T R I A D

NEEDS ANALYSIS SUPPLEMENT

to the final report on

A Preliminary Design

of an

Earth Resources Survey System

ASEE-NASA Langley Research Center
Old Dominion College Research Foundation

1969 Summer Faculty Fellowship Program
in Engineering Systems Design

NASA CONTRACT
NSR 47-003-010

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ABSTRACT

The analysis of societal needs within the context of earth resources is carried out by the consideration of such world problems as pollution, energy resources, transportation, conservation, disaster detection, population density, hunger, urban and rural land use, legal and political conflicts, and educational methods as well as the examination of such existing desciplines as agriculture, forestry, geology, geography, geodesy, cartography, oceanography, and hydrology.

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FOREWORD

This document represents a series of supporting papers that supplement the final report on the preliminary design of an operational earth resources survey system, as prepared by the ASEE-NASA 1969 Summer Faculty Engineering Systems Design Group. These appendices formed the nucleus of the needs analysis phase of the summer study and reflect the multidisciplinary approach of the 20-man group of social scientists, physical scientists, and engineers. This needs analysis phase was carried out by two 10-man subgroups, called the AD group and the AE group.

a) Assignments to the AD and AE groups

1. The Ad group was assigned the task of delineating the social and economic problems pertinent to the survival and progress of civilization in relation to total earth resources. More specifically, the group was expected to do a broad range investigation of present and future needs for food, raw materials, power, and conservation. During the preliminary phase, it was understood that constraints imposed by current technological limitations were to be ignored.

2. The major charge of the AE group was to define the useful applications and the measurement potential of the remote sensors. The group was instructed that no feasibility constraints should be imposed in this initial phase and that the useful applications should not be restricted by user disciplines. Two facts soon became obvious: (1) basic needs crossed discipline boundaries, and (2) certain needs were shared by disciplines. It was thus decided that the group should be subdivided into four study groups. These groups were to investigate the needs from the users' viewpoint in the following areas: (1) Agriculture and Forestry, (2) Geology, Cartography, Geography and Geodetics, (3) Oceanography and Hydrology, and (4) Land Use, Urban Development and Population Density.

b) Methods of Organization of AD and AE groups

1. During this preliminary stage of needs analysis, little or no organizational structure was imposed upon the AD group. Through group discussion a lengthy list of specific problem areas and needs were enumerated. Recognizing that some problems fall within the content area of two or more disciplines and that other problems are not studied thoroughly by

any recognized discipline, the group chose to organize its work from a problematic rather than a disciplinary viewpoint. Problems were grouped into a series of categories and assignments for more detailed investigations agreed upon. For example, two persons were assigned the task of developing a systems analysis design based on a global ecological model. Another member of the group wrote a paper questioning the legitimacy of additional data collection in face of the fact that many societal problems remain unsolved even when adequate data is available.

2. In an attempt to consolidate the AE group efforts, it was decided that the results should be compiled in a somewhat standard outline format. This outline was to contain the following information: (1) General discipline, (2) General needs, (3) Specific needs, and (4) Parameters to be measured. Each group was instructed to take note of the user's resolution requirements necessary to satisfy each need. These resolution requirements were to include, if possible, an estimate of the minimum resolution required to satisfy the user need. Each member of the subgroups was instructed to become enlightened as to the terminology, instrument types and their operation. Upon completion of the above task, the group was redivided into subgroups. Each was charged with the task of investigating a particular instrument or group of instruments for the purpose of determining their technological state of the art and their future capabilities.

Appendix A-1

POLLUTION

A-1.1 Introduction

Air pollution and water pollution can be regarded as two broad categories of environmental contamination, with land pollution falling under both of these. It is commonly known that much of the air and water of the world's industrial environment is polluted, but the extent and long range implications of this is not widely appreciated.

A-1.2 Air Pollution

The tremendous increase in world population together with increasing longevity and a generally higher standard of living have generated pressure for cleaner air. Beyond that however, there are longer range considerations pertinent to the atmospheric gas constituents having to do with oxygen and carbon dioxide. The oxygen in our atmosphere is not a permanent feature, but is rather the result of a delicate balance between its release in the photosynthetic process and its removal by animals, by combustion, and by the slow oxidation of minerals on the earth's surface.

Energy conversion has certain materials by-products, which in sufficient concentrations to become troublesome to man, are classified as "air pollution."[1] The carbon dioxide by-product of the combustion of coal, oil, gas, etc. has gradually raised the general level of carbon dioxide in the atmosphere to about 5% over the concentration many years ago. (CO_2 represents <u>ca</u>. 0.32% of the atmosphere.) A continued increase in the carbon dioxide of the atmosphere (the greenhouse project) could affect the global climate to the extent that the increasing temperature could melt the polar ice-caps, thereby deluging continental coastal areas, with the destruction of lives, cities, and badly needed land over this already crowded planet. The CO_2 content in the atmosphere is checked by photosynthesis and by its rate of solution into the oceans. Particulate matter from the burning of fuels and volcanic eruptions etc. tends to cause a cooling

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1. See B-1, Item 1, pp. 24-25.

effect in the atmosphere by diffusing the incoming solar radiation.

Much more information is needed on this meteorological problem in order to assess what remedies are required. Considerable work has been done with respect to certain regional areas of the globe, but less is known about the large-scale pollution rates of the atmosphere.

Air pollution has effects both on the short and long-range health of humans as well as other living organisms and ecological balances. Acute episodes of excessive air pollution affect individuals and small groups by illness or death from exposure to toxic fumes, vapors, pesticide aerosals, smoke or high concentrations of dust. Community air pollution catastrophes may be caused by a combination of stagnant air, fog, temperature inversion coupled with unusually large amounts of ordinary combustion-produced atmospheric pollutants which sensitizes the populations lung tissue thus resulting in a high incidence of certain communicable diseases such as tuberculosis, influenza and the common cold which are transmitted by airborn microorganisms.

Prolonged exposure to ordinary relatively low levels of urban air pollution has not yet been shown to have unfavorable effects on human health; for example, there has to date been no definite correlation of lung cancer incidence with ordinary urban air pollution. However, urban air pollution can aggravate asthma, and some other chronic respiratory illnesses and can cause transient eye infections.[2]

The Air Conservation Commission of the American Association for the Advancement of Science has identified three basic assumptions that are essential for any rational consideration of the air pollution problem:[3]

1. <u>Air is in the public domain</u>. This excludes public individuals ownership of the <u>flowing</u> air above a man's property and thus limits his freedom in using it.

2. <u>Air pollution is an inevitable concomitant</u>

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2. See B-1, Item 5.

3. See B-1, Item 1.

of modern life. This calls for systematic policies and programs to conserve the atmosphere for its most essential biological function.

3. Scientific knowledge can be applied to the shaping of public policy. We must continue to obtain information about the sources and effects of air pollution and to develop and improve control devices.

A-1.3 Water Pollution

The aspects of water pollution are so complicated and interrelated, it is difficult to clearly delineate any one area which is more important than another. One approach is to consider the following parameters of pollution.[4]

1. Physical. These parameters include color, odor, particulate matter content (which may float, settle or be interminably suspended), transparency, salinity, and temperature. They also embrace density and stability, which are functions of temperature and salinity, plus hydraulic characteristics.

2. Chemical. It would be a monumental task to tabulate and classify all chemical contaminants in the water. However, the following chemical parameters may be used to assess the impact of potential pollutants:

   a) hydrogen ion concentration
   b) dissolved gases, especially O_2 and CO_2
   c) chlorinity
   d) nitrogen analyses, i.e. ammonia, nitrites, and nitrates
   e) organic carbon
   f) biochemical oxygen demand
   g) nutrient elements, especially phosphates, silicates, and nitrogen compounds.
   h) heavy metals, in particular copper, lead, nickel, cadmiun, and chromuim especially where industrial wastes are involved.
   i) oily substances, i.e. hydrocarbons and fats
   j) trace organics, e.g. pesticides, herbicides,

4. See B-1, Item 2, pp. 262-264.

detergents, and sulfite waste liquor.

3. Biological. Enumeration of the principal species of plankton, statistics on fish catches, coliform organisms and possibly other bacteria, and the determination of primary productivity.

4. Radiological. Determination of gross radioactivity of plankton, fish, attached algae, benthic animals, and especially shellfish. For example, it may be prudent to determine the activity of specific radio nuclides in oysters.

The effects of water- and air-borne pollutants on health are presently being studied. The immediate effects of water-borne pollutants on human health may arise from such widely separated mechanisms as the transport of infectious hepatitis by contaminated shellfish to the build-up of DDT (presently at 0.1 gram per person in USA) by the use of pesticides and herbicides. However, the indirect effects of pollution on other living organisms by way of the upset of ecological balances. There are many well known cases of pollution caused transients in the ecological balance which have propagated undesirable results to the human organism.

As an example, consider the effect of the dumping of raw domestic sewage into a stream on its biotic state. Generally, fish and the organism they feed on may be replaced by a dominating horde of animals such as mosquito wrigglers, bloodworms, sludge worms, rat-tailed maggots and leeches. Black-colored gelatinous algae may cover the sludge and, as both rot, foul odors emerge from the water. This biotic picture emphasizes that pollution is just as effective as drought in reducing the utility of a valuable water resource.[5]

The effect of such a dump on dissolved oxygen, the reaeration rate and the biochemical oxygen demand on the environment is shown in Figures A-1.1 and A-1.2.

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5. See B-1, Item 3, pp. 104-110.

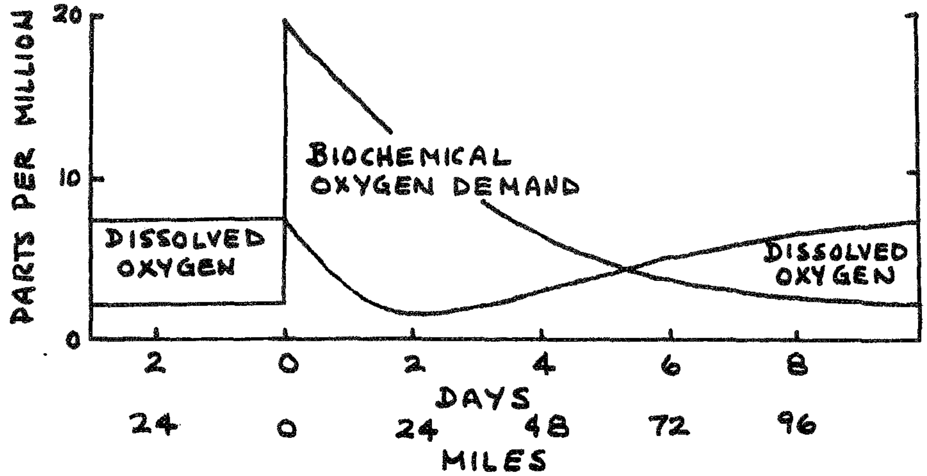

Fig. A-1.1 Assumptions in a hypothetical pollution case are a stream flow of 100 cfs, a discharge of raw sewage from a community of 40,000 and a water temperature of 25°C, with typical variation of dissolved oxygen and BOD. After Bartsch and Ingram, 1959.

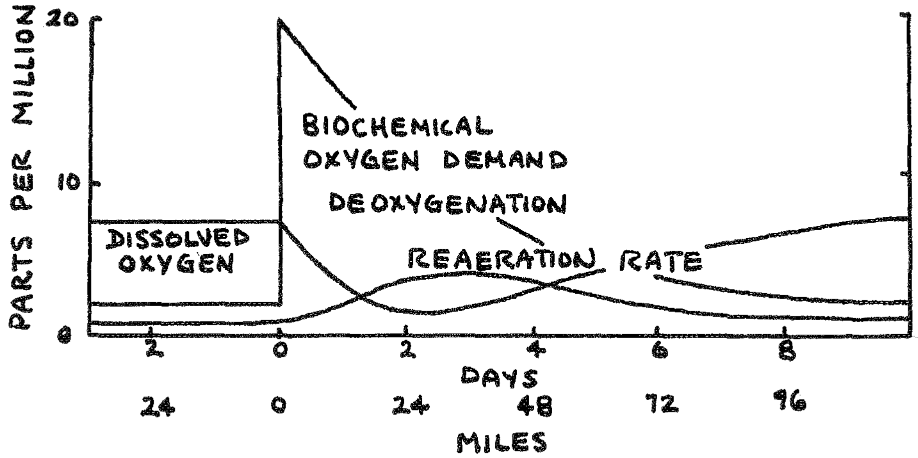

Fig. A-1.2 The dissolved oxygen concentration in the stream is partially destroyed by the pollution load. Full depletion is avoided by reaeration processes. After Bartsch and Ingram, 1959.

The dissolved oxygen fluctuates according to the available light and the temperature and thus these curves must be regarded as simply typical. The growth of sewage moulds and algae is shown in Figure A-1.3.

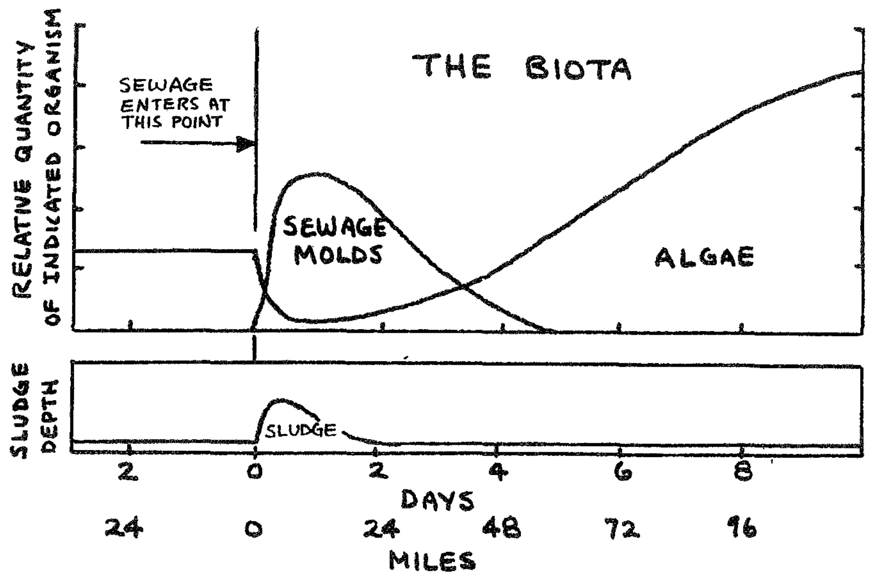

Fig. A-1.3 Shortly after sewage discharge, the moulds show maximum growth. These are associated with sludge deposition shown in the lower curve. The sludge is decomposed gradually; as conditions clear up, algae gain a foothold and multiply. After Bartsch and Ingram, 1959.

Rotifers and crustaceans as fish food evolved after the growth of sewage bacteria and ciliates as shown in Figure A-1.4. These figures give a quick idea of the nature and duration of stream recovery from sewage pollution.

The implications of these biological transients can be seen by noting that 2/3 of U. S. population is served by domestic sewers. Sewage from about one tenth of these people is discharged raw and that from more than another quarter after only primary treatment.

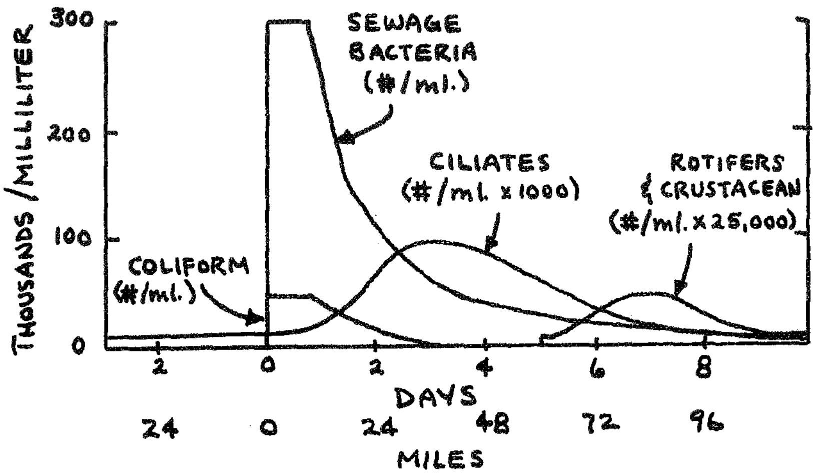

Fig. A-1.4 Bacteria thrive and finally become prey of the ciliates, which then become food for the rotifers and crustaceans. After Bartsch and Ingram, 1959.

Other specific studies have been carried out on many forms of pollution, including radioactive and pesticide pollution. In these two particular cases, much more information is needed to determine the long range effects of the pollution. The thermal pollution of marine environments by heavy industrial waste effluents and nuclear power plants cooling waters is becoming of increasing concern to marine ecologists.

Other common "contaminations" of our environment should briefly be mentioned such as the unpleasant odor of a rendering plant, the noise of a jet airplane or a neighbor's transistor radio, disorderly jumbles of auto hulks, and unsightly trash in a dump. These common forms of sensory and aesthetic pollutions may turn out to be minor indeed in comparison to the large scale, long term forms previously mentioned.

A-1.4 References: See Appendix B-1.

Appendix A-2

ENERGY

A-2.1 Introduction

It seems to be a consensus among projectionists that by the year 2000, oil and gas will continue to supply most of the energy required by the United States.

According to a report by Resources for the Future, Inc.,[1] "the total energy supply picture will probably look about like this: domestic crude oil supplies adequate until around 1980, with a likely tightening of domestic supplies in the latter half of the century; foreign sources of oil adequate to provide a much larger proportion of crude oil than is now imported; coal as a comfortable cushion; shale oil as a supplement later in the century; demand for natural gas approaching domestic resource limits well before 2000, but with the safety factor of possible gas imports and the likely emergence of synthetic gas late in the century; more than enough natural gas liquids to meet growing demand, especially as raw material for the chemical industry: hydropower, a declining energy source; nuclear fission, a growing energy source, resting on current U.S. uranium reserves that, with expected improvements in reactor efficiency, should see us through to the end of the century and beyond. Again, these are not predictions. They are only projections based on present knowledge and doubtless will be revised many times as the century grows older."

A-2.2 Types of Energy Resources

The past, present, and future energy uses are shown in Fig. A-2.1. It is seen that in the remainder of this century, oil and natural gas will provide a projected 65% of all the energy requirements of the U.S. coal, natural gas liquids, hydroelectric, and nuclear energy will probably make-up the rest of the need, with more exotic energy sources such as solar energy, geothermal power, and wind power coming into wider use toward the end of the century.

These projections are very tentative and could change measurably under the influence of environmental and political stresses of various types. Situations can easily be imagined where predominatly nuclear and exotic energy sources may be necessary by the end of the century.

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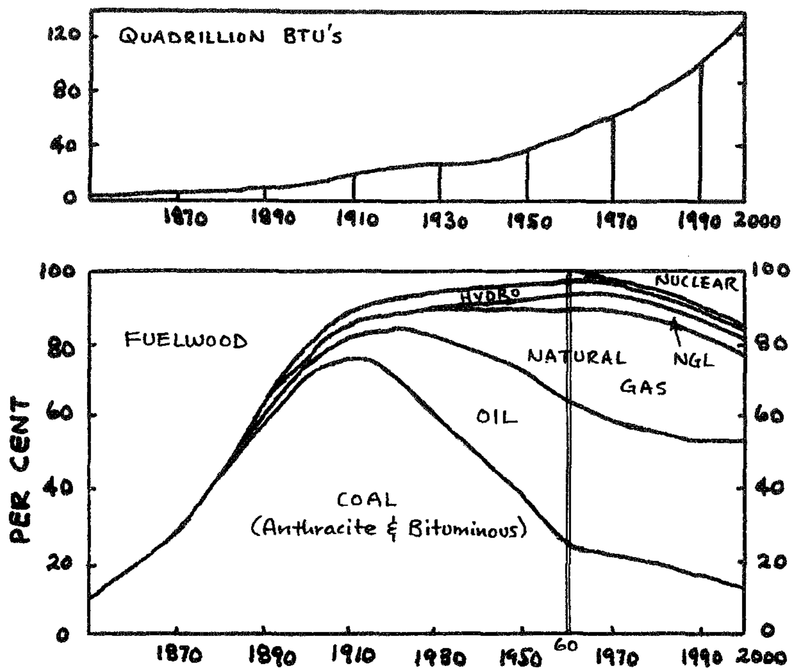
[1] See B-2, Item 4, p. 197.



NGL: Natural Gas Liquids

Fig. A-2.1 Past and projected energy use. After Landsberg, 1964.

The changing patterns of sources for all energy are shown in Figure A-2.2, again showing the expected predominance of oil and natural gas; the decline in the use of coal in the remainder of the century is striking.

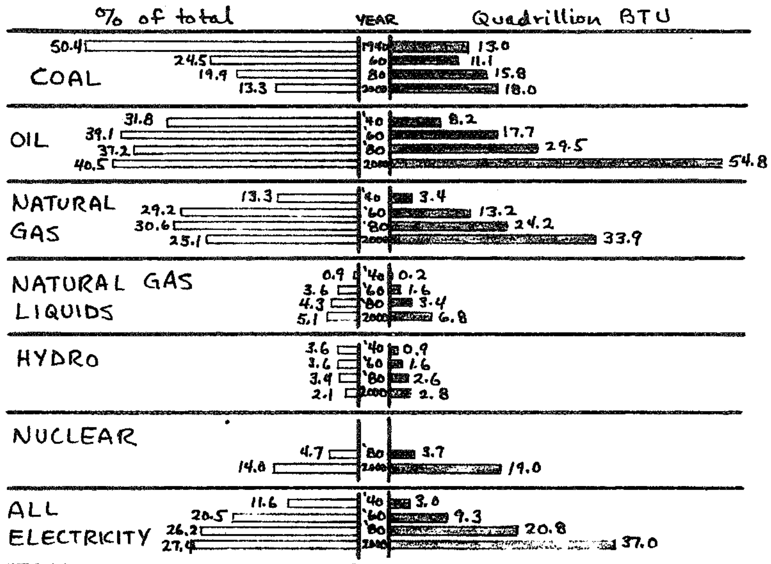


Fig. A-2.2 The changing pattern of sources for all energy. After Landsberg, 1964.

A-2.3 Projections of Uses of Energy

The location of the proved world oil reserves as compared to 1937 and 1960 is shown in Figure 2.3. The development of the Middle Eastern oil fields and the decline in the relative percentage the proven reserves of United States is shown dramatically. The projected demand for domestic oil versus the estimated recoverable supply is shown in Figure A-2.4. Although it appears that the projected demand will not exceed the recoverable reserves by the end of the century, it should be pointed out that (1) the recoverable reserves figures are based on the assumption of both economic and technological practicability of obtaining these figures, and (2) that stringent domestic resource requirements, such as prolonged wartime needs, do not exceed the projected figures.

A similar chart for natural gas projections is shown in Fig. A-2.5. It should be noted that if the underdeveloped nations should suddenly start consuming energy at a per capita rate one-half that of the U.S. in 1960, the proven reserves of gas and oil would be consumed in about three years. Use of shales etc. would only last about another 30 - 50 years.

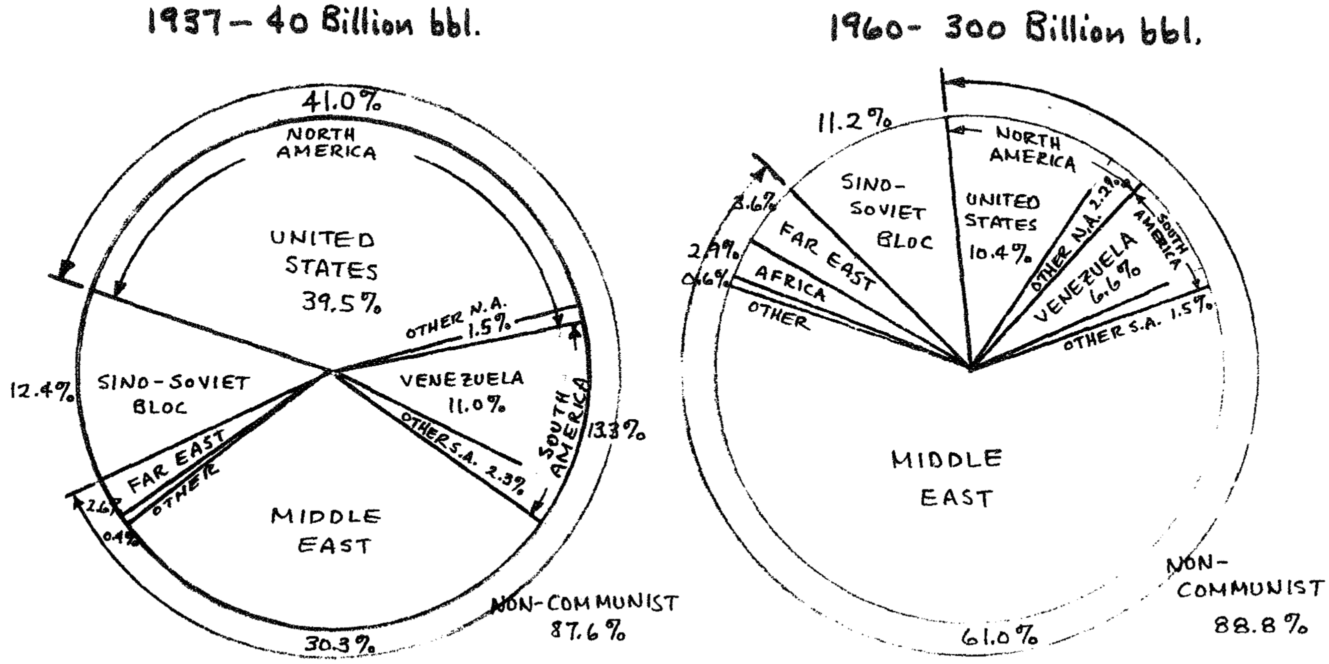


Fig. A-2.3 Location of world's proved reserves of crude oil, 1937 and 1960. After Landsberg, 1964.

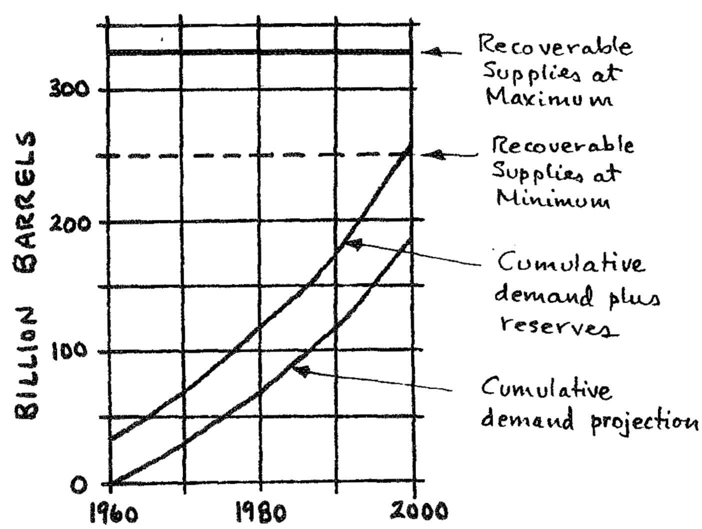


Fig. A-2.4 Projected demand for domestic oil versus estimated recoverable supplies in the United States. After Landsberg, 1964.

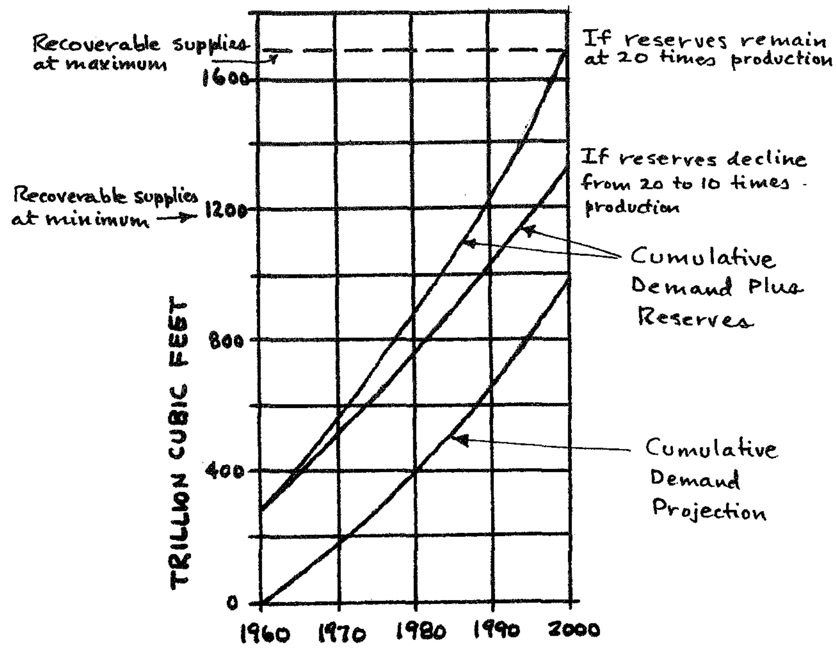


Fig. A-2.5.2 How demand for natural gas compares with the estimated recoverable supplies in United States. After Landsberg, 1964.

A-2.4 Other Factors

Obviously, many of these numbers depend upon projected technological innovations, economic feasibility, etc. However, other side effects may have to be considered. For example, it has been estimated that if the rate of burning conventional fuels continues to increase by a factor of 2 each ten years, the result would be that by the end of the century there will be an increase in carbon dioxide in the atmosphere sufficient to produce atmospheric heating by a few degrees over the globe (the greenhouse effect). This gives rise to a possibility that the polar ice-caps will melt and the level of the oceans would rise, possibly flooding our coastal areas and cities. Such a possibility, if it appears imminent, may dictate the use of energy sources which do not have CO_2 as a by-product, such as nuclear, geothermal, etc.[2] The rate of CO_2 dissolving in the oceans will, however, check the CO_2 concentration in the atmosphere, and particulate production from the burning process if held in the upper atmosphere, will diffuse solar radiation so as to cause a cooling of the atmosphere, thus giving rise to a possibility of an ice age.

A-2.5 References. See Appendix B-2

[2]See B-2, item 7.

Appendix A-3

TRANSPORTATION

A-3.1 Introduction

Continued growth of air, sea, and land transportation appear to be necessary and inevitable in an expanding society. This rapid growth will continue to be accompanied by acute problems in traffic control and navigation. It appears that the problem of planning new transportation systems and the problem of navigation and traffic control should both be improved by a global surveillance system consisting of spacecraft, aircraft, and land survey crews, plus data processing and distribution.

A-3.2 Potential Applications for an Operational System

A-3.2.1 Highway Routing and Planning
A survey system should indicate major geological patterns, surface features, etc. which would greatly aid in the planning and construction of new highways throughout the world. Such a system could be especially helpful to underdeveloped countries beginning major transportation development.

A-3.2.2 City Street Planning
The use of photographic maps is commonplace in city street planning. A survey system could provide timely, updated maps as a matter of routine operation.

A-3.2.3 Automobile Traffic Density Patterns
Items (2) and (3) would require a higher resolution sensor than item (1). The needs here are for indications of areas of present and future congestion and for aids in planning new arteries.

A-3.2.4 Enroute Traffic Control of Aircraft Over Oceans
Improved communications are necessary for reliable air traffic control as traffic density increases.

A-3.2.5 Enroute Traffic Control for Surface Vessels
Again improved communications are needed for better traffic control of all surface vessels including ground effect machines (GEM). This application is needed most urgently at present in the North Atlantic shipping lanes.

A-3.2.6 Navigation of Aircraft and Surface Vessels
A means is needed for more accurate position location in all weather.

A-3.2.7 Search and Rescue
A more efficient communications network is needed for search and rescue operations involving land and sea accidents. It also appears feasible that high altitude sensors could detect wreckage in remote areas of the world. Such detection would greatly aid in rescue operations.

A-3.3 References: See Appendix B-3.

Appendix A-4

CONSERVATION

A-4.1 Introduction

The conservation of the resources of the world is an area wherein a large number of benefits can be derived from an earth survey (surveillance) system. A number of the topics included here correlate with material covered elsewhere in this report; see section A-1 and A-5.

A-4.2 Applications for Aid in Resource Conservation

A-4.2.1 Snow Cover and Ice Occurrence
The magnitudes and locations of snow in mountains should aid in run-off predictions which can be used for reservoir planning and use.

A-4.2.2 Near Shore Underwater Detail in Coastal Waters
Locations of fresh water escaping into sea water should be used to plan new wells.

A-4.2.3 Fresh Water Pollution
The intrusions of industrial community and saline pollutants into fresh water supplies should be determined in greater detail.

A-4.2.4 Reservoir Planning
High altitude viewing should greatly aid in the planning of new reservoirs for the prevention of fresh water loss.

A-4.2.5 Mineral Detection
High altitude viewing of geographic features should be used in the locating and the mining of underground minerals.

A-4.2.6 Wildlife Management
A high altitude surveillance system should be utilized to evaluate rangelands and forests in order to determine suitabilities for different wildlife species. The discovery of pollutant sources of streams and rivers should indicate action necessary in order to save endangered fish species.

A-4.2.7 Conservation of Forests
Diseased areas and areas with insect infestations should be located by an operational surveillance system.

A-4.3. References: See Appendix B-4.

Appendix A-5

DISASTER DETECTION, PREDICTION, POSSIBLE PREVENTION AND RECOVERY PROCEDURES

A-5.1 Introduction

Headlines that read: HUNDREDS DIE IN MAJOR DISASTER! merely inform us that a large number of people have lost their lives-which in itself is a major disaster. Any event causing great damage or destruction, considerable loss of life or property, or violent disruption of the physical or social environment could be termed a disaster. However, there are so many different types of events coming under this description that any attempt to classify them into any meaningful order immediately demonstrates the difficulty of arriving at a precise definition.

For example, we say that some disasters are due to natural causes and others are man-made. Some are preventable and some are not, or at least do not seem to be. Some give plenty of advance warning of the possibility, probability, or even certainty of their occuring for those who will take the time and trouble to observe and correctly interpret available data, while others appear to give no advance indications whatsoever. Disasters may vary greatly in both intensity and in duration also, some having a relatively long time-span but with rather low-level intensity and others occuring in a matter of minutes but with immediate devastating effects. Again, disasters may involve any number of persons at what might be considered to be the "local" level or they might be very far-reaching in their effects and encompass an area that could extend to global proportions.

A-5.2 Disaster Classification

There is even some question as to just what should be included and what should be excluded in one's determination of what constitutes a disaster or as to the particular category into which a given disaster should be placed. Among events generally considered to be caused by natural phenomena could be listed such things as:

Avalanches	Fires caused by lightning
Droughts	Hurricanes
Earthquakes	Landslides
Epidemics	Locust invasions
Famines	Tidal waves
Floods	Tornadoes

Volcanic eruptions

Events coming under the heading of disasters for which man is primarily responsible might include:

Air raids	Fires caused by man
Asphyxiation	Radiation
Collisions or wrecks(land, sea, air)	Revolutions
Cave-ins	Riots
Collapse of man-made structures	Pollution(soil, water, air)
Explosions	Wars

Neither of the above lists is intended to be all-inclusive but merely representative and it is at once obvious that some items could appear on either list or on both or be caused by a combination of natural and human causes.

A-5.3 Nature of Disasters and Preventive Action

We still do not know the exact causes for all disasters, nor are we yet able to foresee all of the direct and indirect consequences that may result from a given disaster. Neither does it seem likely that all disasters are capable of being prevented, although some potential disasters can be and have been prevented by timely advance warning and appropriate preventive action. Still more that have not been prevented from happening might have been if only more data had been available in time to permit preventive action to be taken. Therefore, there is good reason to believe that many more potential disasters in the future can be prevented by substantially increasing our supply and intelligent use of data relating to their nature and causes. Even in the case of those disasters not subject to any effective preventive action, such data and its use should at least greatly reduce the extent or area of disaster and help to minimize the harm done or make it possible to better plan for such things as evacuation, rescue, and relief action in disaster areas.

A-5.4 Present Procedures and Facilities for Dealing with Disasters

Present facilities for dealing with disasters are defective or inadequate for a variety of reasons.

1. They tend to be primarily of a post-disaster nature, such as the use of fire and police departments, ambulances, rescue and evacuation units, volunteer workers, and the setting up of first-aid centers and temporary shelters.
2. They are essentially of a local, ground-level character.
3. That there is a real need for greater promptness and greater accuracy in detecting and reporting disasters than present systems provide is not disputed, despite the many improvements which have been made.
4. Existing ground-based systems are inclined to be too inflexible and difficult to re-adjust to novel conditions which can be expected to develop in the future.

5. Ground-based systems are too limited in coverage and even the use of air-craft still leaves many remote areas on land and sea and in the air unmonitored at all or not on any continuous basis.
6. Increasing the number of ground installations or aircraft used for detecting disasters would add much to costs.
7. There is presently no centralized, coordinated global system of disaster reporting and reporting of data which might aid in avoiding disasters and much of the reporting that is done is entirely on a voluntary basis.
8. Present communications systems involving ship to ship, ship to shore, and aircraft-ship reporting and relaying of information are subject to criticisms which include unreliability, poor quality, inaccuracy, and limited user accessability.

The AMVAR system presently provides for automatic merchant vessel reporting in regions of fairly dense marine traffic only and the United States Coast Guard receives information voluntarily radioed in by about 3000 ships of more than 60 countries each day as to their positions, course, and speed and this information is computerized so that information can be updated. HF and VHF radio relays and submarine cables are used for reporting information but HF radio service is not too reliable and of rather poor quality. VHF radio service is limited to line of sight distances, quality is not very good, costs are high, and available band widths are limited. The use of submarine cables is limited to users of fixed cable terminations and this limits potential user accessability.

The Office of Emergency Planning in Washington, D. C. was established by act of Congress September 22, 1961 within the Executive Office of the President, as a successor agency to offices established in 1958. Activities and organizational characteristics of this office are summarized in the U. S. Government Organization Manual. Coordination of Federal aid to States in coping with major disasters under the Federal Disaster Act of 1950, as amended, and the Disaster Relief Act of 1966 is mentioned and included in the organization is a National Resource Analysis Center and an Emergency Operations Office. The Center's Director "... develops and maintains a complete capability for monitoring, evaluating, and projecting the status of the Nations's resources and economy to meet all types and degrees of national emergency; ... conducts and supports comprehensive research and system analyses to support decisions on alternative emergency preparedness policies, plans, and programs; ..." The Director of the Emergency Operations Office "... provides the over-all leadership and coordination of Federal, State, and local readiness programs designed to assure the capability of government to respond effectively to any emergency."[1]

1. See B-5, Item 7, pp. 67-70.

A-5.5 An Operational Earth Resource Survey Program and Disaster

Numerous other governmental agencies or private organizations within the United States, as well as foreign and international organizations of various types could be mentioned that deal directly or indirectly with the problem of disasters and, admittedly, great progress has been made and hopefully will continue. Should the collection, reporting, dissemination, and use of disaster data through existing systems and methods be improved before we think of going into space to supplement or possibly substitute for existing systems and methods or is it feasible and desirable to simultaneously explore the possibility and problems inherent in ground surface, aircraft, and spacecraft systems and methods? Isn't it highly probable that the optimum to be sought will be some combinational use of all three, utilizing the major advantages of each for the purposes for which they are best suited and varying their role as conditions and technological advances change?

The use of aircraft has already demonstrated how valuable data obtained from this source can be in dealing with disasters and, to a somewhat lesser degree, this is true of spacecraft also. If expanded use of spacecraft is warranted on an operational basis for such purposes, we should critically evaluate those needs that pertain to disasters for which it might be assumes spacecraft obtained data might offer advantages not present in existing systems.

Of the four phases of disaster control-detection, prevention, possible prevention, and recovery procedures, the last, by necessity, would have to remain primarily a ground based system in almost all instances. There is no reason to expect that this phase of dealing with disasters would be altered greatly by either the use of aircraft or satellites. However, for certain types of large scale disasters especially, data obtained from satellites could be of considerable value in relaying information back to earth promptly and over a large area as to the precise location, direction, rate of spread of some types of disasters, the effectiveness of disaster fighting efforts, and in suggesting how some types of disasters might best be handled on the basis of past data for a given area. Aircraft could also do much of this, in some cases probably better than satellites and in others not as well, depending on the situation.

The major contribution satellite obtained data should be able to make to the post-disaster or recovery stage is the detection of disasters. Promptness and accuracy in reporting disasters may help a great deal in getting search, rescue, and evacuation teams on the scene and reducing loss of life and property. Even though initial costs of disaster detection by satellite might be high, the potential benefits would be difficult to calculate with any accuracy. What value can be placed on the numbar of human lives that might be saved thereby, for instance? More important, this service would, in a sense, be a "spin-off" or side effect of a system that could serve multiple purposes.

A-5.6 Impact of an Earth Resource Survey Program on Disaster Detection, Prevention, and Recovery

If, as the saying goes, an ounce of prevention is worth a pound of cure, another very important function that an earth resources satellite system would serve would be disaster prevention. It could do this in at least two ways. First, if continuous and global monitoring resulted in a more accurate and comprehensive, as well as constantly updated collection and dissemination of data relating to the earth's resources than is presently possible under existing systems, it should be possible to predict what is likely or certain to happen much more efficiently, economically, and with greater dispatch. With this kind of information available, it seems logical to assume that more effective measures could be taken in time to prevent or alleviate disasters that could be foreseen that far in advance, particularly those due to natural causes, but also including many caused by man such as pollution.

A study of significant changes in air, water, or land temperatures, movements of water, ice, and snow, soil erosion, or sudden and unusual changes in land structure, sea state, or atmospheric conditions by continuous global monitoring certainly should lead to greatly increased research devoted to the possibilities of weather modification, the possibility of diverting dangerous storm fronts to unpopulated areas, and the construction of better protective devices against disasters due to natural causes. In other words, the more we know about what is likely or certain to happen if we don't do something about it, the more likelihood there is that we will try to find ways of doing something about it. And if we reach the conclusion, as we unquestionably will in some cases, that absolutely nothing effective can be done to prevent a predicted disaster from occurring, we can still take maximum security measures in preparation for the inevitable.

The second way in which an earth resources satellite system could serve as a greatly improved method of preventing disasters is probably of greater immediate benefit than the first. It might take many years of research before man can do much effectively to change quakes, hurricanes, tidal waves, etc. and the energy and expense which would be required to do this could be a very important obstacle, with no guarantee that this could be done.

However, most so-called "accidents" involving human beings, whether on land, the sea, or in the air, are avoidable if only the right people had access to the right information at the right time and place. Here is where an earth resources satellite system could really be of tremendous value. If natural disasters prove unpreventable, they might at least be avoided or by-passed provided sufficient advance warning is given of their presence, location, characteristics, and probable tendencies. Likewise, it is reasonable to suppose that a great number of the many collisions of aircraft or ships that now take place annually could be avoided to a much greater extent than is presently possible if more accurate and continuous information as to position, speed, and direction was made available on a global basis for quick use through a centralized system. Air turbulance, dangerous storm areas, ice blocked sea areas, excessive fog conditions, icebergs, landslides, active or anticipated volcanic action, earth tremors, etc. could be reported and travel re-routed accordingly.

Thus, increased opportunity for avoidance of some of the hazards which contribute to man-caused accidents as well as avoidance of some of the hazards that are imminent in the proximity of natural-caused disasters could be provided. Other benefits would result from the study of data indicating the impact certain types of disasters have on a given area, data indicating the relative effectiveness of alternative measures of predicting, preventing, or coping with disasters. The use of satellite obtained data as a means of predicting, preventing, or coping with political and economic conflicts is much more speculative at this point at least. However, one can not help wonder what the effect might be of continuous publicity available for all nations of data indicating military build-ups, missile bases such as were established in Cuba, etc. It might act as a possible deterrant or at least enable nations to be better prepared for aggressive action and to be able to take effective collective action quicker than might otherwise be the case.

A-5.7 Summary and Conclusions

In a short summary paper such as this, it is not possible to cover in detail all of the many ways in which an earth resources satellite system might be of value in detecting, predicting, and possibly preventing disasters or in assisting in disaster recovery activities, nor have the many political, legal, technological, and economic problems that the operation of such a system would provoke been at all explored. That it is feasible technologically seems evident from the success that TIROS and NIMBUS satellite experiments have already had. That it is urgently needed because of the defects of existing system and that its economic and other benefits would more than compensate for any initial costs eventually also seems quite evident. Much more needs to be done than has been done so far to convince the public of the justification for such a program and the increasing degree to which it becomes more and more necessary as the potentiality for disasters of new and complex types and the greater frequency of disasters of the more convential type becomes more apparent. Perhaps it will take a series of real major disasters for conviction to finally come. Or, as another and very real possibility, perhaps effective action will be postponed so long that, when disaster finally becomes so global in its impact, whether by slow pollution or by some rapid process such as radiation, it will be too late to satisfy man's greatest need--survival.

A-5.8 References: See Appendix B-5.

Appendix A-6

POPULATION DENSITY

A-6.1 The Population Growth

"From the time of Christ until the end of the 16th century world population grew an average of 2 to 5 percent a century. Since about 1960 population has been growing almost 2 percent per year."[1] This increase in growth rate has been called the population explosion. Projection of this growth pattern to the year 2000 (Figure A-6.1) indicates that population will

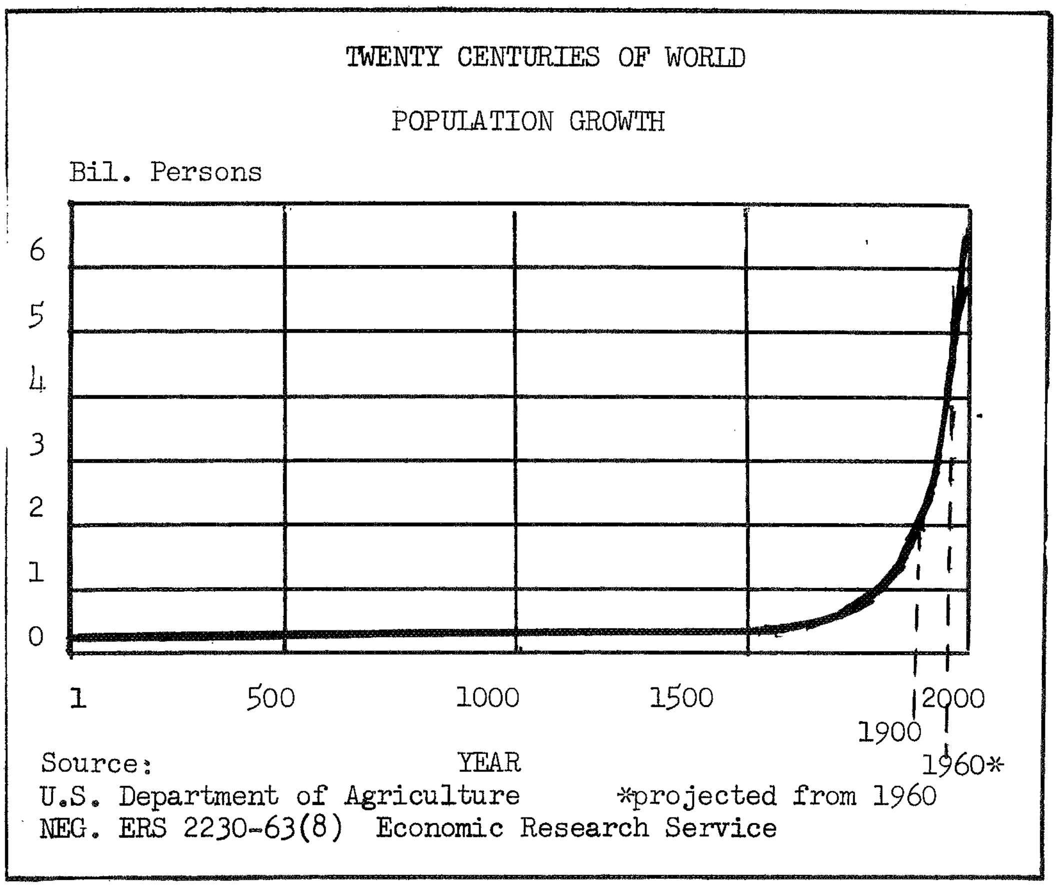


Figure A-6.1

double to 6 billion. Some projections place the total as high as 7.5 billion. Looking further into the future indicates

[1]See Appendix E-6, Item 7, p. 2.

further explosive growth. "It now appears that we will be fortunate indeed if we succeed in stabilizing the world's population at 15 billion persons. It is even possible that in another 90 years the population of human beings will be approaching 25 billion persons."[2]

A-6.2 Factors Contributing to Population Growth

Several factors such as improved pesticides, improved sanitation, and better health care have served to decrease the death rate while the birth rate has tended to remain at a relatively constant high level. The reduced mortality has been especially significant in Asia, Africa and Latin America where deaths per thousand in 1965 had dropped 30 to 45 percent in thirty years (Table A-6.1). In Asia, for example, the projections indicate an

TABLE A-6.1
FALLING DEATH RATES IN THE HUNGRY WORLD
(per thousand)

	1935	1950	1965	1980*
World	25	19	16	12.7
Asia	33	23	20	13
Africa	33	27	23	18
Latin America	22	19	12	8.2

Source: Paddock, Wm. and Paul — *projected
Famine 1975: America's Decision: Who will Survive? p. 16.

increase from 1.62 billion in 1960 to almost 3.9 billion in 2000 (Table A-6.2). Substantial increases are projected for all other regions also.

[2] See Appendix B-6, Item 1, p. 8.

TABLE A-6.2

REGIONAL AND WORLD POPULATION: ACTUAL 1900-1960 & projected 1960-2000

Region	1900	1910[1]	1920[2]	1930[2]	1940[2]	1950	1960	1970	1980	1990	2000
	Millions										
North America . .	81	99	117	135	146	168	197	225	254	283	312
Latin America . .	63	76	90	109	131	163	206	265	348	455	592
Western Europe[3] .	205	220	236	258	279	278	300	321	352	388	421
E. Europe&USSR[3] .	219	234	250	273	297	296	339	390	440	483	526
Africa	120	130	140	155	172	199	235	278	333	410	517
Asia	857	914	970	1047	1176	1380	1620	1980	2470	3090	3870
Oceania	6	7	9	10	11	13	16	19	22	26	29
Total	1551	1680	1812	1987	2212	2497	2913	3478	4219	5235	6267

[1] Figures for this year were not included in the original source but were arrived at by interpolation.

[2] Figures for these years were taken from D. Greenveld, Investment for Food, 1961, p. 107.

[3] For some years figures were available only for "Europe" as a whole in which case the breakdowns between Eastern and Western Europe are estimates based on years for which separate data are available.

Source: United Nations The Future Growth of World Population, 1958 (57).

A-6.3 References: See Appendix B-6.

Appendix A-7

WORLD HUNGER

A-7.1 A specific Resource Requirement

The expanding population (See Appendix A-6) will require at least a proportional increase in food, fiber, shelter and other goods and services. Because of rising expectations of a higher living standard a more than proportional increase probably will be required. How well the world regions are equipped to provide these increases may be estimated by an examination of the distribution of arable land (Table A-7.1) and comparison to population distribution (Table A-6.2).

TABLE A-7.1

LAND UTILIZATION PATTERN, BY REGIONS, 1959

Region	Arable land and land under tree crops	Permanent meadows and pastures	all other land	total area [1]
		Million Acres		
Geographic regions				
North America	566	688	3,524	4,778
Latin America	252	913	3,902	5,067
Western Europe	242	140	522	904
E. Europe&USSR	686	967	4,198	5,851
Africa	583	1,463	5,429	7,475
Asia	1,073	1,077	4,559	6,709
Oceania	69	1,104	937	2,110
World [2]	3,471	6,352	23,071	32,894
Economic regions				
Developed regions	1,563	2,899	9,181	13,643
Less developed reg.	1,908	3,453	13,890	19,251
Political regions				
Free World	2,515	4,946	17,170	24,631
Communist Bloc	956	1,406	5,901	8,263

[1] Refers to total area of the country including area under inland water.

[2] Excludes Greenland and Antarctica. Source: FAO Prod.YRBK., 1960(15).

Latin America, Asia, Africa, and Oceania which contained over 70 percent of the world population (1960) had available only about 57 percent of the arable and tree cropped land (1959). By comparison, North America, Western Europe, Eastern Europe and USSR contained less than 30 percent of the world population (1960), but had available about 43 percent of the arable and tree cropped land (1959). Since food production bears a direct (though changing) relationship to land availability, a serious imbalance is indicated. It appears that this imbalance will tend to worsen since forecasted annual 2 to 4 percent increases in food production have not been achieved at present. The term applied to this imbalance is food gap.

Dr. Bonner of the California Institute of Technology made the following assessment of the rate of food production increase in 1967:

> In fact, however, yields per acre in the developing areas of the world have increased only 8 percent in ten years, or less than 1 percent per annum. The greater part of the increase in food production has resulted from increases of farm acreage, often of quite marginal areas, and this is in dramatic contrast to the experience of the developed countries, in which all increases in food production have been due to raising of per acre yields.[1]

The shortage of arable land coupled with this very slow increase in yield compounds the problem. In 1966 Orville L. Freeman, Secretary of Agriculture, made this statement: "Unless the less developed countries sharply increase their agricultural productivity, and soon, mass famine will take place. Thus more human lives hang in the balance in the race between food and people than have been lost in all the wars in history."[2]

A-7.2 Constraints and Directivity for Meeting Hunger Needs

In order to meet the basic requirements of nutrition the increase in population and the increase in food production must be brought into balance. Checking the population growth becomes involved with attempts to educate and to convince individuals to limit the size of their families. Some effort is under way in this area and it is recognized as a long term proposition. Increasing the food supply is also a long term

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[1]See Appendix B-7, Item 1, p. 33.

[2]See Appendix B-7, Item 3.

proposition involving technological, economic, social, and political considerations.

If the developing regions are unable to react rapidly enough to solve their food gap problems, the developed countries are the logical source of assistance. Since the export of medical technology which, coupled with local efforts in the developing areas, has served to lower the death rate (birth rates remaining high) has created this imbalance, at least in part, there is a moral justification for giving this assistance. What form shall it take? Dr. Bonner has made these suggestions, some of which are obviously interim:

1. A technical solution such as:
   - food from the sea (varieties of fish)
   - have the developed countries feed the developing ones
   - increased use of vegetables (less meat)
   - fermentation of petroleum (to supply protein)
   - reclaim press cake from oil squeezed seeds (soy bean, cottonseed, etc.)
   - irrigate all the world's deserts

2. Massive technical agricultural assistance by the developed countries to the developing ones.

3. Continue the present policy of sporadic, piecemeal assistance when famine has reached a crisis stage in particular areas.[3]

The President's Advisory Committee advocated exporting knowledge, technical aid, adaptive research, education, and institution building, believing that the products of technology and agricultural know-how cannot be transferred directly to the developing nations.[4]

The primary requirement prior to the implementation of such a program would be a world wide survey of all aspects of agricultural applications, an inventory of resources, and an analysis of potential for food and fiber growth for all areas.

A-7.3 References, See Appendix B-7.

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[3]For a more complete discussion see: The Next Ninety Years, California Institute of Technology, Pasadena, California, 1967, pp. 837-9.

[4]For a more detailed discussion see: The World Food Problem, A report of the President's Science Advisory Committee, Vol. I, Report on the Panel on the World Food Supply, 1967, p. 20.

Appendix A-8

URBAN AND RURAL PLANNING AND DEVELOPMENT

A-8.1 Introduction

Although America has had a mobile population as evidenced by a review of over a century of census data[1] the shift of population from rural to urban areas over the last decade has generated more than a few problems not only in the growing number of standard metropolitan statistical areas (SMSA's) but also in the rural communities that are suffering from depopulation. Several of the land use difficulties evident in cities and on the farms can be traced in part to the recent migration patterns.

A-8.2 Increasing problems of Urban Land-Use

One of the more apparent consequences of urbanization and urban population dispersion has been a trend to devote increasing quantities of land to provide intraurban and interurban transportation. Given the propensity to drive automobiles using only a fraction of their capacity--particularly in the home-to-work-to-home cycle--pavement has been rapidly replacing other land uses many of which had provided property tax revenues for urban areas.[2] This loss of tax resources has been particularly perplexing to large city governments which have been struggling to meet the public service needs of a growing number of high cost residents. While concentration upon the extension and improvement of rapid transit systems might slow the need to lay more pavement for highways, there is little evidence which indicates that under present pricing and subsidy arrangement substantial numbers of persons would be willing to shift from the automobile to public transportation especially as a vehicle for intrametropolitan trips. Moreover, many highway programs in populous areas have been located in such a way as to reduce urban blight by tearing down depreciated structures along a lineal path and replacing them with a road.

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1. See Appendix B-8, item 1.

2. A Resources for the Future study estimated that there were 1.2 million acres of urban territory devoted to streets and alleys which does not include rights of way or land acquired for future highway projects. Adding land devoted to port facilities, railway classification yards, passenger and freight terminals, repair stations, some of which, of course, produces urban tax receipts, "...there has come to be at least 2 million acres in city and village transportation uses." Marion Clawson and Charles L. Stewart, Land Use Information, Baltimore: The John Hopkins Press, 1965, p. 99.

All too often little consideration is given to determining if it would be a more economic use of land to renew these buildings and preserve the neighborhoods than build the highway in this location. Likewise, too little attention is given in the majority of cases to locate housing and relieve the burdens of moving for those displaced by the road project. The point here is that every effort should be made to consider both the private and public costs of proposed highway projects relative to their benefits in assessing whether or not to proceed.

A-8.3 Possible Value of an Earth Measuring System

With regard to highway or rapid transit planning, the value of an earth resources survey system via satellite would seem to be limited, under present technology to preliminary evaluation of alternative locations for extension to and improvement in the network. Periodic surveillance of land-use changes in urbanized and urbanizing areas (perhaps once a year in slow growth and semi-annually in rapid growth areas) would reveal the direction of development and its rate of change. Such information could indicate areas where transportation bottlenecks may develop and thus where added facilities will be needed. These locations could be checked periodically by aircraft to determine the extent of congestion and assess traffic flow patterns. However, before any transportation systems can be designed, additional information will be needed to estimate the traffic volumes to be carried. As one study points out this will require such data as "...the square footage of floor space in commercial and industrial areas as a means for estimating the number of automobile [for transit] trips that will result from the activities in the area."[3] Moreover, since different types of commercial and industrial establishments generate different volumes of traffic and at different time periods, these establishments should be identified by standard industrial classification (S. I. C. code). The modest resolution anticipated for the ERTS A and B satellites (in the 100-400 feet range) would not permit estimates for such detailed planning. Consequently, once growth trends are identified from satellite platform, aircraft and ground surveys to obtain detailed land-use data would follow to establish service requirements for the new or upgraded transportation links.

A-8.4 Suburban Areas

The rapid growth of suburban communities and unincorporated territories beyond city limits, relative to the virtually constant aggregate populations of large cities, have created important fiscal and planning problems within SMSA's in recent years. While cities of over 1,000,000 population experienced little change in total population between 1950 and 1960, particularly if annexations are removed, the composition of their population was significantly altered in this period.

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3. See Appendix B-8, item 14; p. 44.

to suburban areas.[4] Not only has this situation limited the city's potential residential property tax receipts but it has also increased the cost of city services particularly in the areas of public assistance and public health. In addition, city services are used extensively by suburbanites who work and enjoy recreational activities in the city which indicates that the losses within the middle income group have not significantly eased the burdens upon the city in providing services for their benefit. It is not difficult to see, then, why large cities are seeking new tax sources and are particularly interested in obtaining revenues from suburbanites who utilize city services. Rising city taxes, growing congestion, relative decline in per pupil school expenditures compared with the suburbs, absence of available large tracts of land, and growing pollution also combine to discourage new industrial and commercial development in large cities which further reduces tax potential. In short, major cities find fiscal crises arising at progressively shorter intervals as service needs increasingly pressure available tax sources.

Proliferation of suburban governmental units has complicated urban planning and limited the effective provision of several public goods. As land is transferred from rural to urban use on the periphery, suburban towns and municipalities are created. Since their tax resources typically are modest, they devote scarce funds to providing basic public functions such as police and fire protection, sanitation, parks and playgrounds plus education. Little if any money is devoted to planning community development or to the regulation of land use during the early stages of community development. As a consequency, strip type development has occured which has increased costs of providing public functions, damaged aesthetics, adversely effected highway efficiency and safety and has been subject to rapid depreciation. In addition, land speculation frequently leads to substantial tracts of idle land and farms in the midst of developed property which raises the cost of most utilities for all within the service area. This situation indicates that households and firms in the compactly developed areas are in fact subsidizing those that choose the more distant or less dense sites with respect to operating costs of several utilities when in the same service

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4. For instance, the percentage of Negroes in cities of 1,000,000 or more population rose from 13% to 19% from 1950 to 1960 and to 26% in 1966. Moreover, data for 1965 reveal that 45% of all non-white families in the United States live in metropolitan areas of 1,000,000 or more population and they comprise 25% of the non-whites below the poverty level. Since only the more affluent non-whites are financially able to leave the city, this one quarter of the non-whites are in poverty is undoubtedly heavily concentrated in city ghettos. See, Department of Commerce, Bureau of Labor Statistics, Report No. 332, "Current Population Reports," Series P. 23, No. 24; "Social and Economic Conditions of Negroes in the United States," (U.S.G.P.O., Washington, D. C., October, 1967) pp. 10, 24.

jurisdiction.

A-8.5 The Pollution Control Problem in Urban Areas

Perhaps a more alarming consequency of government proliferation in urban areas has been the rising institutional complexities in attempting to attack the problem of pollution and the tendancy for pollution to spread with fractionalized government. Where the primary sources of pollution are located in a community such that they occasion little or no adverse effects on the property values or health of its residents but instead create such costs for neighboring jurisdictions, there will be little incentive for local pollution control efforts in the absence of regulation by a higher authority. This problem of negative externalties (also referred to as negative spillover, negafits or external cost) thus arises where it is possible for one political jurisdiction to create social costs for one or more neighbors. And it is just this situation that is likely to occur in urban areas characterized by numerous municipalities that have local authority to regulate pollution.

One reasonable approach to resolving the pollution control problem is to "internalize the externalities"; that is, assign pollution control responsibility to a government jurisdiction whose spatial authority encompasses the area over which benefits occur. Obviously, it is necessary to define the geographic boundaries within which air, water or noise pollution exist for each urban in order to determine the appropriate jurisdiction for regulation. To the extent that sensors could accurately measure the type, concentration and spatial distribution of pollutants, an earth resources survey system would be of value to define benefit areas. Moreover, constant surveillance by the system might enable the regulatory authorities to detect specific resources of pollution and apply the appropriate penalties for such activity. This use, however, is likely to be limited to areas where polluters are not spatially concentrated so that individual acts of pollution are readily discernable.

But assuming an earth resources survey system can provide both information on pollution than currently exists, there remains the pressing needs to develop government institutions, control legislation and procedures to utilize the data for the improvement of man's environment.

A-8.6 Rural Land Use

Several of the problems of rural America are not unlike some for the difficulties of central cities. A recent study by the Advisory Commission on Intergovernmental Relations provides impressive evidence of rural inferiority with respect to the extent and quality of education, health facilities and housing compared with urban areas.[5] As

5. See B-8, item 2, pp. 23-24.

in the case of the cities, poverty exists for a much larger proportion of rural residents than in the S. M. S. A.'s.[6] Moreover, in the last decade rural population has stagnated, with the rapid decline of farm families having been nearly offset by the increase of non-farm families in non-urban areas.[7] Two major trend differences between the cities and the rural periphery are that rural areas do not lack land space for development and that the non-white percentage of the population is declining rather than rising as in the cities.

While the rural population has declined only about half a million from 1950 to 1960, several sections of the nation experienced declines of over 10%. These areas included most of Appalachia, the southern interior plain from Texas through Georgia, marginal corn production sections in Iowa and Missouri, a substantial part of the Ozarks, plus much of the Great Plains.[8] It can be expected that if economic activity does not improve in the above sections of the country, continued out-migration will prevail, which will not only raise population density in many already crowded cities but also seriously reduce the already scarce supply of capital and competent people in the rural areas.

If the United States is to avoid long term "overurbanization" and its resultant economic and social costs, efforts must be made to improve economic opportunities in rural areas. This does not mean the development of government programs in every rural county. Rather, improvements to and addition of social overhead capital should be concentrated in areas of some vitality and economic potential, e.g., the growth enclaves of depressed areas. These so-called "growth polls" frequently are small to medium-size towns that already are absorbing surplus farm populations from their hinterlands. Because of their proximity to poverty, these towns experience little difficulty in recruiting semi-skilled or unskilled labor from the ranks of the unemployed. Moreover, most experience economies of scale as they extend several public services relative to the diseconomies that frequently exist with provision of such functions in large cities. It also is possible that new towns can be developed in rural areas to exploit promising opportunities, including recreational activities. As in the case of developing countries, an earth resources survey system could make a useful contribution to rural development--including relief from excessive urban growth--by indicating geographic areas for potential resources development, particularly those places which have experienced persistent poverty or unemployment levels above the national average.

A-8.7 References: See Appendix B-8

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6. See B-8, item 2, pp. 24-25.

7. Ibid, pp. 19-22.

8. Ibid, pp. 20-21.

Appendix A-9

EDUCATION

A-9.1 Introduction

To the person who reads the literature dealing with the problems facing education, it becomes obvious that the problem areas are numerous and the approaches to them even more numerous. We can discuss the troubles of a too-rigid curriculum, the lack of dedication in many of our teachers, the diversity in background and capacity to learn in our students or the emphasis placed on science and technology by so many institutions, but underlying all of these is the basic question, does contemporary education answer the needs of contemporary living and its ultimate goal of the survival and progress of man?

Thomas Jefferson seems to have had an insight into the basic problem when he said, "If a nation expects to be ignorant and free, in a state of civilization, it expects what never was and never will be." If a student considers each step of his education as something to traverse before starting a new experience in learning, he has lost all perspective about obtaining an education that is meaningful, mind-expanding and directed toward society's problems. This product of our educational system has no more potential toward reaching a goal of preserving mankind and moving mankind than a brick wall. As Thomas Braden[1] has said, "The purpose of education in our country is a very practical one. It is to make self-government work." But self-government can work only as well as the educational system allows it. Footlick[2] attributes the following very pertinent quote to Professor Zacharias: "A Hitler or McCarthy could not survive in a society which demands evidence which can be subjected to examination, re-examination, to doubt, to question, to cross-examination." If an unfounded dogma or an outright demagogue attempted to penetrate this society, it or he would be found out and eliminated.

A-9.2 Function of Thinkers

As a corollory to this is the fact that our society must learn and practice due process in laws applicable to all its elements. Without due process, we have instant demagogery. Although not applied to due process, Leo Rosten[3] wrote a powerful paragraph on the function of the thinker which really encompasses the basic tenets of due process (i.e. to search out all aspects of the truth). Rosten wrote, "To me, the function of the thinker, the scholar, the philosopher, the scientist, or the teacher, is to challenge what seems foolish, or irrational or wicked or even obvious; to search for the truth, no matter where it leads; and to try to find what it is--not what you want it to be, or hope it to be, or prefer it to be. To be an intellectual means to have made a deep commitment of the self, to love ideas, to examine and explore and test them, and even to try to find the conditions or the experimental condition in which your ideas can be shown to be not true. In one sense, no experiment ever fails, for it teaches us that certain correlations do not hold up or do not give us an expected result, and in that they have taught us something we did not know before."

A-9.3 The Influence of Technology

How does technological advance fit into the functioning of self-government? G. T. Seaborg[4] sees the seeming plethora of scientific and technological information as a creative evolution he calls a "Scientific Revolution," the results of which will have tremendous influence on all. He states, "Science, as the central force in this creative effort, is intricately interwoven with government, industry, business, and our whole society and environment. Indeed, the survival of our new way of life depends upon the good health and expansion of scientific effort. . . . Our crystal ball contains little hint of the laws of nature that will be discovered in the future. But with the knowledge of the past, it is possible to foresee to some limited extent, the potential effect of the social application of science in the future." Seaborg sees advances in technology bringing all forms of people together by probing the universe and the far reaches of the earth and by introducing as well as developing forms of mass communication not known to previously isolated societies or to our own.

A-9.4 Ultimate Goals of Educators

But what should we communicate to the people of the world? What should be the highest aims of education universally? Aristotle[5] argued for political education. "The citizens of a state should always be educated to suit the constitution of the state. The type of character appropriate to a constitution is the power which continues to sustain it, as it is also the force which originally creates it." and Raymond English[6] echoes this when he says, "The conclusion that our heritage of creative, speculative and expository literature should be the central concern in the education of free men has been unescapable. . . . Any teacher who dodges the issue of the tension and anxiety of the politics of freedom by resorting to vague complacent abstractions, like those set forth annually in prize essays on "Democracy" and "Why I love America," is unconsciously acting the part of an indoctrinator rather than that of an educator in a free society."

Seaborg,[4] in the previously mentioned article on the "Scientific Revolution" sums up what he calls the larger aims of this revolution thusly: "In my opinion the larger objectives of higher education stripped to their essence, are as follows: first, to expand and accelerate the process of creative evolution; and second to ensure that this process serves and gives further meaning to the modern Western concept of the individual as the focus of human values." Seaborg feels that these objectives are inseparable and equal but it is difficult to conceive that the value of the first objective can persist if the second is not mandatory and an antecedent. Without the second objective, the first could decay into interesting data collecting.

The value judgements placed on which disciplines are most urgent to meet modern needs borders on fatuity since strong and equal cases may be made for virtually all, but an obvious need applicable to all disciplines and about which something can be done is the up-dating of the methods of education. In this regard, it may be appropriate to mention an article that anyone concerned with the future of education should read. It is entitled, "A Twenty-first Century Look at Higher Education," written by Alvin C. Eurich. Eurich attempts to look back in time from the 21st Century and evaluate the steps that took man to a better scheme of educating. He assumes that the major difference between future schools and today's is not the curriculum but what he calls the use of learning resources." Basically this means that the techniques and use of devices for teaching will improve so much that the best teaching will be available to all students and instruction will be adapted to individual rates of learning. This is an enlightening article but space prevents detailed review of it.

So where are we? And which direction should we go in education? It is safe to day if modern man is to be enlightened by his education, if he is to reach a level of understanding which will allow him to make self-government work, his initial task is to abolish the myths by which we live and which lessen the effect of our education system. Some of them have been enumerated and briefly discussed by Leo Rosten[3] in his article previously alluded to. One myth can be mentioned that seem apro pos. As Rosten puts it, "...the myth that schooling is education, that every child has a right to go to college; that the most important things that happen in college are educational; that young people go to college in order to get an education; and that education is the best thing in the world for everybody." He argues that there is now and always will be a need for mechanics, plumbers etc., and that many children are forced into college by their parents who desire to get rid of them or to get them to an environment where they will meet a nice boy or girl. He argues that IQ is not the only standard for guaging the value of an individual to society. With these points, it is heartily agreed. However, one can question that young people do not go to college for an education or that the most important things that happen in college are not educational. This seems to place much of the shortcomings of the system on the student; the educational system may be more at fault here than the individual. It seems that most students arrive on campus in awe of college and are aroused to learn and expand their minds, but they are introduced to a multitude of facts in a rife of coursework in areas that are frequently of little interest to the individual, all presented in a formal, and often boring manner. This is generally not conducive to expanding or stimulating the mind.

Margaret Mead[8] also asks some questions that provoke thought: Why should school terms and length of schooling be inflexible if people learn at different rates? Why should the initial school age of a child be five or six when some are ready for school before and some not until after that age? Should the federal government assume more responsibility for education? Is it the right of every child to receive more and more education? Why can't some of the basic skills be taught at home, especially if the child attends a "poor" school? Which learning, at which time, by what methods belong in our schools?

A-9.5 Conclusions

There are other questions and much rethinking of answers to be done, but in the final analysis, it appears that the educator is slow to change. He still attempts to plod along with many horse-and-buggy techniques attempting to apply them to the jet age. The problems of curriculum, of dedication, of incentive, of finances, of techniques, of dissatisfaction and dissent are all real enough, but it appears many of these are manufactured by our educational system and dispelling the myths with which we live by using our learning resources to a greater capacity may provide at least the initial step toward an educational system that will answer the educational needs of modern man better.

A-9.6 References: See Appendix B-9.

Appendix A-10

POLITICAL AND LEGAL IMPLICATIONS

A-10.1 Introduction

The Space Age could be said to date from October 4, 1957 and the successful flight of Sputnik I. Just as the initial emphasis which encouraged the development of aircraft was for military uses, rocketry at first tended to concentrate on guided missiles and warhead payloads. Another parallel can be seen in the initially high costs of putting aircraft in the air and the launching of spacecraft. For example, in 1909 a plane could only travel at about 43 mph with a pilot and one passenger. The plane had a useful life of about 30 hours and cost $30,000. The cost per passenger mile might then turn out to be something like $25 per passenger mile or, in 1960 dollars, $80 per passenger mile. Today, the cost of operating a jet airplane, flying more than 10 times as fast and with a useful range of almost 100 times what was possible in 1909, with 100 times as many passengers, is only a few cents per passenger mile. Similar progress might be anticipated in space.[1]

Technology seems to have responded, in both instances, primarily because of what were considered urgent security needs, real or imaginary, and only after this initial demand was met, did technology begin to respond to needs of a more fundamental and perhaps more justifiable nature. The major impetus for space technology in the United States at present is civilian and not military. NASA is almost entirely non-military and accounts for about 70% of U.S. space effort. Most nations of the world are now in agreement that space should be used for peaceful and not for military purposes.

Almost 700 space shots were made in the first decade of the Space Age, including artificial earth satellites serving numerous and technical purposes, manned space flights, lunar landings, and probes into outer space. The rapid development of space technology has already created numerous political and legal problems and still more are bound to come. These must be resolved

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1. See B-10, Item 1, pp. 13-14.

through statesmanship, military policies, diplomacy, and imaginative planning in the fields of international law and international organization.

Although legal and political problems are often closely inter-related and not sharply distinguishable from one another, some degree of separation is warranted on the basis of establishing basic principles or ground rules for the use of outer space on the one hand and establishing means of securing cooperation in the application and implementation of those principles through the use of existing organizations or the creation of new ones in the national and international community.

A-10.2 Origin of Space Law and Proposed Models for Space Sovereignty

The origins of space law are to be found in the field of international law and, more specifically, in air law and the law of the sea. International law itself stems largely from principles of common law dating back to ancient Rome. The Paris Convention of 1919 for the regulation of air navigation claimed complete and exclusive sovereignty over the airspace above the territory of every power or state but failed to define what is meant by "airspace". In 1944, the Chicago Convention was signed by all of the major powers except the Soviet Union and Communist China and it re-asserted the principle of exclusive jurisdiction over the airspace above a nation's territory. An aircraft was defined at this time as "any machine which can derive support in the atmosphere from reactions of the air".[2]

The question is still unanswered as to the extent upwards a nation's sovereignty extends, although many answers have been suggested. One proposed by Hans Kelsen and known as the "pie-wedge" theory held that the zone would vary with the rotation of the earth and the natural movement of other celestial bodies.

Another is based on the notion that a state may claim sovereignty over whatever area within which a state can make its laws effective to the exclusion of all other states. This, too, would result in airspace zones of varying size dependent on a nation's antiaircraft or antimissile firepower and assumes that might makes right, a doctrine not likely to be accepted by very many states.

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2. Ibid, p. 116.

It is generally agreed that a state should have the right to its own airspace but the atmosphere can be held to extend to as much as 20,000 miles above the earth's surface. However, half of the entire mass of the earth's atmosphere is less than $3\frac{1}{2}$ miles above the earth's surface. Aerodynamic features which result in the flight of airplanes almost completely disappear by about 50-60 miles but new hybrid craft may be able to pass back and forth across this "boundary". Thus, any proposal for dividing airspace from outer space can not be supported by unchanging data of scientific certainty. The U.N. Committee on the Peaceful Uses of Outer Space was unable to reach agreement on any definition of outer space.

The U.S. Government has tended to favor a 25 mile limit by some writers, and 52 miles urged by others as the "height at which centrifugal forces take over". Andrew Haley suggested the "Karman line", a curve of altitude plotted against velocity, connecting the points at which aerodynamic flight effectively ends and centrifugal force takes over, approximately at an altitude of 55 miles, but experimental rocket planes have already blurred this distinction.[3]

The lowest height at which artificial unpowered satellites can be put into orbit at least once around the earth has also been urged as a possible boundary-somewhere between 70 and 100 miles, but performance figures of some satellites raise the possibility of having a single satellite subject to two different legal orders. Auxiliary power sources on satellite vehicles would enable them to orbit at lower altitudes.

John Cobb Cooper, one of the pioneers in the study of space law, suggested a contiguous zone between territorial airspace and outer space about 300 or 600 miles wide in which the right of innocent passage of nonmilitary craft would be permitted as in the territorial waters of a state. A different proposal would exempt from national territorial sovereignty all craft which describe orbital or suborbital trajectories.

There is also a school of thought which argues that a definition should be concerned with space activities rather than space itself. The means used or the purposes intended are other distinctions considered. Another source

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3. *Ibid.* p. 119.

of disagreement arises over the question of whether a definition of airspace is urgently needed or whether it might not be desirable to continue ambiguity in defining territorial and international limits to avoid premature definitions that could prove inadequate in the long run.

A-10.3 International Working Agreements

The question of national soverignty in outer space has already been settled. The Soviet Union successfully landed national symbols on the moon in September, 1959 which might have been used in support of claims of sovereignty but all territorial claims were rejected. In October of the same year a Soviet map of the far side of the moon based on photos taken at that time assigned Russian names to most of the major lunar features here but international agreement in 1967 resulted in lunar names for both Soviet and American discoveries. A unaminous U.N. resolution in 1961 rejected the idea of any sovereign claims to celestial bodies. In addition, international law, including the U. N. Charter, were held to apply to outer space and celestial bodies and the principle was established of free use of outer space without objection by the state over which a satellite passes.

The United States and the Soviet Union both announcment of their intention not to place in orbit nuclear weapons or other weapons of mass destruction was followed by an unaminous U.N. General Assembly Declaration of Legal Principles Governing Activities of States in the Exploration and Use of Outer Space in December, 1963. The United States recognized it as reflecting international law and later, in 1967, its principles were included in the Outer Space Treaty of 1967.

Article I pledges international cooperation in space, all states being equal in rights and in the enjoyment of free access to any area of any celestial body. Article II declares that space is not subject to national appropriation and specifically includes the moon. All signatories agreed not to station in earth orbit or on celestial bodies any nuclear weapons or any other kind of weapons of mass destruction. The establishment of military bases, installations and fortifications, the testing of any kind of weapons, and the conduct of military maneuvers on celestial bodies was also banned. All installations on the moon and celestial bodies are open to members of other states on a reciprocal basis, provided reasonable notice is given.

The Treaty establishes astronauts as the "envoys of mankind" and extends to them the traditional courtesies given to seafarers. All parties agree to give astronauts all possible assistance and to warn them of possible danger. A separate treaty on the Rescue and Return of Astronauts was subsequently completed in December, 1967. Astronauts or any space objects landing unintentionally on the territory of a signatory, or on the high seas, are assured of speedy assistance and return to their homelands. Expenses incurred are recoverable from the launching authority. Searching operations are to be controlled by the host government however.

Each state is responsible for the activities of any of its agencies such as NASA, or of nongovernmental agencies like ComSat. Intergovernmental organizations such as the European Launcher Development Organization (ELDO) are to be held responsible jointly with each of the states participating in the organization. States launching objects in outer space become internationally liable for damage beyond the state's domestic borders and extending to wherever the danger may occur from earth through airspace to outer space and back.

Ownership of space objects and of personnel in space is retained nationally by the states that are parties to the Treaty of January, 1967. Objects found beyond the limits of the responsible state are to be returned to the owner on receipt of proper identification. The United States still has no authority under domestic law to obtain possession of space debris that falls on private property however.

A-10.4 Unresolved Problem Areas

The question of damages is still being negotiated. Agreement is needed on how costs are to be shared, how damage is to be measured, and which tribunal is to adjudicate. One engaging in an activity involving undue risk to his neighbors is liable for any injury which may take place, even though the activity be lawful, according to present legal doctrine and there are already some legal precedents for this in international law.

Proof of fault is required in collisions of spacecraft and governments, rather than airlines would be liable. John Cobb Cooper suggested that each state create a guarantee fund to compensate its own nationals and accept the compulsory jurisdiction of the International Court of Justice so that the state could eventually recover from another state.

This idea was also suggested by the Council of the

Inter-American Bar Association in its so-called Magna Carta of Space adopted at Bogota' on February 3, 1961 and an international insurance fund to provide for compensation was likewise recommended.

Finally, consideration has been given to the rights of other sentient beings on celestial bodies that might be encountered by man. Andrew Haley, another pioneer in space law study, suggested what he called Metalaw: "Do unto others as they would have you do unto them."[4]

An Ad Hoc Committee on the Peaceful Uses of Outer Space was created in December, 1958 by the U.N. General Assembly and it concluded that "premature codification might prejudice subsequent efforts to develop the law based on a more complete understanding of the practical problems involved."[5]

A-10.5 References: See Appendix B-10.

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4. Ibid, p. 128.

5. Ibid. p. 131.

Appendix A-11

AGRICULTURAL NEEDS AND APPLICATIONS

A-11.1 Introduction

The need for application of remote sensing in the area of agriculture is well established. Many societal problems can be directly attributed to uneven distribution of the world food supply. Hungry people are never content to live beside well fed people. An earth resources survey system can possibly be utilized to inventory, predict, and increase the potential for world food production, and to aid in the distribution of the food supply.

An operational earth resource survey system could be expected to respond to the need for providing periodic agricultural data on drought, disease, insects and other infestations in addition to crop identification and maturity data.

A-11.2 Sampling of Agricultural Data Users

The agencies, groups, and individuals who would utilize the data include the following:

1. Agricultural producers
2. Government agencies (efficiency and economy)
   a. soil conservation service
   b. economic research service
   c. statistical reporting service
3. Industry (demand for distribution of agricultural chemicals and fertilizers)
4. International agricultural development agencies (automatic surveys of soil and vegetation)
5. Research scientist (agricultural economist, economic geographers, soil scientist, land use planners)
6. World financial structure

It is noted that the agricultural interests would also be directly served by meteorological and hydrological data that could be obtained as part of an earth resource survey system.

A-11.3 Agricultural Data Needs and Sensor Selection

A-11.3.1 Introduction

A review of the agriculture area indicates numerous basic and specific needs, and these are outlined below. A paragraph synopsis is presented for each basic need area and where possible the sensor requirement is identified. It is recognized that the monetary value of a need considered for aerial survey must not be the criteria for experiment selection. Basic scientific questions if answered expand scientific knowledge and ultimately lead to economic significance. Biological accomplishments should be identified in terms of new discoveries and insight of processes and occurrences in our environment. Many observation and measurements are now gathered by ground surveillance or airplane, but spacecraft projection would be more complete and swift eliminating time as a variable. Data collection, accuracy in resolution, interpretation, and dissemination pose the difficulties.

A-11.3.2 Land Planning and Management

Tone and color contrasts in visible and near infrared imagery are the items to be measured. Applicable sensors include infrared spectrometer, infrared radiometer-scatterometer, return beam vidicon camera, multi-spectral scanner, or metric mapping camera. Resolution of 100' seems feasible for the parameter measurements with a minimum coverage of twice annually. Harvest schedules need more frequent monitoring to coincide with seasonal variations in order to precisely time application and distribution of chemicals and fertilizers.

A-11.3.3 Animal Inventory

Continued aircraft survey would appear more feasible than spacecraft usage for animal inventory specific needs due to the high resolution requirements for individual animal counts or analysis.

A-11.3.4 Grazing Inventory

Texture, tone, intensity, and density appear to be parameters covering specific needs as forage utilization, litter accumulation, rodent damage, or reseeding areas. Resolution of 100' or better using such sensors as a multispectral scanner, panoramic high-resolution camera, multiband synoptic camera, infrared imager or spectrometer could be employed. Frequency of monitoring would be 2 to 4 times per growing season. Needs concerned with measuring water could best be monitored by thermal infrared sensors at a once or twice per year frequency.

A-11.3.5 Soil Analysis

Soil analysis is needed for 1) identifying potential crop producing lands, and 2) identifying soil deficiencies that can be corrected in order to increase crop yields. Soil characteristics can be directly related to tone and color contrasts of images in the visible and near infrared and by radar imagery. In addition, soil characteristics can be inferred from vegetation types (see crop census) and from temporal and spatial variations in surface temperature as measured by infrared radiometry and imagery in the 8--13μ band and by microwave radiometry. After an initial global survey, coverage every 5--10 years is sufficient. Considerable ground truth is required to develop signatures for soil characteristics. More frequent coverage may be needed in the initial stages when signatures are being verified. A resolution of 100 feet is required.

A-11.3.6 Crop Census

Crop census information could be used for 1) establishing an inventory of world agricultural crops, 2) planning and managing the world supply of food and fiber (harvest predictions during growing season, diversifying one-crop economies, etc.), and 3) verifying farmer compliance in government crop control programs. A crop census will consist of the identification of crop type, quanity, boundary, vigor, and state of maturity. Census conducted periodically will establish the time dependent crop characteristics such as growth rate and crop rotation patterns.

Multi-spectral imaging in the .3--1.2μ range can be used to identify vegetation types by the use of crop signature analysis. Crop types can also be inferred from spatial temperature distributions obtained by the use of infrared imagery and radiometry in the 8--13μ band. A complete global census may be advantageous. Harvest prediction programs will require monthly coverage in selected areas during the growing season. Government crop control programs will require annual coverage. Considerable ground truth will be required in order to develop signatures. A resolution of 100-200 feet is required.

A-11.3.7 Stress Detection

Stress detection capability is desired in order to optimize the world food and fiber supply through 1) detection of stress so that corrective action can be taken quickly, thus minimizing crop loss, and 2) planning, both prior to an during the growing season, to minimize the effect of crop stress on the world food supply.

Fire detection can be implemented through infrared radiometry in the 3.5--5.5μ band. In addition, temperature measurements and dry vegetation conditions can be used to identify regions where fire potential is high. Potential and existing drought conditions can be identified by measuring vegetation signatures with multi-spectral scanners. Diseased and insect infested crops can be located by the use of multi-spectral scanning and also inferred from crop temperatures. Crop temperatures can be measured by infrared radiometry and imagery in the 8--13μ band. Fire coverage frequency should be at least several times per day during the dry season. Survey for disease and insect infestation should occur several times during the growing season, with additional coverage if significant stress is detected. Required resolution is 100 feet.

A-11.3.8 Water Resources

A determination of available water resources is needed in order to predict the crop size a particular region will support during a season. Snow bank volume can possibly be measured with passive microwave systems. Determination of surface water supplies available for irrigation and small ponds for watering livestock can be inventoried by use of imaging in the visible and near infrared band. Several snow bank measurements will be required during the winter and spring. Surface water inventory 4--6 times during the growing season is required. Resolution of 1000 feet is probably sufficient.

A-11.4 Related Agricultural Areas

A-11.4.1 Archaeology

Sensors identifying archaeological sites would require high resolution but with a monitoring frequency of one. Distinguishing stone alignments or remains of extinct canal systems continued by aircraft survey until resolution reaches 30 feet or less is recommended. Sensors useful include metric mapping camera, panoramic high-resolution camera, near infrared radiometer and image.

A-11.4.2

Foliage density, dominant species, plant vigor and related measurements require only color, texture or tone distinctions covered by thermal infrared sensors, or multiband synoptic cameras. To delineate plant communities, dominant species or specific plants would best be accomplished by aircraft with the present state-of-the-art.

A-11.5 Specific Agricultural Data Needs

GENERAL AREA	SPECIFIC AREA
soil analysis	glacial deposition
	bedrock features
	texture
	soil phases - profile
	soil consistency
	chemical composition
	pH
	salinity
	porosity - permeability
	temperature
	types
crop census	status
	density
	maturity, yield
	type
	boundary
	growth rate and changes
	crop rotation pattern
	slope and crop row direction
	fallow acreage
stress detection	soil and water temperature
	hail
	drought
	air pollution
	wind
	fire
	disease location
	disease rate of spread
	disease type
	insect infestation
	flood
	weeds

A-11.5.3 Specific Agricultural Data Needs (cont'd)

GENERAL AREA	SPECIFIC AREA
water resources	farm pond sites
	run off
	soil capacity
	snow volume
land planning & management	irrigation
	drainage
	erosion
	reclaimation profile
	agr. chemical distribution & production fertilizers and mineral deficiencies
	terrain survey - land forms
	harvest schedule - seasonal calculations
animal inventory	livestock census
	livestock disease
	potential density of herd
	livestock age or size
	livestock sex ratio
grazing inventory	areas needing reseeding
	rodent concentration
	salt grounds
	locate spring and watering sites
	fences
	evaluate forage utilization
	litter accumulation
	water purity - pollution
	overgrazing areas

A-11.6 Specific Data Needs of Related Agricultural Areas

GENERAL AREA	SPECIFIC NEED
archaeology	archaeological excavation sites
	ancient road & canal systems
	stone alignments
	foot trails, moats
botany	species mapping and identification
	plant indicator for mineral location
	delineate plant communities
	foliage density
	dominant species
	plant vigor index
	ground cover - accumulated litter

A-11.7 Parameters

One or more signature parameters needed for each specific need include temperature, time, height, color, area size, texture, water concentration, tone, spatial distribution, bioluminescence, intensity, light, density, inclination, volume, repetitive cycle, and infrared radiance.

A-11.8 References. See Appendix B-11.

Appendix A-12

FORESTRY NEEDS AND APPLICATIONS

A-12.1 Introduction

There are similarities in remote sensing of forestry resources and agricultural resources (see Appendix A-11). The approach employed here follows that used in presenting the summary information for the agriculture discipline, Appendix A-11. A paragraph synopsis is given for each basic need area.

A-12.2 Census

All the specific needs listed in this general area could be measured using electro-magnetic radiation in the visible and near infrared (.35-1.5μ) range. A camera or equivalent imaging device would be the probable sensor. Multispectral imagery would be required to obtain species signature. With color spectral analysis it is possible to determine to what extent the land is utilized by forestry, to detect the state of advancement of forest growth, and when the forest should be ready for harvest.

A-12.3 Stress Detection

Infrared detection observation techniques can indicate the early outbreak of forest fires. By color analysis techniques it is possible to detect disease in forests. From color variations by way of signatures an indication of a particular line of disease, insect infestation, drought, flood and wind storm damage can be assessed in forests.

All the measurements in this area could be measured in the visible and near infrared range using a camera or equivalent imaging device.

A-12.4 Site Quality

Texture, tone, hue, and patterns of timber and vegetation measured by visible and near infrared imagery coupled with information available on vegetation, soils, and surface temperatures from ground truth would allow inference of site quality for forestry needs.

Aircraft survey would appear more feasible than spacecraft usage for wildlife census, bird migration and their nesting areas due to the high resolution required.

Microwave reflections in various frequency bands for inferring soil type, moisture composition and porosity measured by radar imagery could be employed.

A-12.5 Topography

Optical imagery with a camera or optical scanner would allow mapping of haul roads, rock crops, river drive routes, etc. that would facilitate logging operations. Tone and color contrasts would indicate erosion potential, possible new recreation areas, and sites of gravel, sand, and clay for road and dam building.

A-12.6 Summary

In summary, the most useful sensors for forestry and related disciplines such as agriculture, employ thermal infrared or photographic imagery. Many specific needs now desired will require better sensor resolution before airplane monitoring techniques can be traded for spacecraft. The ideal system would utilize the best combination of ground, aircraft, and spacecraft sensing capabilities.

A-12.7 Specific Data Needs of Forestry

GENERAL AREA	SPECIFIC NEED
census	density (crown closure) type (inventory, species) boundary of forest trunk diameter height of stand growth increment of stand tree malformation harvest rate regeneration rate
stress detection	fire control disease location disease rate of spread disease type insect infestation flood wildlife census (overpopulation)

GENERAL AREA	SPECIFIC NEED
	drought
	air pollution trends
	wind storm
	cutover survey
	seasonal change (leaf bloom and fall)
site quality	annual rainfall
	seasonal temperature
	soil type (pore space)
	soil fertility
	soil mineral content
	humus depth
	soil moisture
	water table
	wild life census (numbers and types)
	bird migration and nesting areas
	profile and cover change
topography	haul road--strip road layout
	chart rivers, creeks, lakes
	chart rock outcrops
	log routes--river drive routes
	river control dam sites
	sites of gravel, sand, clay for road and dam building
	relief of area (slope, ridges)
	erosion
	identify new recreation areas

A-12.8 References: See Appendix B-12.

Appendix A-13

GEOLOGY

A-13.1

Geologic natural resources are capable of being used for the satisfaction of a wide variety of human wants. Consequently, improvements in their location, inventory and use management is of real concern to mankind.

A-13.2 Types of Geologic Materials

Energy materials include:

1. Oil and gas
2. Coal
3. Nuclear Fuels
4. Geothermal

Industrial materials include:

1. Metals
2. Chemicals (salt, lime, sulfur, etc.)

Construction materials include:

1. Stone
2. Sand and gravel
3. Clay

A-13.3 Relation of Geology to Other Disciplines

Geology is related to a number of other disciplines among which the following are especially important:

A. Hydrology
B. Oceanography
C. Cartography
D. Geodesy
E. Geography
F. Geophysics

A-13.4 Geologic Needs and Know-How

Geologists are proficient in the interpretation of photographs and maps, based on recognition of surface patterns and features. The use of non-ground-based remote sensors is largely in the experimental stage. The specific needs for data which follow are biased toward usefulness to geologists in the immediate future.

A. Specific needs-surface features

1. Soils
   a. color
   b. water content
   c. texture
   d. topography
   e. elemental composition
   f. mineral composition
   g. vegetative cover
   h. density
   i. temperature
2. Rocks
   a. color
   b. density
   c. elemental composition
   d. mineral composition
   e. topography
   f. temperature
3. Fold and Fault Structures
   a. movement
   b. water content
   c. temperature
   d. topography
4. Rock alteration zones
   a. color
   b. water content
   c. elemental composition
   d. mineral composition
   e. temperature

B. Specific needs-subsurface features

1. thermal
2. magnetic
3. gravity
4. seismic

A-13.5 Sensor platforms and times of observations

A. Platforms

1. aircraft
2. balloons
3. ships

4. satellites
5. ground

B. Time of observations

1. relations to orbit and sun-angle
2. relations to location
3. relations to phenomena

A-13.6 References: See Appendix B-13.

Appendix A-14

GEOGRAPHY, GEODESY, AND CARTOGRAPHY

A-14.1 Introduction

The most pressing need is to obtain sufficient data at the earliest possible time which provides a current inventory of our resources. The obvious questions which arise are: (1) Which data is necessary?; and (2) How often should it be taken?; and (3) What quality is necesary to distinguish the information desired? Assuming these questions can be answered one is then faced with the following decisions: What is the minimum amount of data and its format which will be useful to the largest audience? What are the criteria for priority determination if a limit is set on the amount of data collected? Can the best platform for its collection? Once this level of decision making has been made one is faced with the decision regarding data processing and distribution. Who is responsible for dissemination of the collected information and in what form?

A-14.2 Needs and Problems of Measurement

From a geographer's, geologist's and cartographer's point of view the measurements required are quite "simple." In the electromagnetic spectrum we can measure spectral or band reflectance of incoming energy; spectral or band absorptance of incoming energy or spectral or band emission of energy. In looking at this data we look at spectral or band intensity and contrast as a means of signature analysis. The problem is in deciding which band or bands to use and how large they must be to obtain the desired signature. The first decision is to decide whether to select those bands which contain the maximum information for a maximum number of users or to select as many bands as possible in hopes of providing as much information as possible. Obviously this decision cannot be reached until sensor technology and signature research has progressed to a certain confidence level. The other measurements required involve time synchronization between events, frequency of observation and position measurements; area location, relative position, angular location and absolute location. A careful distinction should be made between global, regional and local measurements to optimize the features offered by satellite, aircraft and ground platforms. As in any operational system, the criteria for data selection should be the ultimate usability of the data. To this extent nobody can predict the ultimate user or use of the data but certainly the data format selection should contain sufficient information so that it will be available to the widest audience of users for further processing. More than likely the data transmission link between the sensor platform and data collection center will be the ultimate constraint.

As far as the cartographer is concerned, as well as other users, the first need is for global mapping. On a global basis, maps of the medium scale (1:250,000: 1,000,000) would provide the greatest amount of general information concerning the physical features of the earth. The physical features include biological, geological as well as cultural features. The common parameters to be viewed can be listed as identification of rock types, soil types and vegetation types for the purpose of location distribution and time variations. In addition these and other features (i.e. pollution, man-made activities and structures) might be recognizable by one or more of the parameters measurable in the electromagnetic spectrum such as temperature, moisture content, specific chemical content, etc. Regardless of the map usage, all maps are concerned to one degree or the other with areas and their spatial and quantitative content.

The geodetic interests are more refined and highly specialized. Although he can use most of the data acceptable to the geologist and cartographer, his needs require global observations with acceptably high resolution. Fortunately location and displacement measurements in a global sense do not require frequent measurements.

An additional problem facing the cartographer and geographer is the lack of people with the ability to interpret and analyze data obtained from a satellite. Most investigators are skilled in reading and analyzing aerial photographs so that either the data be converted to a photographic form or these investigators be retained to analyze multispectral data.

The global or synoptic view obtained from orbital heights is an absolute necessity to obtain up-to-date maps which can be used to predict usage, distribution patterns, trends and inventories.

In discussing the advantages of an orbital platform it is obvious that at these heights distortion due to the earth's curvature is minimal and that the frequency of observation of large areas is greatly increased.

A-14.3 Other Constraints

In addition to the extreme sensor resolution requirements of geodetics there are other secondary restrictions. (1) The tracking station locations must be accurately known within ± 1 m. in geocentric coordinates. (2) The orbit must be predictable four to six weeks ahead to ±1' angular accuracy. (3) Orbit analysis must be improved to provide orbit perturbations to ±5 to ±10m. (4) The tracking system must be calibrated to be able to locate the satellite to ±10m. In summary a geodetic satellite must: (1) Have the ability to provide precise relative and geocentric locations of widely separated points on the earth by ground to satellite measurement. (2) Have the ability to provide knowledge of the time invariant and time variant gravitational forces and surface forces acting on satellites from precise analysis of orbital perturbations and by satellite borne gravity sensing devices. (3) Have the ability to provide the precise geocentric location of a spacecraft. (4) Have the ability to provide measurements of time invariant and time variant aspects of vertical geometry of oceans and land on a rapid and continuing basis. It seems obvious that these needs will require a separate platform if such precision is to be attained.

A-14.4 References: See Appendix B-14.

Appendix A-15

OCEANOGRAPHY AND HYDROLOGY

A-15.1 Oceanography

Other than for purely scientific benefit, an operational earth resources system is desirable and useful primarily for biological, navigational and meteorological information. Coastal and shoal mapping, coastal processes, and perhaps marine mineral resources studies would also benefit from a concerted effort to gather data about the marine environment.

Such a system would have three levels of data input, viz. satellite, aircraft, and surface sensors. Satellites can be expected to provide rapid synoptic information on a scale of about 1:10^6. More detailed information is very possible, but at a tremendous penalty for increased processing time; therefore, for that reason, and in particular when one considers the extent of the ocean surface, detailed information from satellites is not desired. Detailed surface resolution might be interpreted as 1000 feet or less, average resolution as 2-4 miles, and coarse resolution as 10 miles or more.

Hopefully, users will not request continuous coverage. As experience is gained in this area, statistical sampling techniques for many purposes should suffice. When such a system is achieved, then more detailed satellite sensed information from a sampling area (i.e. resolution down to ca. 100') would be feasible.

Sensors to be flown in satellites for oceanography purposes should include a multispectral visible system, especially for blue-green signatures, and at least two infrared (solar-reflective and thermal) channels. From this information it should be possible to infer chlorophyll content, turbidity, temperature, humidity, upwelling, fishing success probability, cloud cover and type, major current location, and general weather conditions. (This is assuming considerable progress in remote sensor data interpretation, primarily from the ERST program.)

Buoy readout and relay capability must be incorporated in order to obtain some detailed information (hopefully the locations of these buoys have been chosen to be statistically significant) of surface and subsurface conditions. Buoy information is also needed for calibrations of satellite sensor information, e.g. temperature measurement sensors may have fairly good sensitivity (a few tenths of a degree) but their accuracy is poor (several degrees).

Early remote temperature sensing will be by bolometers, but it is probable that later replacement satellites (ca. 1980) will use microwave systems. All weather microwave and radar systems are highly desirable, but is questionable as to how many of these devices will be operateable from satellites by 1975. If microwave systems become truly operational (GE & RCA Systems) by 1975, then a microwave scatterometer or (a microwave radiometer) should be flown for sea state and temperature information.

One satellite in polar orbit at a nominal 500nm altitude would repeat its track every seventeen or eighteen days. It would come close to the same region every twenty-four hours (ca. 150 miles further over at the equator: considerable overlap near the poles.) Two satellites, twelve hours apart, would provide diurnal coverage of the same areas.

Data gathering satellites should have analog computer capability (reprogramable by digital systems) to recognize cloud coverage so as to reduce the number of fruitless reports due to excessive cloud cover, unless of course, cloud pictures are wanted.

Global coverage by ca. six geostationary satellites should be included for communication purposes. Data center to ships at sea and aircraft, and for data input, viz. distress calls, local weather, water and air temperature etc., sea state information position reports, and fishing effort and success reports. These geostationary satellites should have some meteorology capability, e.g. synoptic cloud cover and temperature sensors. In addition, if satellite to satellite communication can be achieved, it is recommended that these satellites also have on board computers for some data reduction capability.

Aircraft should be employed only in local areas where more specific information is required. For example, over existing fishing grounds (once or twice a day to once a week depending on specific needs) and to explore new areas as indicated by satellite information. They will also serve for search and rescue, and where needed for more detailed coastal mapping, sediment transport studies, and some pollution monitoring. The sensors employed would be the same as those on satellites, plus hard copy and radar capabilities. (Hard copy imagery is not recommended from satellites).

For some aircraft observations it is recommended that a readily attachable pod of instruments to common commercial carriers be investigated and developed.

A-15.2 Hydrology

For an operational earth resources data system, it is recommended that early hydrology needs to be coupled with those of cartography, forestry and agriculture, and meteorology.

There is an immediate need for accurate and complete mapping of water and ice boundaries of a scale of 1:5 x 10^5 (low altitude satellite orbit by microwave and infrared imagery with $\leq$ 500' resolutions) and on a 1:24,000 scale for selected regions (aircraft acquired information by radar or microwave and infrared imagery with $<$10' resolution). Elevation as well as horizontal distance is required. In conjunction with this, complete mapping of ground cover (agriculture and forestry multispectral information) is required for purposes of inferring water run off, evaporation and transpiration rates.

Ground water information might be gained by cooperative effort with geologic interests. (Multispectral imagery from aircraft or satellite and surface seismic, interpretations).

On a long term basis, hydrology and meteorology will have the greatest data intercourse. Due to the fact that meteorological interests are and will be orbiting weather satellites, there is no reason to specifically supplement that sensing capability.

Ground sensors readout capability, viz. rainfall, stream height, turbidity and flow rate etc.) should be limited to those in remote regions only, since for U. S. coverage alone hydrologists are talking on the order of 20,000 stations.

It is hoped that a statistical sampling method for ground sensors, and for satellite sensed data can be developed, otherwise the data handling problem will become emense.

A-15.3 References: See Appendix B-15.

Appendix A-16

LAND-USAGE AND REGIONAL DEVELOPMENT

A-16.1 Introduction

Given the time and manpower constraints imposed on the preparation of this report, no attempt has been made to present a comprehensive list or analysis of land-use issues or needs. Rather, attention is focused on those areas in which an international resources survey system conceivably could favorably or unfavorably influence land use from the standpoint of different countries. Since this system essentially will establish a sophisticated global data gathering program, its value in improving the effectiveness of planning and regulating land use will depend upon how rapidly useful programs and policies relating to land can be instituted from the relevant information provided. For no matter how important the new data may be, its usefulness to man rests upon how effectively it can be meaningfully utilized.

A-16.2 Some International Land-Use Considerations

Before it is possible to conceive of a wholly economic utilization of land resources on a global basis, or for that matter other productive resources, a necessary prerequisite would be the establishment of free trade among nations, including the elimination of all barriers to the mobility of resources. All forms of protection for domestic industries would have to be removed, whether in the form of tariffs, quotas, embargoes, subsidies, cartels, special purchasing agreements, etc. In addition, capital and labor could not be prevented from flowing among regions and nations in such a way as to maximize the returns to their owners.

While significant progress has been made since the early 1930's in reducing trade barriers, particularly among the members of the General Agreements on Tariffs and Trade (GATT), there are no immediate prospects of attaining these free trade and resources mobility conditions in international markets. Indeed, in the last few years demands for greater protection have come from an increasing number of domestic industries partially because of more intensive international competition occasioned by the movement to freer trade and the rapid rate of industrialization in such countries as Japan. Should Congress and other legislative bodies acquiesce to those demand, a movement toward greater protectionism would be established. Consequently, even if there were complete information on the location, quality and quantity of all earth resources, including human capital and capital stocks, together with global distribution of latest technology, there would remain sub-optimal allocation of resources over space occasioned by national laws and policies which limit international flows of goods, services and productive resources.

There are, of course, significant costs which would occur with the continued movement toward free trade, particularly in the short run and in those countries that have several important industries whose existence is dependent upon continuous protection. But in the long run, freeing trade will lend to more rational production and exchange of output and greater world production than could be obtained with protectionism. The value judgement to be made, then, is whether the long run benefits outweigh the short run costs or vice versa in deciding upon world trade policies from an international perspective.

While greater information on the distribution of earth resources might have little immediate impact upon international trade and factor mobility policies among nations, it possibly could enable more accurate estimates of the costs occasioned by such policies, particularly in terms of the loss of world output which might otherwise have been obtained in the absence of these barriers to the free flow of goods, services and resource inputs. Moreover, to the people of underdeveloped and developing countries, who should be especially concerned with economic efficiency to bolster or at least maintain living standards, these costs could raise serious questions regarding the ways societies limit productivity advance.

Suppose, for example, a commercially important mineral discovery occured in a low income country interested in development. With rigid international trade barriers it is conceivable that the country could find no foreign markets for the output resultant from development of the resource and have limited internal demand for the output. The discovery of the mineral would in this case have very limited economic significance and could engender considerable ill will among nations interested in economic growth for their country. On the other hand, suppose the mineral resource is quickly and extensively exploited and sold without restraint in the international market. Such an event could seriously depress the world price of the mineral which, in turn, could lead to fiscal problems for countries dependent upon export of this output as a major source of foreign exchange.

The point is that extensive international discoveries of commercially important mineral or metal deposits over a short time period--a possible result of a world-wide earth resources survey system--could foster international tensions occasioned by the real or imagined distribution of economic benefits and costs resultant from such discoveries among countries. Admittedly, this is a short run consideration and over time one could expect world demand for many resources to grow sufficiently to absorb the added supply without adverse price effects.

A-16.3 Proposing a Regional Development Program

In a recent staff study by Resources for the Future for the United Nations, the methodology is presented for a research-training program in regional development.[1] Given the notable lack of knowledge about the regional development process and the scarcity of persons trained in the areas of regional planning, urban analysis, rural development and industrial development, particularly in underdeveloped countries, the program anticipated an in-depth study of between six and twelve large-scale regional development efforts combined with the training of graduate students in such development-related activities as those just mentioned. To the extent that these studies could identify factors universally critical to the success of development programs, they would make an important contribution to the resolution of the population distribution problems of many low income countries. More specifically, such countries need to develop new and/or expand existing urban places with viable economic bases in order to absorb redundant rural populations which presently cannot by accommodated effectively in major cities because of limited job opportunities and urban social capital. As the Resources for the Future report to the United Nations succinctly observes:

> The high rates of natural increase in these low income countries not only swell urban populations directly but also generate the rural population pressures which are the principal factor in the massive flow of migrants from the countryside into the cities. In some rapidly growing countries, the urban population threatens to double every twelve to fifteen years. In spite of strenuous efforts, however, their economies have failed to generate new employment rates sufficient to match the growth rates of the urban labor force; at the same time, public authorities have not been able to expand urban services and facilities to cope with the growing demand. It is not surprising that social problems have proliferated and that political unrest and instability have spread.[2]

In deciding which locations will be chosen for development efforts, information on the distribution of human and natural resources within nations would appear to be critical initial step. Economic returns from public and private investment undoubtedly will be high in regions that possess a variety of commercially important natural resources, including navigable waterways which connect the areas with important national or international markets In such cases, a multiproduct economic base (export market) can be

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1. See Appendix B-16, item 12.

2. Ibid, p. 29.

developed to create job opportunities initially in the export sectors which, in turn, would generate demand for locally consumed services which are likely to be labor intensive in character. Moreover, as the export market expands and the labor force and population of the region grow, manufacturing activities should appear not only because of the available material inputs and labor resources but also as a result of the growing regional market for such outputs. In short, as the region expands its exports, its growth attracts productive activities closer to the ultimate consumer and the region moves progressively toward greater self-sufficiency through a process known as import substitution. Over time, then, export activities that started the growth process tend to become less important and manufacturing, commercial, and service functions ascend in significance as important employment generators.

This discussion does not suggest reduced efforts to improve agricultural productivity and extend production of commodities, especially in those countries where semi-starvation diets are commonplace. To be sure, greater emphasis in agriculture is important not only to raise living standards but also to employ more people in this sector and slow massive migration to over crowded urban centers. Particularly important would be the development of transportation networks capable of moving agricultural outputs rapidly from areas of surplus production to urban markets where food needs are most pressing. Nevertheless, it would be heroic to contend that even large agricultural development programs in many developing countries could absorb the rapidly expanding labor force. Thus, the need to develop new urban centers with growth potential remains an important objective to stimulate development.

A-16.4 Possible Constraints

Of course, many "slips twix the cup and the lip" may inhibit or even reverse the growth process crudely outlined above in a particular region. Should demand for a region's exports drop in the early stages of development, there is little chance that it will become more than a marginal producer of raw materials and considerable likelihood ghost towns will emerge. But this is more likely to occur in a region that depends on one export product rather than on a mix of exports for its initial growth.[3] Unless careful attention is given to the prevention of air and water pollution during the process of regional growth, firms that rely upon a clean

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3. It follows, then, that discovery and development of additional commercially valuable mineral and metal deposits in a region presently dependent upon a single export is important to reduce the possibilities of cyclial sensitivity of the area and stimulate its growth.

atmosphere or high quality water for operations may seek to locate elsewhere thus reducing the regional growth potential.

There is also growing evidence of the avoidance of polluted areas by United States firms that require highly skilled, scarce labor inputs to produce, probably because of management concern that they will not attract such labor to environmentally inferior locations. Similarly, a failure to provide quality public services--not only such economic overhead capital as roads, waterworks and sewage treatment plants but also social overhead capital like parks, libraries and specialized educational facilities--may; deter entrance of new firms. This is more likely to occur in the later stages of growth where natural resources are not a significant constraint on firm location. What seems apparent, then, is that careful attention to the region's environment and continued stress on improvement of public facilities is necessary if the region is to progress from a simple to complex economy.

A-16.5 Land Use Categories

If the operational earth resources satellite system includes the complete range of data acquisition modes (say, from on-site measurements to measurements from space) then many, if not most, of the physical data needs can probably be met. Two questions often arise: 1. which collection mode is most efficient and/or economical for collecting each type of data; and 2. is there a user who is willing to pay the costs.

Clawson[4] enumerates nine broad land use categories:

1. Residential
2,3. Manufacturing
4. Transportation, communication, and utilities
5. Trade
6. Utilities
7. Cultural, entertainment, and recreational
8. Resource production and extraction
9. Undeveloped land and water areas

These categories were utilized as the basis for outlining land use data needs. Data needs of the last two categories were not explored since these categories seemed to fall within the purview of the other groups.

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4. See appendix B-16, item 9, p. 301

A-16.6 Data Needs of These Categories[5]

I. Residental

A. Urban planning (including regional and national planning)

1. location of activities engaged in by residents
2. trends in location
3. geological, hydrological, sociological, etc. aspects
4. transportation needs of people; now; future
5. population density and location
6. alternative land uses
7. location of building materials, transportation
8. rental prices and/or tenure
9. location of food and energy supplies and transportation systems
10. alternative residental locations, styles
11. control of pollution
12. control and utilization of wastes

B. Value

1. location
2. type
3. size/quantity
4. state of repair, structural defects, etc.
5. activities of surrounding areas
6. relationship to other activities/locations
7. quality of surrounding property
8. alternative uses
9. conformity to zoning requirements and other regulations

II. Manufacturing

A. Inventory of: for property tax purposes

1. location
2. value
3. type of land, land improvement
4. relationship to surrounding activities
5. conformity to zoning requirements and other regulations

B. Urban planning (expansion and/or renewal)

1. location of employees (and trends)
2. location of related activities (and trends)
3. transportation needs
4. geological, hydrological, etc. aspects
5. current land uses

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5. Abstracted from Clawson, Marion. <u>Land Use Information</u>.

6. suitability of particular land areas for particular uses
7. detection and control of resource pollution
8. population density and location, trends
9. location of building materials/transportation

C. Improving transportation patterns

1. location of vendors
2. location of vendees
3. volume/weight, etc. of materials movement
4. current transportation patterns
5. intransit routing and rerouting of materials
6. traffic patterns of employees

D. Detection/control of pollution

1. amounts and types of pollution - air, liquid, solid, noise
2. present disposal systems

E. Plant location

1. property taxes
2. income taxes
3. labor market, availability, skills
4. availability of raw materials
5. type, quantity, reliability, etc. of transportation systems
6. utilities, types, quantities
7. land improvements
8. security/protection
9. education and religion
10. cultural factors
11. attitude of people
12. zoning
13. availability of buildings--quality, etc.
14. geological aspects
15. location of building materials, quality, transportation
16. trends in plant locations
17. location of related industry

F. Planning for industrial location

1. suitability of land for various uses
2. current uses of land
3. current and planned/feasible transportation system

IIIA. Transportation

A. Planning transportation routes

1. amounts of items to be moved, weight, etc.
2. perishability of items
3. geological factors
4. location/transportation of building materials
5. population location and density
6. interrelationship with urban planning, utilities, etc.
7. current inventory, including facility size, traffic loads
8. effects of environmental conditions on traffic patterns
9. storage, maintenance of the various means of transportation
10. location of entrances, exits, terminals
11. costs, benefits

B. Detection and control/avoidance of hazardous conditions

1. location
2. nature of hazard
3. duration of hazard
4. alternative routes
5. dispatch of emergency/repair facilities

C. Traffic control

1. volume, density
2. stoppages, slowdowns
3. alternate routing

D. Mapping/inventory of transportation systems

1. location
2. type
3. quality
4. volume or density handling capabilities

IIIB. Communications

A. Planning communication networks

1. quality, quantity, types of messages
2. traffic patterns
3. geological, topological features
4. protection from natural and man-made hazards

B. Inventory of facilities

1. location
2. type
3. state of repair
4. quantity
5. value

C. Detection of breakdowns

1. location
2. cause
3. extent
4. temporary alternative routing
5. dispatching/control of repair facilities

IIIC. Other utilities (water, electricity, gas)

A. Planning transmission networks

1. location of possible sources, including total quantity and density
2. location of demands, time series of demand
3. location of current sources and transmission networks
4. geological, topological features
5. protection from natural and man-made hazards
6. quantity, density, location, etc., of pollution and waste disposal methods and/or areas
7. location of suitable storage areas (including quantities)
8. safety
9. pollution, prevention and/or control

B. Inventory of facilities

1. location
2. type
3. state of repair
4. quantity
5. value for tax purposes (market, highest use, etc.)
6. conformity to zoning requirements and other requirements

C. Detection of breakdowns, leakage, etc.

1. location
2. cause
3. extent
4. temporary patching/bypassing
5. dispatching/control of repair facilities

D. Location of potential energy

1. hydroelectric
2. oil
3. coal
4. gas
5. geothermal

IV. Trade

A. Impact of new shop/shopping center on shopping behavior

1. quantity of customers
2. volume of business
3. density of population in surrounding area
4. shopping patterns of people

B. Estimation of value for property tax purposes

1. location, size
2. type
3. state of repair
4. relationship to surrounding activities and customers
5. conformity to zoning and other regulations

C. Rehabilitation of central business district

VA. Services (non-government)

A. Location planning

1. population location and density
2. volume of service demanded
3. types of service demanded, level

B. Inventory of property and estimation of value

1. location
2. quantity
3. type
4. state of repair
5. relationship to surrounging activities and customers
6. income

VB. Services (government)

A. Planning government services, facilities location

1. types of service required
   a. social
   b. employment
   c. police
   d. fire
   e. health
2. quantity/quality of service required
3. topological features
4. alternative methods of providing same service
5. evaluation of methods

B. Detection/control of fires and other dangerous events (floods, earthquakes, epidemics, smogs, underground fires)

1. location
2. type
3. extent
4. dispatching and routing of vehicles, etc.
5. movement and trends

C. Military

D. Public investment

1. identification of blighted areas
2. slum clearance programs
3. urban renewal
4. rehabilitation of gray areas
5. improvement of transportation systems
6. construction of public buildings (and inspection thereof)
7. national parks, historical sites, etc.
8. renewal of central business district
9. provision of health and safety facilities
10. transportation systems
11. administration of research and other grants
12. regional planning

E. Establishing zoning and other regulations (sanitation, health, utilities)

1. inventory of land uses
2. interrelationships between residential, industrial, trades, recreational, etc.
3. geological/topological features
4. health and safety

F. Estimation of taxes and expenditures

G. Detection and control of pollution

1. composition and density of discharged materials (gaseous, liquid, solid)
2. relationship to and effect on surrounding land and activities
3. noise pollution
4. thermal pollution
5. location of "dumping" areas
6. detection and location of insecticides, pesticides, etc. (including concentrations, trends, etc.)
7. detection of radioactive substances and leakages
8. "The U. S. Public Health Service classifies pollutants entering water bodies under eight broad categories:

oxygen-demanding wastes
infectious agents
plant nutrients
organic chemicals
other minerals and chemicals
sediment from land erosion
radioactive substances
heat from industry."[6]

H. Provision for waste disposal (sewage, garbage, etc.)

1. type, location, volume
2. geological, topological, hydrological, etc. aspects

I. Provision of water

J. Protection from crime, violence

K. Protection of liberty, religious freedom

L. Prediction services (weather, smog, floods, sea states, water tables, agriculture)

M. Data processing

N. Detection and control of human, animal, and vegetable diseases

1. location
2. type
3. density

O. Research in historical geography

VI. Cultural, entertainment, and recreation

A. Inventory

1. location
2. quality
3. quantity

B. Planning

1. inventory
2. demands--type, level, quantity, density, time
3. location of feasible areas
4. geological/topological aspects
5. interrelationship with other human activities

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6. See B-16, item 4, p. 53

6. preservation of some areas for future recreational development
7. traffic patterns
8. alternative uses

A-16.7 References: See Appendix B-16.

Appendix A-17

SOCIAL PROBLEMS AND TECHNOLOGICAL SOLUTIONS

A-17.1 Unforeseen Benefits of Earth Resource Survey Satellites

The initial raw data compiled from earth resources collected from the first earth resource satellites may be informative to yet unknown and unrelated questions. We simply do not know the applications and institutions that could relate or benefit from the satellite data until the data is collected and tabulated then channeled to as yet unanswerable questions. If plant pathogens can be labeled via satellite and their path of destruction followed through an agricultural crop, animal pathogens or human epidemics might also be charted and followed from the source of origin. Data of topography, weather, or any one of the earth resources singly or in specific combination might correlate to a new strain of influenza. The path of the disease might be charted by exact combinations of data monitored by an earth resource satellite such as temperature, topography, rainfall, population, density or even vegetation density and type. To prevent another occurrence of the epidemic, it might be feasible to try to eliminate the specific combination of monitored entities in being re-established. It is desirable to collect widely varied and unrelated earth resource data then massage the data into endless combinations and direct the information to entirely unrelated questions in order to benefit society and solve problems hindering the progress of society. There is danger that the combined data might become contaminated with human limitations and misconceptions. The problems of concern might be medical, social, economic, even political. The problems might be unknown and not revealed until an orbital satellite collects earth resource data. Unrelenting problems may not show their existence until viewed from a distance. In a similar analogy, the proverbial forest can not be seen for the trees due to proximity of viewing.

If monitoring urban populations becomes a reality, current civilization's common ailments such as heart disease, cancer and stroke affecting man in epidemic proportions might have relevant facts uncovered. A disease in any proportion brings thousands of deaths and billions of lost man hours of work to productive individuals. For this reason alone, causative epidemic agents and prevention create feasibility and monitoring studies.

A-17.2 Monitoring Social Stresses

Human activities of urban areas related to social problems lead to other areas of socio-economic needs requiring monitoring. If settlement patterns, expansion rates of communities, and the layout of transportation facilities are aerially viewed, then data collected could sense differences in cultural characteristics or community patterns in varied world populations. Simply, new identity is given to social stresses or tensions of a population, whether the population being monitored is plant or human. Additional assessment of the current and continued changing state of a population produces possible causative agents for the economic health of the community.. Urban sprawl brings infinite stresses, some due to land limitations. Manhattan can not expand outward, only upward. Monitoring social stresses for a lengthly period of time via satellite may lead the reviewer to earth space for therapeutic and recreational objectives(9). Future hospitals and vacation resorts may be built and placed in orbit (19).

A-17.3 Space Program Spinoffs

A cure for cancer or a cure for an urban problem are equally remote realities by monitoring populated areas as are many of the space program spinoffs. The medical profession for example has recently benefitted with such items as techniques for monitoring heart rate, rapid changes in blood pressure, methods of quantitatively studying diseased membranes in joints of the human body, and a low-cost, swallowable, temperature sensing telemetry capsule (17). The physically handicapped have received such items as an eye operated wheelchair, and respirator helmet (22). Biomedical application teams have directed to best use the collected medical benefits from space research (23, 24). Spinoffs of the space program have been amply identified as the real product of NASA, not just the training of some 400,000 people in new ways of doing things but creating the technology in which they were trained (6). Although a large number of people are employed, relatively few new occupations are specifically related to the space program and clearly or officially identified by job title (15).

From non-stick frying pans to electronic heart pacers spinoff research and research grants have expanded technology and lessened social needs. Portable electronics are becoming more portable thus decreasing the need of being a titled weight lifter in transporting a television set from a living room to a boat sun deck. Applications of this same technology redirected slightly may solve pressing problems. Senator Gaylord Nelson during the 89th Congress raised mute points in question. "Why can not highly trained manpower which can calculate a way to transmit pictures for millions of miles in space, also show us a way to transmit enough simple information to keep track of our criminals?" (8). This is possible if the collection of scientific knowledge is applied with the same vigor to analyze and solve social problems as it is applied to space problems. Systems analysis technology from space science is a method for solving social problems. In a symposium of systems analysis Hoos (12) considers every major problem facing urban society is multifaced in nature. Understanding calls for knowledge collected on many fronts, a multidisciplined approach involving economic, political, and social rationality and synthesis. A warning in the rapidity of technological change and benefits comes if our culture is morally immature in plotting freeways or even developing public information systems for example (7).

Research and development by NASA programs or subsidiary programs have caused major impacts upon aviation and aeronautics, upon science, upon new materials technology and alloys, economic impacts, upon public health, medicine and biological research, and occupational categories (15). Materials and new equipment already available for general use and in production number in the thousands. A sampling of such items creating benefits for the general public, thus satisfying social needs, include microelectronic units and magnetic tape recorders (1), valve technology (5), structural design in buildings (18), insulation materials (10), analytical chemistry instrumentation (25), metallurgy (2,13), inorganic fibers (11), lubrication coatings (16), precipitation-hardening treatments of stainless steel (20), etc. In order to best utilize the vast storehouse consisting of thousands of innovations, a NASA Technology Utilization Program exists to encourage use of results, initiate an investment return of aerospace research, decrease time and convey discovery of new knowledge for use in society across disciplinary and regional boundaries. Such information exists as tech briefs, technology surveys, handbooks, reports, conference proceedings, special studies, selected bibliographies, technical notes, translations and special publications. New concepts, designs, techniques, materials, and equipment yield new solutions to old problems and novel solutions to unusual problems. An important communication link or two way shuttle of R & D information exists between NASA and NASA industrial subsidiaries with universities (21). Further needs are identified as the old needs are satisfied, a never ending cycle fed by research and development. NASA provides a stimulus through space research programs to the development of numerous scientific disciplines (3).

A-17.4 Space Program Methodology and Society

There exists a feasibility of applying space capability to problems of the community. Kuhlman sees at all levels of development potential interactions and relationships of socio-economic and space disciplines (14). Techniques learned in aerospace management and systems analysis embraces the theories for making a problem understandable. Methodology of aerospace management technology offers some possible avenues of solution and establishes additional criteria for selection of the best alternative to satisfy socio-economic problems (4). A ground truth is actively apparent today in sociology and economics, distant aerial viewing may broaden or change that truth. Often cited George Bernard Shaw identifies a reasonable man as one who adapts to the world, but the unreasonable one persists in trying to adapt the world to himself. The unreasonable man establishes progress.

A-17.5 References: See Appendix B-17

Appendix B

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