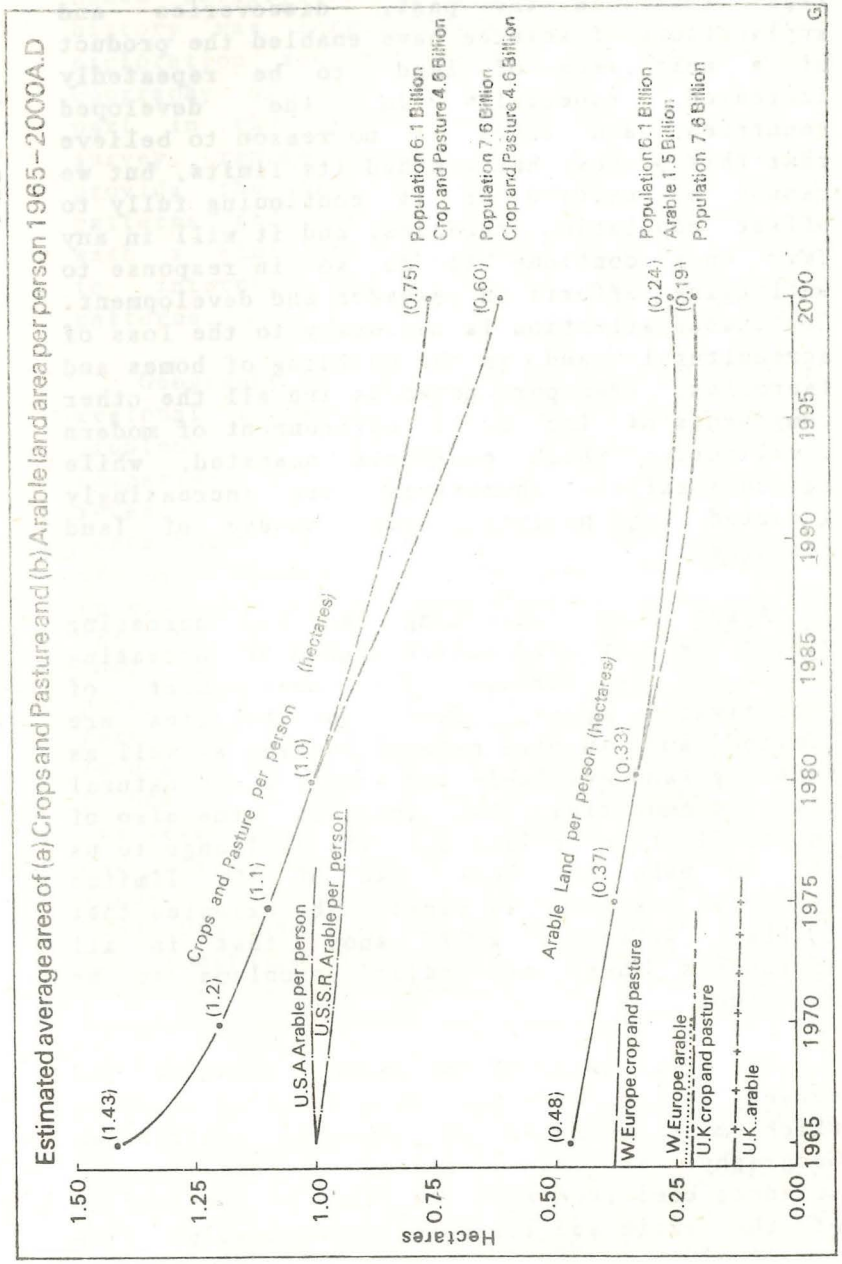

Figure 2. Cultivated land per person, world and selected regional examples. Sources as for Figure 1.

earth, even in terms of numbers alone. It is true that, in the past, discoveries and applications of science have enabled the product of a unit area of land to be repeatedly increased, especially in the developed countries, and there is no reason to believe that this process has reached its limits, but we cannot be certain of it continuing fully to offset population increases, and it will in any case only continue to do so in response to unflagging efforts in research and development. Continuous attention is necessary to the loss of agricultural land in the building of homes and factories, transport networks and all the other components of the built environment of modern civilisation which continues unabated, while agriculturalists themselves are increasingly indicted for pollution and misuse of land resources.

Apart from conserving land and increasing yields the only alternative method of increasing production is through the development of uncultivated areas. Such possibilities are limited and involve natural hazards as well as reducing land available for wildlife and natural plant communities, but this is true also of intensification of land use. The challenge to us all to make the best use of the limited resources available is clear. The examples that I shall introduce will show that in all approaches there are major problems to be overcome.

The evaluation of the earth's resources and society's use of them is a field of study to which many branches of learning contribute. Geography, as the division of the natural sciences concerned with the study of the surface of the earth and its inter-relationships with

human society, is deeply involved. Its early history was largely concerned with discovery, exploration and map-making. The Department of Geography of this College has played a major part in the recent academic development of survey, remote sensing and cartography. These provide the basis of understanding the spatial patterns and variations of man's activities, with a wide range of techniques being employed to interpret and criticise the resulting patterns.

Geography has also been distinguished by its regional approach, analysing the character and problems of particular areas, often in comparison with other parts of the world. In recent years geographical expertise has contributed to the interdisciplinary approaches of Area Studies, and it was the Centre of Russian and East European Studies established at this College that led to my appointment here some twelve years ago. Those of us who are professionally involved in the study of a particular region or country will naturally tend to draw examples from that area when developing a thesis. We shall also be particularly alert for developments in that region in relation to our special systematic fields of study. The value of an Area Studies approach in relation to land use questions may be seen when we consider the contrasts that occur between different societies in their approach to their problems, involving political, economic and historical factors.

In Britain and, indeed, in Europe, response to development questions tends to be of a gradualist kind and the result of the activities and efforts of a large number of individuals. The diffusion of knowledge and the adoption of

innovations and other aspects of decision-making by farmers are among the most popular fields of study chosen by our agricultural geographers for research, with my own colleagues in the Department of Geography well to the fore. But at least one-half of the world's farmers on perhaps one-third of the world's agricultural land are subject to a much greater degree of direction. Where government takes all the major decisions and oversees their implementation the effects on the environment may be both sudden and drastic. This I hope to show by reference to Russian and Soviet experience, seeking to appraise that experience in comparison with developments in countries more familiar - for the Union of Socialist Soviet Republics, though occupying one-sixth of the world's land surface, is still little known to many westerners.

The Russians, dominant in this great and powerful state, have a dark and tragic history, and have evolved, as stressed in another recent inaugural lecture (Woodward, 1981), a passive and fatalistic attitude to their sufferings. This attitude may well have been fashioned in part by the physical environment in which the nation has developed, a physical environment which in turn has suffered from ill-usage and over-ambitious attempts at development. Man and land have developed, not in the beautiful symbiosis imagined by many romantic admirers of peasant societies, but in a grim struggle in which the odds have always been against man's success, physical odds made more onerous by the ignorance and greed of the more powerful people.

This theme is, however, by no means limited to Russia, and as we are increasingly aware of the despoliation of the environment in our own country and elsewhere in the western world, I

shall try to put into perspective some of the activities which are sources of controversy today. For the problems of land use are world-wide, with markedly different societies revealing striking similarities in their problems - similarities which transcend the political differences of capitalist and communist social systems. Yet differences there must be and we shall find them in part in this difference in the organisation of society, in part in the scale of the land, and in part in the physical environment. It is possible here to take only selected examples but I hope that they will illustrate these arguments.

Before considering present-day issues, I wish to recall the response of 18th-century writers and scientists to the challenge of better use of the land which they perceived at a time when modern farming and industrial and scientific developments were making possible material and cultural progress at a speed hitherto unimagined. Geographical knowledge had advanced rapidly during the age of the great discoveries but near the end of the 16th century Mercator was still drawing on the travels of Marco Polo some 300 years earlier and maps remained objects of art rather than of science. During the 17th century, however, charting of coasts became common and in the following century reached high levels of accuracy and even in remote regions progress was spectacular, as for example, James Cook's chart of the coastline of New Zealand (1769-70). On land, commerce had less need of detailed maps but military survey had developed the trigonometrical methods used by Cook. In the British Isles, as the surveyors and cartographers provided the outlines of rivers and roads and laid out new routes, other observers collected data to fill in the

skeletons with information on agrarian and settlement patterns. Observers such as Arthur Young, experienced in the improved farming of the English lowlands, travelled as far as Ireland, reporting in great detail on the husbandry they found (Young, 1780). Literary description was unrivalled for recording land use patterns until the field-by-field mapping of British land use 150 years later by L.D.Stamp and his team of geographers.

State and geography in 18th-century Russia

Isolated from the west by distance, language and religion, Russia's development lagged far behind. Peter I, tsar from 1682 to 1725, however, was a man who would accept any challenge and he established a strong state with industrial development in the north-central and Ural regions and a new capital, St. Petersburg. The area under Russian control, already including all of Siberia, was further enlarged but the resources of this vast territory were little known and even its dimensions, towns and villages were only sketchily mapped. Peter initiated systematic mapping (Fel', 1960) and laid the foundations of the Academy of Sciences. In this, a geography department was founded and the leadership entrusted to a man who had already proved himself an outstanding scientist, yet who is now perhaps known chiefly for his literary works and his synthesis of the Russian language (Woodward, 1981,8), Mikhail Vasil'evich Lomonosov.

Born in 1711, the son of a peasant family of the Arkhangel'sk region of northern Russia, Lomonosov, having succeeded in gaining entry to higher education, normally denied to peasants,

was sent to Germany to widen his knowledge and later became a member of the staff of the Academy in St. Petersburg. After being entrusted with the development of geography in 1758 he became deeply involved in the production of atlases and surveys of Russia. Much of the information which was collected on the location, features and resources of towns and villages, was derived from questionnaires (Dik, 1961). Thus, the state assumed the main responsibility for a task which in Britain was largely dealt with by the learned societies and private individuals. Lomonosov was, however, no mere gatherer of information. He contributed valuable original work in physical geography, especially in soil science, in which he prepared the way for the Russian founding of modern soil science under V. V. Dokuchayev in the next century. Lomonosov was also particularly interested in meteorology and this was linked with aeronautical aspirations. His model helicopters were probably the most advanced designs of their time and are believed to have achieved flight.

Russian society was at this time in disarray and the focus of discontent was the land. Serfdom was at its most onerous and more than one-half of the population were more or less enslaved. Landlords thus enjoyed almost free labour, there was little necessity for them to improve their estates and even less incentive for the serfs to produce more since most of the benefits would accrue to the landlord. It was a classic case of the operation in an agrarian society of the surplus product of labour benefiting the owner of the land and the capital, though Marx had not yet appeared on the scene to systematise the thesis.

Discontent led to the greatest of the Russian peasant rebellions (1773-75), led by Pugachev, who proclaimed the abolition of serfdom and appropriation of the land for the peasants some ninety years before Alexander II's Edict of Emancipation actually began a tardy reform. There was recurrent famine, commonly most serious in the fertile central black-earth region - on the chernozem soils to which Lomonosov gave much detailed attention. There was, however, no shortage of land in the Russian empire, which was still expanding.

In Russia, as in the contemporary America, the frontiers of cultivation were for ever being pushed outward. The Tatars had been subdued and the Ukrainian and southern Russian steppes could be colonised and developed for cattle and wheat. From these areas, through the Black Sea ports, were later to come great quantities of grain for the growing towns of industrial Britain. Because of serfdom, not enough peasants could migrate to cultivate the new lands, though many ran away from the old Russian areas on penalty of death or at least a flogging, to the south or to a Siberia that was for them still a land of freedom - though the chains were already being wrought for the exiles and prisoners who would be deported through the centuries under the 'katorga' system

The contemporary response in Britain and comparison with Russia

In England agricultural improvement was advancing rapidly at this time, stimulated by the improvements already effected in the Low Countries. The friction of distance is evident when comparison is made between the well-limed

fertile fields of 18th-century southern England and the unimproved and war-torn Scottish Highlands. Yet innovative ideas could spread quickly in a land that was relatively small - a man could travel by horse or even by stage coach from London to the north of Scotland in 3-4 days (Bates, 1969), whereas in Russia tenfold greater distances were exacerbated by the lack of roads so that most long journeys had to be by the hazardous rivers which claimed innumerable lives (Armstrong, 1965, 32-38).

In Britain there were two main responses to the increased demands for land consequent upon rapidly rising urban populations. The one we like to remember was the improvement movement. One we would prefer to forget was the legalised seizure of the clan and crofting lands of the Highlands, to the order of the Dutch and German kings of England, albeit enthusiastically supported by some Scots, and the acquisition by the English textile barons of the grazings of southern Scotland for sheep pasturage. Displaced crofters and cottars were resettled on barren coasts of the West Highlands to collect kelp for the chemical industry or were sent by the shipload to the colonies. New lands there were in plenty in the colonies, but their exploitation was only for the bravest adventurers - apart from those who were despatched with little or no choice. For Russia it was quite different, the colonies were not spatially detached from the cultural hearth of eastern and southern Slavs, the seemingly limitless steppes always offered another place for settlement at or beyond the horizon, and even the mountains - the Urals - offered no serious barrier to the fur traders and cossacks who led the way into Siberia, or the peasants who followed.

Soviet responses to agricultural production problems

There were limits even to the Russian Empire and, as successors to the tsars, Soviet leaders were to find that obtaining sufficient production from the land was a constant problem. In an attempt to ensure adequate grain supplies for the cities Stalin enforced collectivisation from 1928 (Davies, 1980) but peasant resistance resulted in greater shortages. By 1941 the collective farms had been reorganised and modernised sufficiently for the Soviet Union to survive the war, but loss of manpower and lack of investment resulted in drastic deterioration of their productive capacity.

As an illustration of how eastern responses to the land use challenge differ from those of the west, I could elaborate on the form of the collective system. I have not chosen to do this because it has been scrutinised, analysed and assessed in many detailed studies (for example, Laird and Crowley (eds), 1965: Hahn, 1970). A few recent writers have given more credit to the system, balancing its failures with its successes in markedly increasing gross output (Millar, 1980: Shaffer, 1980) but the majority of western studies have been highly critical. In this lecture I wish to elaborate on one aspect of Soviet land development - the virgin lands scheme.

After the death of Stalin in 1953 the agricultural production situation, exacerbated by the lack of incentives to farmworkers, was acute. The produce of the cultivated land - limited to about ten per cent of the USSR by climate and relief - was inadequate for the

proper feeding and raw material supply of the growing population. Famine had been banished, but Khrushchev recognised the need to free the Soviet citizen from Stalin's overwhelming dedication to industrialisation. Khrushchev was essentially a liberaliser and a populist (Breslauer, 1980). He judged it time to provide more milk, more meat, more fruit and vegetables, more modest luxuries. He was by no means unaware of the potential for intensification of production on the fertile lands of the Ukraine and the non-chernozem soils of central Russia but to him the great challenge in Soviet land use and food production lay in the vast areas of virgin and idle lands in west Siberia, Kazakhstan and other areas east of the Urals.

Surveying and mapping must precede land development. I doubt if any scientist would disagree with that statement but politicians tend to think that development cannot wait, or at least that any survey must be completed so quickly that it may well be only superficial. Khrushchev sent many surveyors into the virgin lands to measure areas, lay out the lines of roads and the light railways that formed a network over the natural grasslands that were to give way to the plough. There were also special soil surveys but it seems that they were commissioned only to provide evidence in support of political decisions already taken. Some were carried out when snow blanketed the land and blizzards made the steppes almost untenable (McCauley, 1976, 170). There is little evidence of study of the climatic fluctuations, an appalling omission where the regions concerned were known to suffer from low humidity resulting from a dangerous combination of summer warmth and low precipitation together with short frost-free periods (Figures 3 and 4).

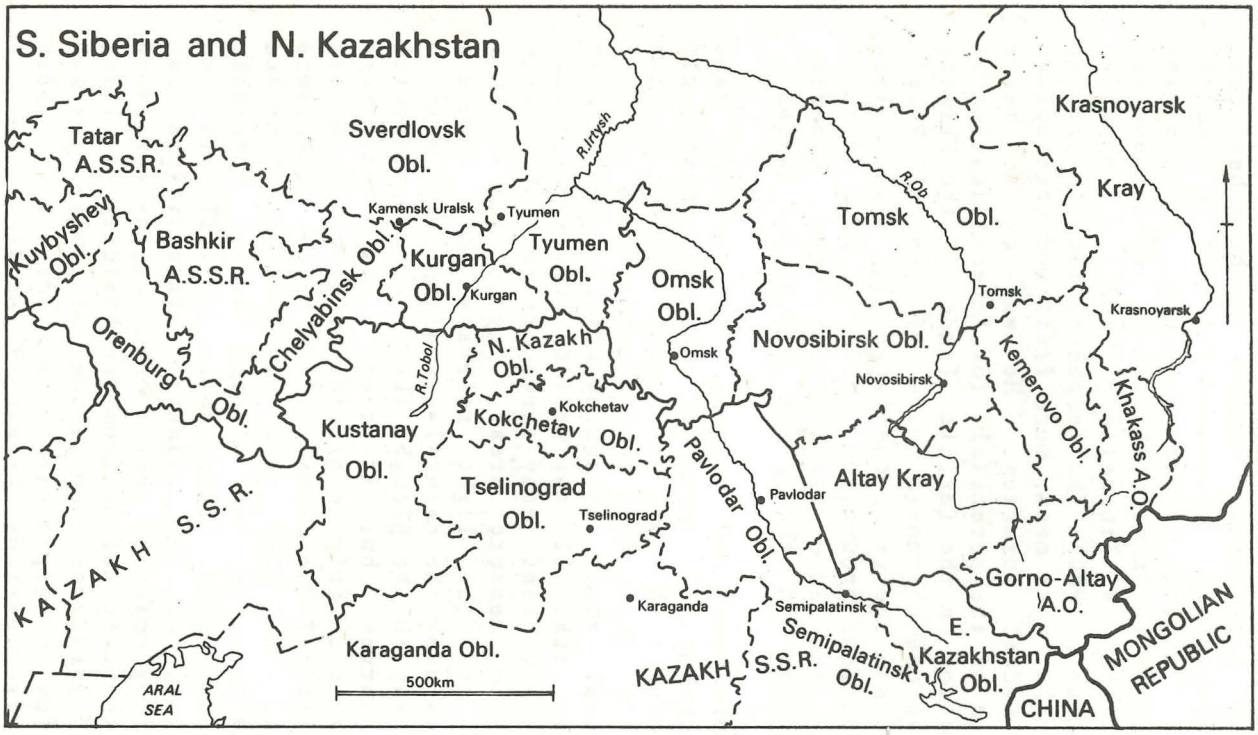

Figure 3. The Virgin Lands - Administrative Areas.
Source: Atlas SSSR and others.

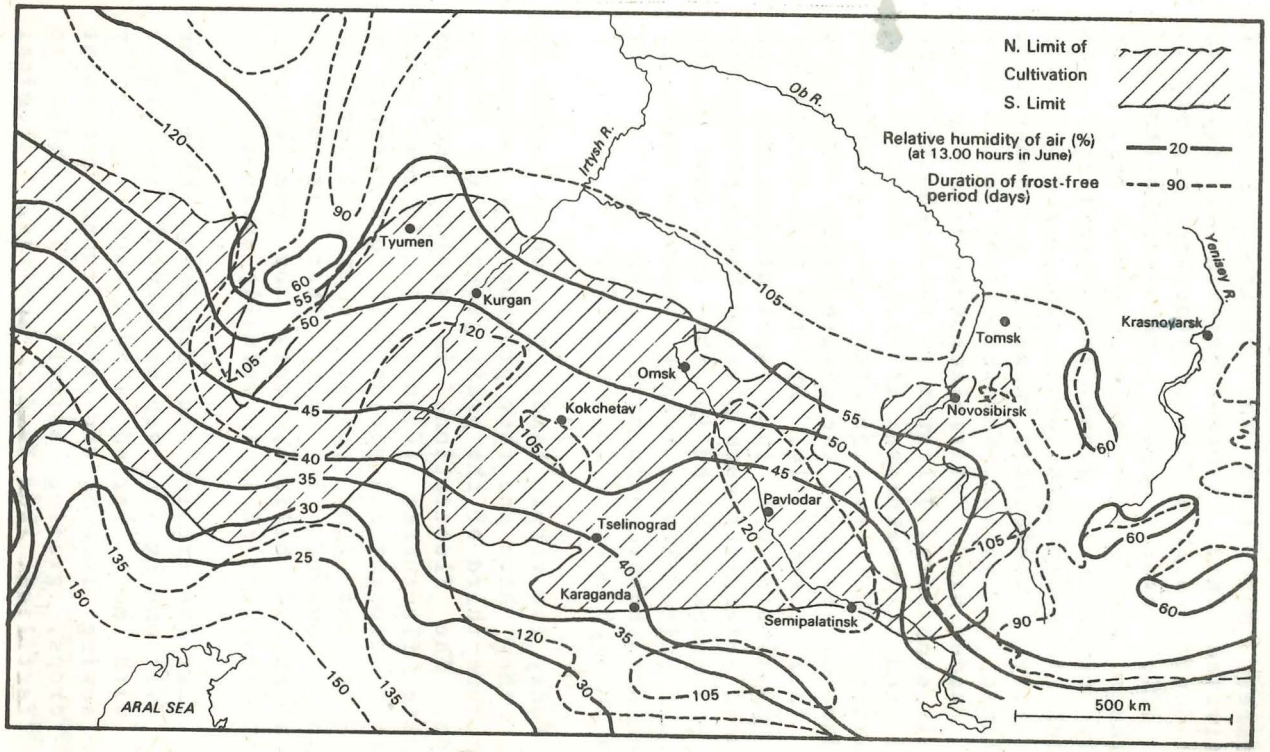

Figure 4. Virgin land area geographical characteristics.
Source: Atlas SSSR and others.
Smaller cultivated areas occur outside the main belt.

Between 1954 and 1964 an area of 35 million hectares, more than the whole of the area of cultivated land in Great Britain, was added to the Soviet arable area by ploughing the virgin and idle lands, mainly in Kazakhstan and southern Siberia (McCauley, 1976, 85). The early results are widely known, initially high yields, then droughts, depletion of accrued soil fertility, accelerated erosion and consequent collapse of yields. Khrushchev was ousted from the leadership. Politicians were learning that it is necessary to listen to those who know the land and its weaknesses if use is not to end in disaster. What is important for agricultural production is that the virgin lands scheme did not fail permanently. By the time Khrushchev was pensioned off the agriculturalists and natural scientists were already being allowed to apply lessons acquired in the dust bowl of the western United States twenty years earlier, on which Khrushchev could have drawn had he not been in such a hurry (Symons, 1972).

Today the virgin lands produce as highly as ever they have and they provide, on average, over one-third of the grain grown in the Soviet Union. The fluctuations in yields remain as climate fluctuates (Figure 5). In some years there is drought and yields fall to a quarter or less of the good years. The overall level of output, however, is such that it can be explained, I believe, only by one of two hypotheses, not entirely mutually exclusive:

(1) that the erosion and depletion have been overcome by improved management techniques with more varied land use, especially sowing lucerne and other drought-resistant crops, grazing animals which helps to fertilise the land, applying chemical

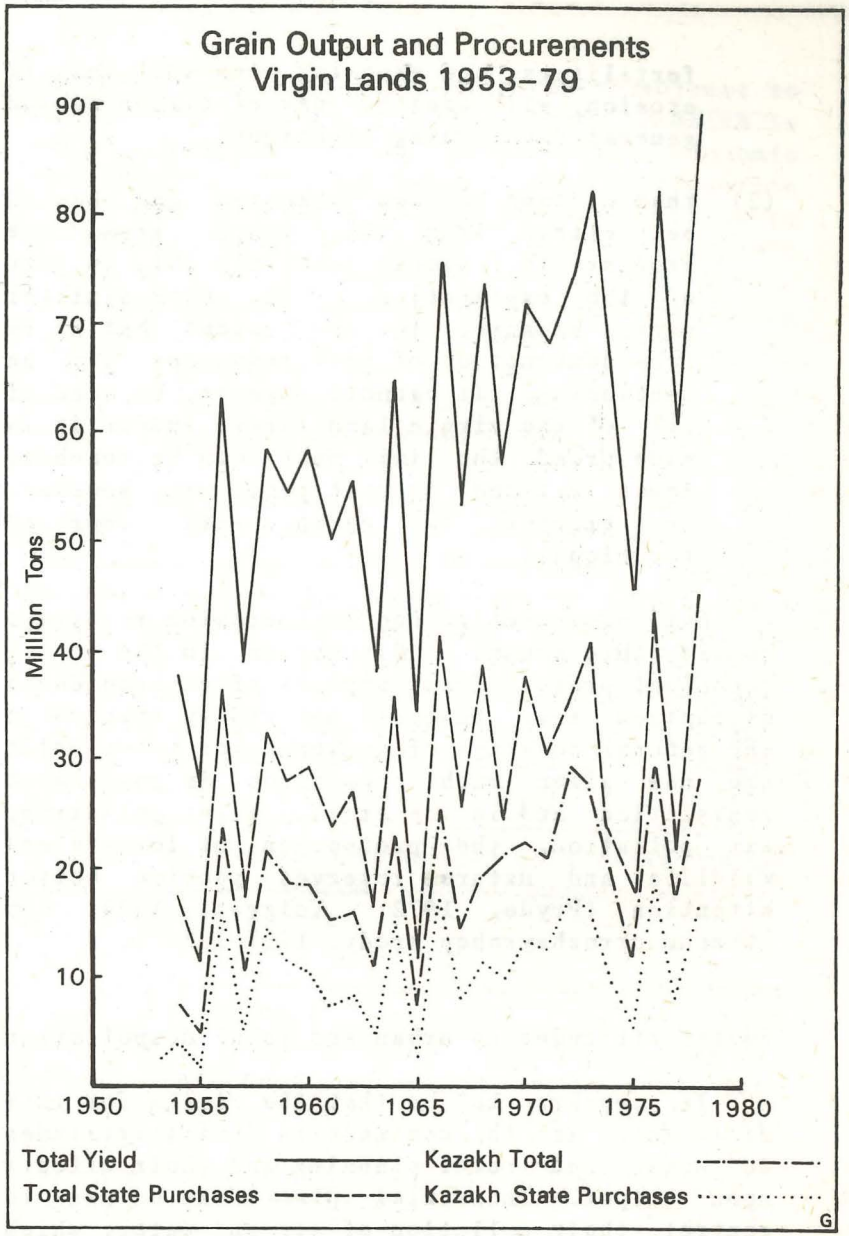

Figure 5. Grain yields in virgin land areas
Source: Narodnoye Khozyaystvo SSSR, various years.

fertilisers, and exposing the soil less to erosion, with greater use of fallowing and general dry-farming techniques.

(2) that as land becomes exhausted and has to be retired from use, other areas are brought in. Almost certainly this is part of the explanation - the more sinister part, because, to the extent that it is true destruction of soil resources may be continuing. It cannot, however, be true of all of the virgin land farms, and if it is widespread the limit must soon be reached. Areas 'retired' in past years may, however, be brought in again with improved techniques.

Soil conservation and soil erosion receive a considerable amount of discussion in the Soviet technical press. These aspects of environmental disruption are, however, not widely treated in the general coverage of conservation needs which are now given much prominence in government legislation and in the press. Water pollution, air pollution, the protection of forests and wildlife and nature reserves receive better attention (Pryde, 1972: Volgyes, 1974: 'Ob okhrane okruzhayschey sredy, 1917-1978').

Soviet attitudes to urban and rural despoliation

It appears to me that the reason for this difference is the contrast in Soviet attitudes to urban and rural planning and their effects upon output. Industrial plants can be made to control their pollution of air and water, which is relatively visible to the city dweller and politically unwelcome to the city soviets. Indeed, the relocation of noxious industries

outside city limits is a necessary adjunct to present-day planning, the acceptance of which is central to Soviet political and economic philosophy. Maximisation of production undoubtedly results in tolerance of pollution to an undesirable extent, though probably no more than in most western societies, and almost certainly less than in most industrialising countries of the Third World. The will to control pollution and improve the urban and suburban environment is now fairly strong in the Soviet Union (Pallot and Shaw, 1981).

The agricultural lands are different. The urban dweller sees little of them and does not understand much of what he does see. Nothing, however, annoys the average Soviet citizen more than the perennial shortage of meat in the shops, so he is unlikely to get enthusiastic at the idea of limiting production in the interests of conservation. The government is particularly vulnerable to international currency problems in its purchase of grain from overseas so this will be limited to the essential. Excessive reliance on imports is also discouraged by limitations of the transport system which hinder movement inland from the ports.

Therefore, Soviet five-year and annual plans alike are virtually entirely concerned with production. I have seen no suggestions in Soviet literature, popular or scientific, that the extension of farming should be curbed in the interests of conservation.

Conflict between conservation and farming interests in the West

In 'western' developed countries there is increasing antipathy between agricultural and urban interests. This has been particularly marked in North America but has been evident in recent years in Britain. Such criticisms of the agricultural industry are probably only possible given the urban dominance of these countries. In the United Kingdom, under two per cent of the population depend upon agriculture for a living. To most urban dwellers the countryside is now a place in which to seek recreation and pleasure: for many, sadly, an alien environment in which many citizens think they have rights to do as they please - and whose dogs may do likewise! Vandalism is one of the newer costs to farmers, but the environmentalist and conservationist lobbies are also becoming disliked and even feared in farming circles. The antipathy that began with criticism of the use of sprays and other chemicals has now broadened to encompass almost every facet of present-day agricultural production. Illustration of this growing antagonism between the conservationist and agricultural interests is well seen in the controversy over Sites of Special Scientific Interest defined by the Nature Conservancy Council. A total area of about 1.3 million hectares, 5.5 per cent of Britain's surface area, is involved in these sites. There has been delimitation of 170 National Nature Reserves (134,000 hectares), 735 'Key Sites' (approximately one million hectares), and 3,900 Sites of Special Scientific Interest (about 1.25 million hectares).

Individual sites vary from 0.4 hectare (one acre) to 26,000 hectares. There are no publicly

available lists to reveal the whereabouts of the sites because the Nature Conservancy could not control public access to them and, since most of the SSSIs are on private land, it can be argued that the owners also do not wish them to be advertised. Friction sometimes arises between the Nature Conservancy Council and farmers because of the limitation of activities which the Council seeks to impose on the owners. Furthermore, anyone who sells land with such a site on it has no statutory obligation to tell the purchaser that it is so designated, so a site could be damaged simply through the owner not knowing of its designation. During the past year the problems have been aired as a result of the Countryside Bill in which the Council sought more controls over sites while farming interests have become increasingly critical of attempts to restrict their use of land (Farmers Weekly, 20.2.81, 20.3.81, 22.5.81, 14.8.81).

In the case of nature conservation sites, the individual farmer, though living on the land, may find it difficult to understand the importance of a small patch of woodland or fen in the overall pattern of conservation. Guidance, or to put it bluntly, interference with land owned by another, may be completely justified on scientific grounds and may have very beneficial results provided the objectives are pursued with tact and understanding, backed, where necessary, by cash, so that farmers are not themselves required to stand the full cost of preserving and not developing a piece of land, but only the politicians can approve the necessary expenditure from public funds.

Less clear cut is the fundamental question of production methods. Farming in Britain enjoys, on the whole, good markets and, under

the umbrella of the Common Agricultural Policy, virtually unlimited guaranteed disposal of products. This is, of course, achieved at enormous cost to British tax-payers and consumers and is inherently damaging to other more competitive systems. There are strong incentives to achieve high production of crops readily marketed within the system. Most of the surpluses thereby produced are unhappily inaccessible to and unsuitable for the needs of the hungry countries of the Third World. In the USA the system is different but there are again protected markets and farmers feel relatively little of the chill winds of international competition. But cost-consciousness is prevalent throughout the world of commercial farming and good profits depend on high productivity and sound, uniform crops with moderate rather than minimum outlays. Except where immune varieties can be developed the input-output equation makes it almost mandatory to use a wide range of chemical inputs - fertilisers, pesticides, herbicides, defoliants, etc. The townsman, in general, stands opposed to the chemicalisation of farming, but knows too little to be able to exert control or indeed even to understand where and when control is essential or at least desirable. There is, therefore, much unthinking criticism of farming, though it is also true that many farmers have rather an uncritical attitude to the claims of the manufacturers of chemicals and spraying equipment.

The response to the problems created by pests and diseases in the USSR and Eastern Europe is basically similar to that in the west. The main difference is that the USA and Western Europe are far in advance in the number and range of chemicals and types of sprayers

available and to that extent the dangers to which the land is exposed are greater in the west. On the other hand, crops are better safeguarded, yields are better, quality is higher in the west - to no small extent because of this greater chemicalisation. It is common, especially in the USA, to blame the failures of Soviet agriculture almost entirely on the collective system. Not only is little regard paid to the additional hazards of the climates of Russia and Siberia, but the different levels of inputs, especially of chemicals, is almost always disregarded. We must recognise that in the present state of knowledge, if we want maximum yields and minimum blemishes, we shall have to accept chemical farming. There are, however, great risks, notably from the emergence of resistant strains, and fungicides, used especially in controlling barley mildew and other cereal diseases are particularly under suspicion. The challenge is how to limit and control applications to the most desirable level, balancing environmental risks with production. This is easier to talk about than to achieve. Few townsfolk have any idea of the range or intensity of pests and diseases with which the farmer has to contend. Much more research is needed and geographers are among those who have yet to offer their techniques as widely as they could to help solve these environmental problems.

Aerial application of chemicals

Particularly controversial is the application of chemicals from aircraft. This is a technological advance that is rapidly becoming a normal form of mechanisation in British farming. It has long been so on the croplands

of the USA and the USSR and the tussock grasslands of New Zealand, where aerial application of fertiliser and grass seed was pioneered in the 1950s. Aerial application is particularly controversial because of the alleged lack of control and accuracy and consequent hazards to the environment. It is also extensively used for forest-pest control and it was, indeed, in the attack on the spruce budworm in Canada that it was discovered that chemicals such as DDT, persistent in soils, were severely endangering wildlife, leading to strict control over their use (Mastromatteo, 1969: Gunn and Stevens, 1976).

As with almost every technological development, there are good and bad results to be seen in aerial application. It is not possible to generalise. In geographical and natural science circles I think it safe to assume that most attitudes towards aerial application will be negative. Therefore, I propose to use the limited time available for this subject mainly to indicate some of the less recognised positive benefits.

Aerial application has one major advantage for the farmer (which may be seen as a disadvantage by those who object to its use). It is exceedingly quick - typically about 20 times as fast as application by ground machines. One aircraft can deal with up to or over 20,000 ha (the average for Australia and New Zealand) in one year (ECE, 1981,141). The risk of drift of toxic chemicals on to surrounding areas may be slightly higher than with ground machinery. Offsetting this is the much greater strictness exercised by government authorities - in Britain, the Ministry of Agriculture, Fisheries and Food - over the chemicals that may be used

from the air. Also, the firms applying the chemicals are specialists and know much more about their use than does the average farmer. Another point favourable to aerial application is that much smaller volumes may be used owing to the better dispersal of the spray among the crop than with most ground-based sprayers. Finally, it may also be relevant to point out that when a farmer contracts to have his land sprayed from the air he is committing a considerable sum of money and is not likely to do this as lightly as he might employ his own labour. No farmer will pay out perhaps thousands of pounds for a single job unless he is fairly certain that the need is acute!

In the Soviet Union, aerial application has extended to over 90 million hectares per annum for the past three years (N.Kh. SSSR 1979, 350: Voz. Trans., 16.8.80). This is about 36 per cent of all land treated from the air, with a further 28 per cent being in the USA so these two countries dominate aerial application in volume terms (ECE,1981). Though pesticides, fungicides and defoliants are applied in the USSR, much more of the aerial work is putting on fertilisers than is the case in Britain or the USA. This is because of the wetness of fields in the USSR after the snow cover has melted in the spring, preventing machinery from getting on to the land when fertiliser is most needed, together with the large size of fields and farms which facilitates aerial work. As with other chemicals, the application by air should really only be controversial insofar as the use of mineral fertilisers is to be regarded as fundamentally undesirable. Few go this far when food in reliable quantities and at reasonable prices is required for ever-growing world needs

but resulting pollution of land and water should not be ignored.

The challenge to make good use of land extends to grazings which cannot be cultivated owing to steepness or remoteness of terrain. In New Zealand the tussock grasslands simply could not be improved until aircraft, at first war surplus machines, could be pressed into use for application of superphosphate, a development described as a revolution in land use paralleled in New Zealand only by the introduction of improved management systems (Stephens, 1976). A less spectacular but similarly widespread problem exists in Britain with control of bracken on hill gazings. About 200,000 hectares in Scotland alone are infested with this fern and it is also a major handicap to hill farming in Wales. Much of the land is inaccessible to ground machinery, thus ruling out ploughing and other mechanical control of the bracken. Bracken, however, grows on the more fertile hill land, of especially high importance on hill farms because of its role in wintering stock as well as for lambing and fattening animals. It is not widely realised that in addition to neutralising grazing areas bracken is a poisonous weed (WRO, 1976). It has carcinogenic properties proved to affect cattle especially. It also harbours the sheep tick which is a major problem on many hill farms, particularly in the north and west of Britain.

It is the development of the helicopter which has revolutionised the prospects for improving this type of land by applying asulam or other compounds which attack the plant through its rhizomes and, when these are followed by fertilising and controlled grazing, it is possible to achieve very successful

results. The helicopter provides the essential tool because it can operate from any small patch of flat ground to which the necessary chemicals and fuel can be transported, and is sufficiently manoeuverable to deal with areas as small as one or two hectares, getting in close to rock outcrops, walls, hedges, etc.

International campaigns against pests

The challenge to agricultural land use is, in some parts of the world, on a scale unknown in Europe. Natural hazards such as drought, hurricane and flood are added to by the insect and other biotic depredators that attack man, his crops and animals on the continental scale and here, especially, the speed and range of aircraft are of inestimable value. The Russians began to use aircraft to attack locust invasions in Central Asia and Iran in the 1920s, and, in 1945, collaboration in the Persian Gulf area between the Royal Air Force and the Soviet authorities (Rainey, 1976) led to the proving of radar as a valuable tool in the airborne campaign against the desert locust. Trials were also carried out in Kenya and Tanganyika and in 1949 the International Red Locust Control Organisation was founded and soon afterwards made a decisive switch from ground to aerial methods of control. One of the most useful aircraft ever produced for service in the Third World and remote areas, the Islander, built by Pilatus-Britten-Norman in the Isle of Wight, is part of the fleet of the Desert Locust Control Organisation based in Kenya. Such aircraft can be used for transport as well as for crop protection and other spraying duties (Symons, 1981).

Particularly important also in Africa and other regions of the Third World are the public health aerial spraying campaigns against diseases carried by insect vectors. One of the most promising operations, which is also an outstanding example of effective international co-operation, is that directed against river blindness (onchocerciasis) which is endemic in the Volta River Basin (Figure 6). It is estimated that over one million people are affected by the disease and about 100,000 have become virtually blind. In addition to the large-scale suffering, this means that they are unable to cultivate their land and become dependent on others. Over one million hectares have been abandoned for this reason (ECE, 1981, 8). The disease is carried by the blackfly (Simulium damnosum) which lays its eggs on vegetation, rocks and flotsam at the water level and larvae may be found to depths of 30-40 cm. Very small quantities of insecticide are effective but the breeding grounds are largely inaccessible and the areas involved so great that aircraft are essential for spraying. The programme covers about 700,000 sq. km. and at least 14,000 km. of the river system (Parker, 1976).

The Northern Forests

In the great boreal forests also, aircraft are the only means of access for pest control and fire-fighting. The campaign against the spruce budworm in Canada remains controversial, the use of pesticides being fiercely contested by those who believe in letting the biological cycle run its course, despite the great loss of standing timber that this would involve, but the fire-fighting operations are opposed only by a

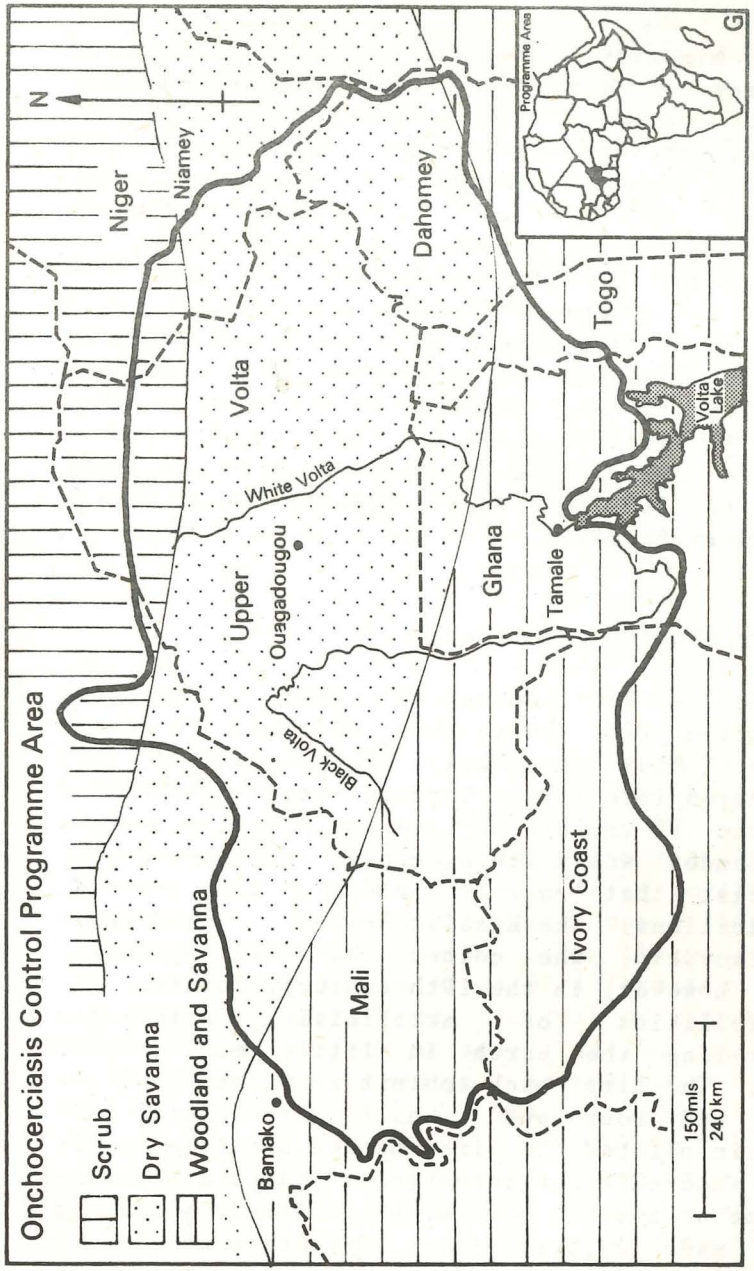

Figure 6. The area covered by the international onchocerciasis control scheme.

small minority. The destruction of millions of hectares of timber by fire occurs from both natural causes, such as drought and lightning strike, and from carelessness by tourists. The use of spotter aircraft, a fleet of water bombers and aircraft applying chemical retardants keep a measure of control in Canada and several European countries. In the USSR there is a lack of adequate and suitable lakes for the water bombers to be fully effective so greater reliance is placed on other methods, including ground teams, but to position them aircraft are essential and the big helicopters, in the construction of which the USSR can claim to have led the world, provide the essential transport facility.

Remote sensing from spacecraft

For a few moments I wish to transfer attention from the earth's envelope to outer space. When the Nazis introduced a new dimension into terror bombing with the launching of the V2 rockets in 1944 the civilian targets in London would not have been impressed by any forecast that rockets could also have peaceful applications. The Russian scientist, Konstantin Tsiolkovskiy, who coined the work 'sputnik', had, however, in the 19th century, foreseen the possibilities of artificial satellites encircling the earth in little more than an hour. The first such sputnik went into orbit in 1957 and four and a half years later Yuri Gagarin piloted the first manned spacecraft. In the succeeding twenty years satellites have become an awesome part of the military scene and have made possible almost instantaneous viewing through television of events on the other side of the world. They have also provided a new

tool for the examination of the land-use patterns of the world. The USA's National Aeronautics and Space Administration's first Earth Resources Technology Satellite was launched in 1972 and was renamed Landsat I in 1975, and shortly afterwards Landsat II was placed in orbit.

It is not possible here to describe either the capabilities or achievements of the Landsat series in any but the briefest terms. Suffice to say that Landsat orbits the earth 14 times each day on a progressive trajectory so that it covers most parts of the earth on an 18-day cycle. It records images and transmits them to earth-based receiving stations for recording on to magnetic tape and later reconstruction into images that resemble photographs on black and white or infra-red (false colour) film. For the interpretation of land use the latter is much the most important. From Landsat we can obtain regular pictures of almost all parts of the world, though cloud cover limits practical availability. The resulting generalised views are of great interest and some scientific value.

Recording the long-term changes in the cultivated area or destruction of large areas of forest are well within the capability of Landsat, the main problems being the processing of the immense quantities of information being relayed to earth and the cost of manpower to interpret it - for at some stage man must take over from the computer. As one comes to look for greater detail so Landsat is found to be lacking. The spatial resolution limits representation to a square of approximately 80m, i.e. it is impossible to identify an area smaller than that, and in areas of relatively homogeneous character the minimum resolution is

about three times greater. Hence Landsat can monitor only major changes such as the progress of a new motorway, railway, airport, or a major forest fire. The detail of small fields in Wales for example, cannot be seen, even when cloud cover is obligingly absent when the satellite passes over. The great fields of the Soviet Union, however, can be distinguished, and the progress of crops within them can be monitored. The Americans claim that they can predict Soviet crop yields more closely than the Russians can, though I doubt this, for ground control is all-important for interpretation. In any case, the Soviet Union has ample opportunities for recording its own territories even though it does not operate an internationally available service like that of Landsat.

In time, greater detail will become available from satellites. A new radar (microwave) imager built for the US Defence Meteorological Satellite Programme can 'see' through clouds and will be able to map such features as ice coverage and determine ground moisture content. (Flight International, 29.8.81). For most purposes, however, conventional air photography is still the most practical form of airborne remote sensing. The technical problems of air photography have been largely overcome, the two things that hinder its more extensive use are cost and secrecy. British authorities are among the least generous when it comes to making available the results of aerial surveys flown for official purposes, even when totally unrelated to defence. In general terms, however, remote sensing offers the key to the solution of many problems in world land use, when allied to appropriate survey and investigation on the ground.

I have deliberately spent some time on aerial aids to land utilisation because they are aids distinctive to the present day and promising for the future. I wonder what Lomonosov would think of all these uses for flying machines such as he envisaged and tried to model in St. Petersburg over two hundred years ago? I imagine that he would be fascinated and very pleased to feel that man had conquered the air and, to some extent, outer space as well and that these impressive achievements of this century were being employed in the development of land and in other ways beneficial to mankind. Sadly, however, we are all too fully aware that peaceful applications have to depend on the crumbs that fall from the tables of the generals, whether Russian, American or other.

Conclusion

It is apparent that through the centuries the land-use challenge has provoked many different responses from man, sometimes patient and gradual, sometimes hasty and ill-considered. Even well-intentioned schemes may produce conflicts because of the varying interests of different individuals and groups, and these are likely to become more intense as pressure increases on available land resources. In the west, government tends to be passive, exercising some control but rarely initiating major actions on the land, though there are exceptions such as airport development and urban and industrial expansion. In the USSR, immense landscape changes may result from central planning. All farmers, in the west as well as in the east, are liable to make decisions, in search of greater profitability, which are in the long run harmful to the land and environment. In the west they

are more vulnerable to public criticism, but the urbanised public tends to underestimate the farmer's problems, such as the realities of adverse climate, pests and diseases and the dilemmas faced in counteracting them and ensuring adequate and good quality produce. The scale of the problems varies in different countries and in a small and comparatively benign environment it is easy to underestimate the difficulties encountered in harsher lands.

There is no easy solution to these problems, the combination of natural and cultural factors in land-use problems produces exceedingly complex situations. To unravel them we need to exploit all our scientific resources. In our service we have aids that could not have been visualised by Lomonosov and his contemporaries 250 years ago, some that could hardly have been foreseen 25 years ago. But to make the most of the newest aids, like satellite-borne remote sensing, we shall have to continue with the oldest methods such as field survey and experimentation. The complexity of the task demands maximum co-operation and I trust that the difficulties which stem from its very nature will not always be made yet more difficult by governments bent on short-term economies and political objectives. If scientists are not frustrated in such ways, if the world-wide drift to the cities does not result in the collapse of rural infrastructures and the excessive growth of the built-up area, if trade patterns are not so distorted by political blocs that production becomes excessively concerned with unwanted goods, if the control of pests and diseases and the application of fertilisers and other chemicals can be controlled at a level below that which will cause serious pollution, if birth control practices can be extended

adequately to the Third World, then we and our children need not fear severe shortages of food and raw materials. As each of these provisos - and many others might be cited - fails to be met, so the shrinking area of land available per person will become a greater threat to the quality of life and the stability of societies.

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