Forum

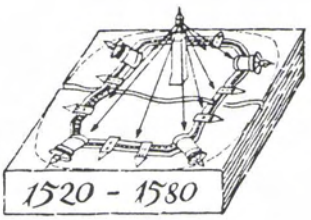
Earth Resources Remote Sensing Platforms

I REFER to the illustration, "Earth Resources Remote Sensing Platforms," by F. Barzegar, which appeared on page 1669 of the December 1983 issue of this Journal.

This compilation illustrates the full spectrum of platforms ranging from man on the ground to geosynchronous satellites. I do miss in Barzegar's drawing the man of the 16th century who climbed up to the top of a tower of a cathedral, about 50 to 60 metres high, in order to look down and around (see figure). His view was of course limited to some kilometres, but as far as his eye reached he brought down on paper everything he saw. This way he mostly produced a circular map.

In 1529 the Nuremburg illuminator and printer Nicolaus Meldemann published a circupolar circular map of the city of Vienna. The map was prepared by a pupil of Dürer's, Sebald Beham. The explanation of the map states that, at the time of the siege by the Turks, the city of Vienna was documented (from the tower of St. Stephan's) by a "famous artist." Each single one of the churches was placed "in its fitting place and district."

Ludwig Morant also produced an excellent map



of the city of Strasbourg in the same style in 1546. All the facades of the buildings in his map face the minster. Morant employs a simple and yet very effective method to represent the third dimension of the minster. The minster facade was traced, cut out, and the foot only stuck to the map and hence could be flapped open.

This town-cartography from the top of a tower demonstrates perhaps also the dream of man to free himself from the Earth's gravity and have a complete overview.

—Walter Satzinger, Director
Institut für Angewandte Geodäsie
Frankfurt am Main, F.R.G.

The Census*

AS I SAY in my letter printed in your January issue, I am pleased to see the Journal exploring the wider uses of aerial photography to assist our troubled national Census. The "spy in the sky" question raised in your letter column, also in January, is an important issue. But I think it should be pointed out that this is a question with more than one answer.

We are all being "spied on" these days, for example, by banks, credit bureaus, our employers, the FBI, people who tap our telephones, and so on and so on. Beyond this usually covert type of "spying" which seems to take place all around us, there is the whole range of state, county, and local information-gathering, usually for reasonably good purposes but which nevertheless pries into our private lives. We are subject to all forms of surveys—market, media, church, school, club, and so forth—via house-to-house canvasses, over telephones, in offices and meeting places, in the streets, wherever. The other day I filled in an innocent looking questionnaire in a supermarket, and found that I had set myself up for a photo-film swindle scheme (luckily, a minor one). Nothing is sacred any more!

By contrast, the imaging of the Earth's surface from the air, and of our own house or apartment building or whatever, seems rather innocuous. A plane flying overhead and taking pictures might reveal a new car in the driveway, or a new swimming pool being constructed, or something like that. But usually these things go right onto computers anyway. In Fairfax County, Virginia, for example, the moment you register a new car, this information

* This and the following letter are in response to the article, "The Census: It Can Be Done More Accurately with Space-Age Technology," by Dino A. Brugioni, which appeared on pages 1337-1339 of the September 1983 issue of this Journal; comments on that article by Dean Sinclair and by Robert W. Morgan, with a response by Mr. Brugioni, which appeared in the "Forum" column on pages 80-81 of the January 1984 issue; and the article, "Remote Sensing Technology and the U.S. Census," by Hazel A. Morrow-Jones and John F. Watkins, which appeared on pages 229-232 of the February 1984 issue.

PHOTOGRAMMETRIC ENGINEERING AND REMOTE SENSING,
Vol. 50, No. 11, November 1984, pp. 1609-1612.

0099-1112/84/5011-1609$02.25/0

goes onto at least two computers that I know of (state and county), and maybe more. And so it is with almost everything else we do.

Beyond all this, remote sensing (or "remote snooping" if you prefer) can perform a whole range of useful services which the Credit Bureau and the FBI cannot. To list just a few of these useful services, remote sensing can help us keep track of weather and rainfall; of crops, forests, herds, and grazing lands; of population and housing densities and the quality of housing over wide areas of the country; of potential labor supplies for new industries; of future school and teacher needs, and the need for other social amenities such as roads and bridges, police forces and fire departments, parks and playgrounds, and so forth. The list of good uses for "remote snooping" is virtually endless.

The following diagram is intended to illustrate this important point:

Type of "Spying" or "Snooping"	Good (+) Things	Bad (−) Things
Use of Aerial Photos and Other Forms of Remote Sensing to Assist Census, and Many Other Types of Development Programs:	+ + + + +	− −
Investigations (Usually Covert) by Credit Bureaus, Banks, Employers, the FBI; Computerization of Our Private Lives; and so forth:	+ +	− − − − −

It should be pointed out that the way aerial photography would be used in assisting a census makes it even less of a menace from the "spying" or "snooping" point of view. The operation would take place in four phases: (1) imaging of physical objects on the ground, such as houses, new cars, swimming pools, and many less exotic sorts of things such as trash cans and outhouses; (2) sample surveys on the ground; (3) the periodic census as usual; and (4) meshing of all this information on a computer (as is done anyway with the census, the information being confidential to the extent that census information is confidential). Typical population densities for different images of physical conglomerations on the ground are determined from the sample surveys, so that population estimates are made for the entire country by the computer. These estimates are compared with the actual census. Where this has been done in the past, the estimates are frequently more accurate than the census figures, and in fact they have the potential in the long run for being much more accurate, because they are not influenced by people being away from home on the day of the census, or hiding from the census-taker, or whatever. In time, it becomes possible to rely much more heavily on the aerial imagery plus the sample surveys, less on the census itself which can then be done less often (and hence save the taxpayer some money). I can envision the time when aerial scans might be done yearly, sample surveys every three years, and the census every 15 or 20 years to validate the estimates. This would have the effect of giving us a "census" every year, and one that in time should become cheaper, quicker, easier, and more accurate than our present not-so-accurate census which only happens every 10 years.

I hope that if we come to use aerial photography to assist the census and other forms of national development activities (and the census is fundamental to all forms of national development, in the U.S. and elsewhere in the world), we will do so for the right reasons; and that if we ultimately reject these uses of modern technology, it will not be for the wrong reasons.

—Robert W. Morgan
Department of Sociology
& African Studies Center
Boston University

More on the Census

I HAVE BEEN FOLLOWING the various commentaries and letters concerning the use of remote sensing technology in the census. I would like to contribute an additional perspective to this application of our profession's technology. Incidentally, I am pleased that you are again encouraging this type of debate in the pages of *Photogrammetric Engineering and Remote Sensing*. You used to catalog these debates under the title "Forum," and they provided interesting and informative reading to the membership of the American Society of Photogrammetry.

The following observations and opinions are mine and not necessarily those of the U.S. Agency for International Development.

The two points I am going to try to make below are the following:

- Remote Sensing technology can be useful *in conjunction* with traditional demographic enumeration techniques, but cannot be used as a replacement; and
- Social science applications of remote sensing technology are in general undervalued and underutilized.

I believe that both the original article and commentaries may miss the point of census applications by remote sensing because of the greatly separated positions which emerge concerning the contribution which the technology can make. Mr. Brugioni places a great deal of credence in its potential contribution, while Messrs. Morrow-Jones and Watkins take what I feel is an overly conservative view of how remote sensing can assist in a population census. My colleagues in the U.S. Census Bureau will undoubtedly be writing you regarding the application of remote sensing for U.S. population enumeration, and I don't want to try to preview what their comments may be for this specific application. However, I do want to describe in general potential and tried techniques in population census applications.

Messrs. Morrow-Jones and Watkins state that the census is one field where the level of application suggested is tenuous. I am somewhat disheartened to see this statement in writing, because I have often felt that the technology of remote sensing has more potential in the sociological (population, health, nutrition) sciences than we remote sensing scientists realize. We have perhaps devoted too much of our efforts in pursuing the more obvious "hard technology" applications (mineral exploration, renewable resource monitoring, agriculture, engineering site analysis) at the expense of possible benefits to the former "people-intensive" applications. I disagree that the application of remote sensing to population census is tenuous, but I would agree that the technology will probably never become a mainstay or provide a baseline of data for a U.S. population census.

My impression of the article and commentaries is that they argue the point whether remote sensing can or cannot substitute for the existing method of conducting a census. Neither argues for the multistage approach, where data of varying resolutions offered from the satellite to lower altitude platforms can target opportunities for efficient data enumeration on the ground. The data collected by field questionnaires can probably never be replaced by data collected by other means, including remote sensing. The multi-stage approach applies to all applications of remote sensing. Indeed, Dr. Morgan's letter (January 1984 issue of *PE&RS*) describes head counts taken in Nigeria by combining air photos with ground surveys. I think that satellite data could also have played a role.

I know of no instances where data extracted directly from remote sensing platforms have impacted a decision-making process, in any sector of social and economic development. I think that a realistic expectation is that these data must be used to define more efficient ways to collect on the ground the sample data which represent the traditional informational requirements which decision-makers use. I couldn't agree more with the commentary by Messrs. Morrow-Jones and Watkins that a vast reservoir of knowledge does not exist about the relationship between features which are observable on an image and population variables which are not. Such a reservoir of knowledge does exist for physical variables in other applications (mineral exploration, vegetation, water). I am dubious (as I think these commentators are) that arguments concerning imagery observables serving as surrogates for such variables as house size, value, quality, and even population density have any validity whatsoever. I recall my surprise and disappointment years ago when, in an attempt to correlate average house sizes from aerial photographs with population densities in the Silverlake Area of Los Angeles where I lived, I discovered hundreds of fairly nice homes abandoned and scores of others listed as abandoned teeming with "street people." One may argue whether "squatters" should be counted, but they do place a demand on city services and certainly were missed by my random experiment with air photos.

I think that the advantage of using remote sensing technology, in a population census or any other application in which a traditional operational data collection procedure is already in place, is not to reduce cost but to improve precision in the estimate of the variable with a fixed cost. In testimony on the Hill regarding the commercialization of the civil land remote sensing satellites, Dr. Joel Greenberg of ECON made the point that budgets for data collection have remained fairly constant over the past few years as remote sensing technology has been absorbed by agencies responsible for collecting data. This says a lot. For one thing, it demonstrates that the so-called "lower cost argument" of data collection by remote sensing techniques has not inspired any noble offer by such agencies to reduce their own budgets. But interestingly enough, higher precision of the data because of the contribution of remote sensing has not led to budget increases to experiment with the new remote sensing technologies either. Constant budget outlays for data collection may reflect the maturity of the application of the technology as the technology finds its limited, howbeit important, niche in the data collection process. I suppose the point made by Messrs. Morrow-Jones and Watkins is whether there is a niche at all in a population census.

I would argue that there is a niche, and the niche provides more than a handhold for applying remote sensing in developing countries. The use of remote

sensing data, especially from the Landsat Multispectral Scanner (MSS), represents not only a supplemental tool, but has served as a critical reconnaissance-level base for population census with which our Agency assisted several developing countries. As one example, Bolivia had not conducted a census in almost 30 years when we used Landsat data for the 1976 census. There was no geographic plan for distribution of field enumerators until land-use maps were prepared from MSS imagery, showing whole villages, roads, agriculture cultivation, and forest clearings. These features were not shown on the old existing maps in the Bolivian government. Similarly, in Kenya, the imagery was used to redraw district maps placing enumeration boundaries between differing land uses to effect a more efficient survey on the ground than was done previously, when district boundaries were drawn for other reasons. In developing countries, where maps are out-of-date, where field enumeration has to be done in remote areas, where other records are non-existent or unavailable, and where rural populations are relatively nomadic, the technology of remote sensing has proven to be effective for population census. This conclusion was confirmed and reiterated by participants at a well-attended international symposium on remote sensing in demography held in La Paz, Bolivia, in 1977.

In summary, the technology of remote sensing must find an appropriate role and fertile ground in the sociological sciences if the information provided by it is going to have more influence in political decisions which impact land use and management of natural resources. It is simply not enough to monitor these physical resources and provide the information in a passive sense for others to hopefully use in addressing population pressures on the planet's natural resource base. The forest clearings registered on the MSS imagery in the Bolivian example above were the results of the actions of many small farmers seeking fuelwood, a phenomenon now regarded as a major cause of the decimation of the world's tropical forests and a potential loss of much of the planet's biological diversity. This project was oriented toward understanding people and their distribution and needs, not the loss of the rain forest. However, in understanding the former, the latter as well as other physical phenomena are put in better perspective. The technology must penetrate the sociological arena where decisions are made affecting people if we want the technology to become an accepted tool in the management of natural resources and the environment.

The enumeration of the population is in this arena, and that is why I find the commentary by Messrs. Morris-Jones and Watkins disturbing—it seems to imply that remote sensing cannot penetrate traditional enumeration procedures. I wonder if this view is shared in the community of population experts and sociologists in general. I recall five or six years ago (what I call the heyday of satellite remote sensing) that there were many applications directed toward anthropology and archaeology. Federal agencies were studying American Indian archaeological sites (Chaco Canyon in New Mexico comes to mind), there were scientists using MSS imagery to study rural migration patterns in the Sahel, and there was I think a symposium on the use of remote sensing in anthropology. One doesn't hear very much about these applications any more. Is it because of the prevailing environment, in which remote sensing must demonstrate quick economic profits, resulting in emphasis on the more proven applications at the expense of the longer term understanding of the interplay between people and natural resources? Or is it because the limitations of the technology in the social sciences are clearly defined and prevent a useful role for it in dealing with people?

These are questions precipitated by Mr. Brugioni's article. As such, I think that it opens up a window on the directions which the science might go in the future. In this sense, I'm glad that he wrote it.

—Charles K. Paul, Manager
Remote Sensing Program
Office of Forestry, Environment
and Natural Resources
Agency for International Development
Washington, DC 20523