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Congressional paper
opening thoughts :

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Background Paper for Information of CIA
Oversight Committees on the Partial
Use of NRP Assets for Civil
Applications

The attached paper indicates a long series of activities within the Executive Branch to use National Reconnaissance Program (NRP) assets for civil agency applications. Over the years these activities have involved the Bureau of the Budget/Office of Management and Budget, the President's Science Advisor and the former Office of Science and Technology, the Department of Defense and the Central Intelligence Agency who operate and use the bulk of the data furnished by the NRP, and several civilian agencies. The Director of Central Intelligence has exercised his statutory responsibilities in connection with these efforts.

These activities are based on the obvious opportunities to conserve U.S. resources on the one hand and to separate scientific and technical capabilities from the intelligence purposes for which they were developed and make them available, insofar as possible, for additional purposes - in this case, civil applications.

The results, we believe, are impressive. While Mapping, Charting and Geodesy (MC&G) activities, beginning with the military and to a lesser degree civilian MC&G, are quite vast, the remainder of civil applications has not yet developed to its full potential. However, there is

an OMB study now under consideration to extend civilian MC&G use of NRP assets. Also, there is current activity to make NRP products more available to the civil agencies based on a recent Presidential decision to selectively decontrol certain NRP products.

This development has not been without its difficulties. The tough security compartmentations of reconnaissance activity for several years has been a handicap to making the product available for full U.S. civil benefit. Professionals in the civil agencies could not "publish" in their fields. Distributions of NRP material could not be widely made throughout the civil agencies field echelons. The non-interference with intelligence missions did not allow all the coverage desired. And, very importantly, the NRP systems are designed for intelligence purposes in terms of scale and resolution. Further, they do not emphasize all the characteristics, such as other parts of the spectrum, required for all civil uses.

A further comment for the benefit of those who read this would be that insofar as U.S. resources or costs are concerned a few points should be kept in mind in considering civil use of NRP assets. ^{When} The satellites are ^{in orbit,} ^{over} the U.S. ^{in addition to intelligence target areas} ~~part of the time~~ as they circle the globe. Also, "engineering passes" supportive of the intelligence mission use film over the U.S. Thus, insofar as ^{these passes} ~~they~~ satisfy civil purposes, the cost is minimal as most of it

would be spent in any event for the NRP intelligence mission. The expense in film used over the U.S. for non-engineering passes (civil use) is only slightly more as the system expense is already provided.

The NRP and the MC&G Community

The 1950's saw the development of the NRP manifested in the U-2 aircraft overflights beginning in 1956 and subsequent successful CORONA satellite mission in 1960. The Army's Engineers were very much involved at an early date with the use of NRP products in their MC&G activity. In 1960 they established a division in AMS to use U-2 photography and later satellite photography. A budget was provided for a series of ARGON satellite missions occurring in the early 1960's (flown under DISCOVERER cover and administered like CORONA). ^{The Engineers} They contracted with [redacted] [redacted] for support in exploitation. Army R&D funds established a Project 25 which employed ARGON satellite imagery (DAFF) of Africa.

The original ARGON imagery was targeted at the Soviet Union for the purpose of obtaining exact geodetic fixes and an extension of datum planes throughout the USSR. The proper basic orientation was military MC&G. Nonetheless it was apparent that some civilian MC&G needs could also be met by the NRP. The Bureau of the Budget issued a staff report, dated June 30, 1962, titled "Survey of the Federal Domestic Cartographic Activities, Requirements, and Organization," - listing 36 federal agencies which were significant producers or users of domestic maps and charts. Included were the USGS, C&GS, Census, Forestry Service, Stabilization

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and Conservation Service, Agriculture Soil Conservation Service, TVA and AID.

Following this 1962 BOB staff report and with military MC&G clearly an established user of NRP, the BOB in 1965 again entered the picture by requesting a DoD study of the application of NRP imagery to civil agencies' MC&G, - including the security aspects. A report was submitted entitled "Study for BOB of Potential Applications of DOD MC&G Data, Systems Techniques and Equipment to the Work of the Civil Mapping Agencies," December 1965. The report was SECRET with one volume TK-controlled. Following this study, the USGS obtained a budget for establishment of a TK facility at Reston for its use of NRP imagery and use by other civil agencies.

During this 1950's & 1960's MC&G activity, it became clear that there were rather extensive civil uses for NRP imagery in a variety of fields extending beyond classic MC&G. To examine these and provide for them, the President's Science Advisor called upon the DCI, Deputy Secretary of Defense and the civil agencies to join in this effort. The effort became known as ARGO and is the subject of the next section of this background paper which constitutes the major substantive exposition of a variety of the civil applications.

A quick perspective of mapping coverage provided by the NRP can be seen in these figures: (both military and civil) (am not sure this is practical or wise at this point, particularly as we would involve data of other agencies.)

Following the consolidation of the Department of Defense Mapping activities into the Defense Mapping Agency (DMA) an OMB directed Federal Mapping Task Force, established in 1972, reported in 1973 regarding consolidation and coordination among the civil agencies mapping functions. They also made recommendations regarding the increased use of NRP material.

Policy

This section on policy could be very long and detailed if it covered all policies relevant to all NRP activities and possible civil applications thereof. Suffice it to say here that the activities of the NSAM 156 Committee throughout the 1960's is a very involved experience in the foreign policy and security aspects of satellite reconnaissance, including a complex investigation in 1966 of the policy implications of NASA's systems upon the NRP. This 1966 review was undertaken at the request of Shultz (Director, BoB and Hornig (Director, OST) to Rusk (Secretary of State). This section ^{however} will be limited to reference ^{of} ~~to~~ selected policy matters which should be kept in mind in the civil applications field.

Concern with "domestic affairs": Four restrictions appear in the National Security Act of 1947. They concern police, subpoena, law enforcement and internal security. A fifth area seems to have been added ^{for our attention} - "domestic affairs" - and one reads and hears legislative suggestions such as 'add one word foreign to legislation involving intelligence activities' and finds great concern on this point in such documents as the DCI's nomination hearings. Certainly, there must be a way to consider reconnaissance systems as available for civil applications. These systems are commonly "owned", represent great expense, and should be at the service of civil applications to the extent that

sources and methods are protected where necessary and intelligence priorities are met. Certainly, we, in the foreign intelligence field, are familiar and would agree with any interest that we avoid interfering with or "targeting" U.S. interests by whatever intelligence technique. However, that should not preclude the application of these ^{mechanical} systems to civil functions, where possible, under civil agency requirements.

"Competition" between NASA and NRP:

A "grey" area seems to exist between these two programs in terms of both present and future systems. That area involves "economic intelligence" and "civil applications." This situation has many analogies in all areas of intelligence. It would seem that any civil collection program ^{should} ~~can~~ contribute "overt" data to intelligence and any "covert" or "clandestine" program ^{should, where security permits,} ~~could~~ contribute their data to civil programs. The probability of a "system mix" involving just civil applications requirements and the two collectors might be one early order of business for any new intelligence community and civil agency interface. ^{At the same time, NRP managers would take account of any civil capabilities already existing and Coordination} ~~and Coordination~~ ^{or proposed.}

Intelligence Community Policy on Civil Applications:

There might be need to assure a single point of NRP contact on civil applications (one office or one officer). This would include the civil agencies' contact responsibility on requirements - also, on state-of-the-art matters

with NASA, involving both scientific and technical assistance and protection of sources and methods. Any NASA-NRP "systems mix on civil requirements" should be included. It would also help policy coordination if the same office/officer had cognizance of space policy matters, such as NSAM 156, NSSM 72 and relevant proposals and issues from whatever quarter.

DRAFT

BACKGROUND PAPER ON USE OF
NRP ASSETS IN CIVIL APPLICATIONS

(Developed for use in support of the DCI especially as he may deal with Congress and the public in this area of civil applications)

Introduction

National Reconnaissance Program

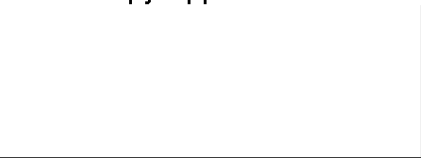
The development of the ^(NRP) in the 1950's to meet national air and space intelligence reconnaissance needs has been paralleled by a ^{desire} ~~requirement~~ to use these capabilities for military and civilian mapping and, eventually (mid-1960's), also support other civil applications represented by the functions of several U.S. civilian agencies.

Early in this NRP development, the Corps of Engineers began the examination and application of the NRP's air and satellite imagery for MC&G purposes. By 1965, in response to a Bureau of the Budget request, the Department of Defense prepared a study of U.S. civil agency MC&G activities, ^{and their potential improvement through use of NRP assets.} As a result of this study the Department of Interior, U.S. Geological Survey, budgeted for and received funds to obtain a facility for common use of NRP imagery by the civil agencies. From this early MC&G activity using NRP imagery came an expanded interest in additional uses of the imagery for civil applications in general.

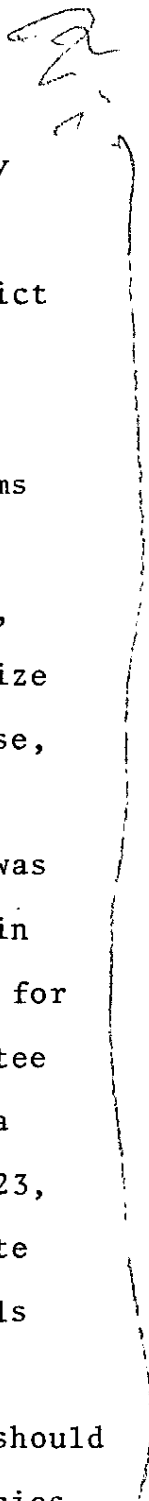
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To meet this general civil applications need by further defining it and preparing appropriate procedures, the President's Science Advisor in 1966 requested the DCI, ^{the} Deputy Secretary of Defense and ^{the} civil agencies to examine the question. The result was an in-depth study, called ARGO, showing extensive detailed civil applications' potential for NRP imagery. Also, there was provision ^{later} in 1968, of an ARGO Steering Committee, chaired by the Office of Science and Technology under the President's Science Advisor, which brought the intelligence community together with the civil agencies. The ARGO committee continued until the abolition of the President's Science Advisor's office in 1973 and the transfer of his functions.

A very significant number of ^{activities} ~~requirements and produc-~~ ^{tion} occurred under the ARGO committee's auspices and a review of this work will constitute the major portion of this background paper. During 1973 and 1974 planning has been going on to establish a new relationship between the NRP, NASA and the civilian agencies, replacing and improving the earlier ARGO committee arrangement and providing for the NRP and NASA systems interface.



Throughout this period, there have been many policy problems. These include international aspects of space policy, security of systems, and some problems of conflict between security and maximum use. Much of the policy involves the international implications of U.S. use of space for intelligence reconnaissance, primarily in terms of potential Soviet posture and, increasingly, other foreign national interests. In 1962, President Kennedy, in NSAM 156, requested the Department of State to organize a committee of themselves, and representatives of Defense, DCI, NASA and ACDA to make recommendations. The 156 Committee reported and NSC Action 2454 on space policy was approved. Since then the 156 Committee has taken certain actions and recently has again been faced with requests for policy recommendations. Whether the form of 156 Committee will continue to be employed or another form set up is a current (April 1974) question. Meanwhile, on November 23, 1973 the President declared "the fact of " U.S. satellite reconnaissance would be removed from its special controls and held at the SECRET level. This decision included decontrolling some of the products and information and should further ease the use of NRP materials by the civil agencies.



The current situation can be described briefly as follows: Based on the ^{developments mentioned in the} foregoing historical sketch of the use of NRP assets in MC&G activity and related civil applications and the development of U.S. space policy, it is now apparent that new arrangements involving the NRP and the civil agencies are in order. This is important as questions involving NRP future systems mix are raised and the provision therein for civil applications is considered, - new determinations of requirements for civil applications are developed, - a new interface, succeeding the ARGO committee, is prepared, - a new potential increased use of NRP is made possible by the recent (Nov. '73) decontrol of "the fact of" U.S. satellite reconnaissance and concurrent partial product decontrol, - reviews and clarification of the use of intelligence assets including the NRP are made, particularly as they may affect the non-intelligence sectors, and the examination of the way in which the NRP and NASA contribute to meeting civil applications draws closer. Important throughout this period will be a thorough understanding of these factors by all concerned in the Executive Branch and the Congress and, to an appropriate degree, the public.

A Major Examination of NRP Products and Civil Applications -
Project ARGO

In November 1966, the Special Assistant to the President for Science and Technology took action to begin a formal study of the use of classified photography by civilian agencies. With the approval of the Director of Central Intelligence and the Secretary of Defense, and in concert with the Departments of Agriculture, Interior, and Commerce, the Agency for International Development, and the National Aeronautics and Space Administration, a plan was developed and "Project ARGO" began in July 1967. The objectives of the study were to evaluate the information content of the existing photography as it would apply to various physical resource surveys and to determine whether it could be used to meet some current needs of the civilian agencies; also, to develop within the civilian agencies a cadre of people who would understand the photography and exploitation techniques and who could then assist their agency in making use of the photography and in planning for future systems and applications; and last - to determine whether the existing systems could yield information of operational value to AID about the less developed countries.

The study was performed by a team of scientists and engineers from the participating agencies representing the disciplinary interests of Agriculture, Geology, Hydrology, Geography, Marine Sciences, Map Products, and Engineering.

Advice and technical assistance were provided by the CIA and DoD through NPIC, DIA, U.S. Army Corps of Engineers, and Army Map Service. The U.S. Army Engineer Topographic Laboratories served as contract monitor [redacted]

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[redacted] which provided fully cleared office and laboratory facilities, technical support, and consulting services to the participants. Administrative coordination was provided by a steering committee, composed of the senior members of each agency team and chaired by the Office of Science and Technology.

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The project extended over eight months during which a total of 2,178 satellite photographs were used. This photography was acquired by four reconnaissance satellite systems using six camera systems which included the KH-4 panoramic and index cameras, the KH-5 camera, the KH-7 strip and index cameras, [redacted]

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Most of the photography covered South American areas where AID had special interest, and areas in the United States where good collateral data was available. In South America, specifically, one area consisted of about 30,000 square miles that included parts of Chile, Peru, and Boliva. A second area consisted of about 20,000 square miles of eastern Boliva, and a third area consisted of some 70,000 square miles, mainly the estuary of the Rio de la Plata in Argentina and Uruguay.

Using KH-4 panoramic and KH-7 strip photography of the South American areas, the ARGO investigators performed detailed empirical analyses with each participant interpreting the imagery for specific information relating to his discipline. Using the KH-5 and index photography from the KH-4 and KH-7, [] performed a regional study for the entire 1.2 million square mile area. Attachment 1 lists the sites in the United States which were the subject of direct disciplinary or operational interest. On the basis of comparisons with data from other sources, assessments were made in regard to the accuracy, completeness, and usefulness of the information derived from the satellite photography. A synopsis of the results is provided in Attachment 2.

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The study results were not directly synergistic since the participants evaluated the photography from the perspective of their special interests and experience. Other limitations were that the photography was from systems designed for intelligence purposes and not necessarily optimized for the resource disciplines, either from the standpoint of spectral capability, format, resolution, or the frequency and timing of coverage. Secondly, the participants were selected for their training and experience in their various disciplines and not for their knowledge of satellite systems technology. Third, the team members had incomplete access to cost information and were not expected to derive alternative system costs. Thus, their conclusions about utility are subject to qualification in terms of a full cost benefit analysis.

There were a number of topics about which most of the investigators were in agreement. There was general agreement that the intelligence systems could be useful to current ^{CIVILIAN} agency operations. The participants were careful to qualify this conclusion, however, by noting that the degree of this utility will depend on the cost of exploitation and on the limitations that security classification might place on the handling of the information. In regard to the cost, it was generally assumed that the bulk

of the system operation costs would be borne by the intelligence community but it was recognized that exploitation costs would have to be defined and considered for each potential application. Opinions about security limitation varied according to the applications envisaged and the current operating procedure of the agency. Where current procedure makes wide distribution of the photography itself - as in the (ASCS), ^{small net} for example - security poses a serious problem unless the agency procedures can be modified. On the other hand, where only a few people need access to the photography or where only derived information is distributed, security may be no problem at all.

Most of the investigators found that color enhances the value of the photography to a considerable extent.

In general, the team was not prepared to make categorical statements about the value of various levels of resolution. Many of the investigators were impressed by the vast area synoptic view provided by mosaics using the low resolution index cameras and its value as a basis for regional planning for the identification of areas for which more detailed information might be desired. At the same time, most of the specific applications that were identified by the team made use of the higher resolution KH-4 and KH-7 systems

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The investigators were generally reluctant to give up what they considered a major advantage of satellite photography - large area coverage. Although the KH-7 gave more detailed information because of its higher resolution, most authors considered the KH-4, which is a panormaic camera with large area coverage, to be a better system for most of their purposes.

Most investigators discussed how the timeliness and frequency of coverage affected its usefulness and expressed opinions which varied widely according to the particular application and interest. Some interests were served by exploiting the photography already on hand. Most required new coverage targeted for particular areas and at particular times. Many required repetitive coverage and timeliness. For example, the geographer felt he could use the imagery presently on hand as a data base with which to compare future worldwide coverage for the study of long term effects. The hydrologist can use existing photography for delineating flood plains, but wanted repetitive coverage six times annually for snow cover determination and flood forecasting, and on-demand coverage for flood damage surveys. All natural disaster evaluations require timely on-demand coverage, but the geologists can use one-time KH-4 coverage for the study of the world's fault system as an aid to the understanding

of earthquake mechanisms. The point was made that "Agriculture is dynamic in that plant and soil conditions are constantly changing." Crop acreage, yield estimates and estimates of stress would require scheduling of coverage during specific periods of the growing season. For forestry applications such as land use dynamics and timber depletion, annual coverage would be desired, but for forest inventories, coverage every five years would suffice. Oceanographic studies, such as those involving polar sea ice, may require only one time coverage for water balance studies but perhaps weekly coverage for optimum sea ice monitoring. Coverage for chart revision may only be needed at five or ten year intervals.

All authors considered the TK systems to be only a portion of the complete family of tools needed to perform a task or to provide information at some required level of specificity. They point out that the satellite materials should not be expected to solve all problems nor to replace the need for alternate sources of information.

ATTACHMENT 1

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~~PHASE III~~ - SUMMARY OF AREAS AND SUBJECTS INVESTIGATED

<u>AREAS</u>	<u>SUBJECTS</u>
1. Rock Creek Watershed	Land use trends, hydro studies, comparisons of conventional and satellite photos, land use planning, forestry.
2. Sierra Nevada Mt. Range Flat Head Lake	Snow studies, seasonal comparisons cloud structure, runoff estimates.
3. Phoenix, Arizona Area	Resolution/distortion, acreage measurement
4. Merced County, California	Crop acreage measurement, conventional/U-2 comparisons
5. Cape Cod, Mass., State of Rhode Island New England Grand Canyon Petrified Forest Montgomery Co., Maryland Lower Rio Grande Valley	Area studies and sensor comparisons, forestry " " " " Soil, forestry Resolution/soils
7. Inyo County, California Boulder County, Colorado North Central North Dakota Sitgreaves National Forest King and Snohomish Co., Wash.	Geology " " Forestry Sensor comparisons, forestry
9. Siberia	Flood analysis
10. Taiwan, La Paz, Lake Milluni, Altiplano, Achachicala, Chuquiaquillo	Cultural Features " "
11. S. W. Pennsylvania S. W. Utah Palisade, Colorado Washington, D. C. Santa Cruz	Geography Land use, land patterns, agriculture use Urban dynamics, water and land pollution, archeology.
12. Iquique, Chile N. W. Territories of Canada Red Sea Grand Exuma Island, Bahamas Northern Coast of Spain Elliott Bay Shoreline Seattle Area, Washington	Ocean surface features Ice and current flow direction Current phenomena Water depth and penetration Usefulness of color photos Hydrographic chart revision Sensor comparison

~~Figure 5~~

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SYNOPSIS OF RESULTS

The papers presented in this report have been prepared by engineers and scientists who studied the classified satellite and aircraft photography from the standpoint of seven different resource disciplines. Although the investigators all started from a common source, they viewed the information content and the potential usefulness from the perspective of their special interests and experience. Their results are therefore not directly synergistic and any attempt to summarize them presents some difficulties. However, the authors have made some rather explicit points about the uses and limitations of the photography and for the reader who will not be able to read more than just this summary, it seems important to bring these to his attention. For the reader who can afford to spend additional time, a condensation of each author's paper follows this synopsis. For those who wish to follow and understand the analyses in detail, the complete papers and the supporting photography and overlays appear in Volumes II, III and IV.

The Information Content of the Photography

Each team member considered in detail the information content of the satellite photography as applied to his background. In general, as a first step in his evaluation, each author selected categories of information which his experience indicated were of general or special interest to his agency's operations or to his discipline, and for each category evaluated the ability of the current photography to provide all or part of this information.

⑤ All authors considered the TK systems to be only a portion of the complete family of tools needed to perform a task or to provide information at some required level of specificity. They point out that the satellite materials should not be expected to solve all problems nor to replace the need for alternate sources of information. ~~Most of the authors have documented their judgments about the contributions to desired information that can be supplied by each current system and the reader is invited to their individual papers for a complete discussion. However, the following abstracts are representative of the information capabilities and limitations of the TK photography as described by the ARGO investigators~~

SYNOPSIS OF RESULTS

ATTACHMENT 2

Agriculture (Plants and Soils)

~~None of the current panchromatic photography has sufficient information content to be useful for determining plant disease or insect infestation. In that~~ All evaluated photography shows vegetative patterns and land use features. Coverage at the appropriate time of the year can show detailed patterns such as differences between standing crops and bare fields. In regard to crop yield, ~~the KH-7 can distinguish windrows of harvested crops and~~ ~~parameters like this may be useful in making crop yield predictions.~~ No conclusions about standing crop identification or differentiation between standing crops were drawn from the study of the TK photography since timely coverage was not available which would permit collateral verification of species. However, ~~in his agriculture summary, points out that~~ other experiments have shown that it is possible to differentiate between some standing crops of different species.

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Agriculture (Crop and Land Use Measurements)

~~Reports also~~ The use of mathematical rectification makes it possible to obtain the required accuracy for crop acreage measurement in the U. S. with the KH-7 strip, although its limited area coverage limits its usefulness for the purpose. ~~Reports also~~ The KH-4 panoramic photography, again through the use of mathematical rectification, can provide 1% accuracies which meet domestic requirements for fields of 20 acres or more in size. In foreign areas, where less collateral data is available and fields are not always so favorably shaped for measurement purposes, accuracies of about 5% can be expected for fields of 20 acres or more.


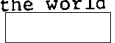
Agriculture (Forestry)

~~Reports also~~ Distinguishing commercial forest land from non-commercial forest land is generally beyond the capabilities of all but the KH-7 strip photography, but ~~the~~ the separation of vegetative areas from non-vegetated areas can be accomplished even with the index photography. Forests can be distinguished from other vegetation with KH-7 strip and KH-4 panoramic photography. The best resolution of KH-7 strip approaches the minimum required for interpreting components of stand description data. Wildlife management tasks are generally not feasible with any current systems.

Agriculture (Limitations and New Development)

~~Reports also~~ Severe erosion is easily observed on the TK photography, but moderate and slight erosion is difficult to detect; the same situation is true for salinity. ~~They conclude that~~ Agricultural information obtained from the KH-4 panoramic photography can be used to good advantage by the planner to delineate areas for development and to permit the concentration of field sampling in selected areas.

Map Products

~~Reports also~~ The index frame photographs from the KH-4, 7  and the KH-5 photographs have little or no value in the geodetic sense in the United States. However, ~~in some areas of the world where~~ little or no ground control or geodetic network exists one can use  to establish an extensive network of photogrammetric control which has a fair internal relative accuracy and can provide provisional control.

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~~Reports also~~ Maps at various scales are currently being compiled using the satellite photography, and planimetric and topographic maps prepared by the USGS, Forest Service, and Bureau of Land Management, etc., could be revised and updated with base materials provided by satellite photography.

Geology

~~Reports also~~ The geologic information extractable from the DAFF and index photography is so small in amount and so generalized that this photography has little value as a primary source of data. ~~Reports also~~, however, ~~the~~ the KH-4 panoramic and KH-7 strip photography provides good information for the

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geologic understanding of landforms, drainage patterns, anomalies, and physiography and would be useful if aircraft coverage were not available, or for worldwide examinations of special geologic features such as fault systems. ~~the KH-4 panoramic~~ KH-7 strip photographs compare favorably in information content with aircraft photography but that KH-7 has no real advantage in width of coverage; and that KH-4 panoramic trades something like 25-30% of the geologic information content of conventional photography for much more coverage. Because of this combination, ~~the KH-4 panoramic~~ KH-4 panoramic more useful to geologists than the other TK systems.

^{124c} ¹ IS CONSIDERED

Hydrology

~~the KH-4 panoramic~~ ^{the} KH-4 panoramic ~~photo~~ photography can be used for broad water resource planning, for cartographic delineation of flood plains and, when supplemented with KH-7 strip, for some aspects of detailed water resource development and conservation planning. ~~the KH-4 panoramic~~ However, ~~the KH-4 panoramic~~ space photography cannot in all cases compete with aerial photography, if available, and cannot replace the need for field investigations for detailed water-resource development and conservation. ~~the KH-4 panoramic~~ KH-4 has sufficient resolution for sea ice reconnaissance and ~~the KH-4 panoramic~~ a combination of KH-4 ~~photo~~ could be used for snow coverage measurements, flood prediction and water management. ~~the KH-4 panoramic~~ All existing photography provides usable information for cloud formation studies.

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Geography and Cultural Features

~~the KH-4 panoramic~~ The KH-4 panoramic photography can be used for preliminary engineering surveys and route selection, and ~~the KH-7 strip~~ the KH-7 strip photography could assist in determining possible highway river crossings and selecting possible dam sites. ~~the KH-4 panoramic~~ To varying degrees, all TK photography has some utility in cartography and in contributions to the physiographic description of the earth's surface. The KH-4 panoramic photography is excellent for thematic mapping and provides good information for land use dynamics and determination of climatic zones by inference. In contrast, the index and DAFF photographs have only marginal utility for thematic mapping, and essentially no utility for urban analysis, air and land pollution studies or determination of climatic zones.

Oceanography and Hydrography

~~the KH-4 panoramic~~ It is not practical to perform marine biology and chemical oceanography studies with any of the current systems. The DAFF and index photography is not useful for marine geology studies, for measuring near shore or subsurface currents, for determining length and direction of wave propagation, or for subsurface topographic contouring. However, ~~the KH-4 panoramic~~ ^{the} KH-4 panoramic and KH-7 strip can measure ice coverage and ice movement, and ~~the KH-4 panoramic~~ ^{possibly} these systems could aid in studies of ocean water currents and wave motion. ~~the KH-7 strip~~ ^{the} KH-7 strip has sufficient resolution to be used for revising nautical charts of harbors and other coastal areas.

Regional Studies

~~the six geoscience overlays~~ The six geoscience overlays (drainage, engineering geology, vegetation, surficial materials, surface configuration and landforms, and

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climatology) prepared for a 1.2 million square mile area from DAFF, Index-4 and -7 photography were, in many cases, superior in overall detail to published small-scale geologic maps, USAF Operational Navigation Charts, and National Intelligence Survey reports. DAFF photography provided marginal information and was used primarily as a gap filler for areas not covered by the index materials. The very general information resulting from regional studies is greatly enhanced by ground truth and sampling with higher resolution photography.

Potential Agency Uses

Having determined the information content, each author considered specific ways in which this information might be used by their agencies. Highlighted below are those which seem to merit special attention for additional study.

Foreign Crop Acreage Measurement for Department of Agriculture

~~Frank Applegate~~ The results of the ARGO studies and of other related experiments **WERE APPLIED** to the Department of Agriculture's need for data about foreign crop yields and ~~the~~ the following conclusion **WAS DRAWN**.

"There is a difference in utility for domestic as opposed to foreign applications even though the same information is required. In most cases, if not all, this basic difference is the amount of available ground truth and detail required in the U. S. versus the limited ground truth and the importance of less detailed information in foreign countries. Along with detail goes accuracy of measurements. In the U. S. we have accuracy requirements of $\pm 1\%$ on some crop acreage measurements. However, where we do not have acreage control programs the accuracy of our own data is considerably less. In most foreign countries accuracy on the order of 10% would surpass anything presently available in agricultural statistics. Iverson's results indicate that such accuracy is possible with the KH-4 system... The USDA has a vital interest in foreign agriculture. Each year the Secretary of Agriculture has the responsibility of acreage allotments to U. S. farmers for certain crops. Most of these crops are involved in our export market. Information about the worldwide situation for these crops and especially about our major competitors would be invaluable data. The ability to make identification of these crops with some degree of reliability is critical to the assessment of regional agriculture production. The ARGO authors were able to differentiate easily between standing crops and plowed fields. In addition, on some of the photography they were able to detect textural and tonal differences between different standing crops. Other work done by USDA from Gemini photos substantiates this capability... With regard to identifying what those crops are, there is a distinct difference between being able to identify species from the photography alone and being able to identify species on the photography using collateral data... The major food crops of the world, their geographic distribution, their harvesting methods, their climatological requirements for planting, sprouting, full growth, and harvesting are all known parameters. Using these collateral data, the current satellite photography permits us to monitor this evolution, to measure the acreage and predict to within a certain degree of accuracy the potential yield. A statistically valid sampling procedure for these countries could be employed to reduce the data handling to manageable proportions."

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A.I.D. Use for Less Developed Countries

From the findings of the ARGO investigators and from the results of work done elsewhere, ~~with the following conclusions~~ ^{conclusions were drawn} about the photography's potential utility to AID for agricultural assessments, population estimates and as a base for fiscal estimates and tax assessment formulae.

1. Agriculture

"The ARGO study shows that acreage measurement of areas under cultivation is feasible from satellite photographs, provided a small amount of additional information obtained directly from the ground is available. The technique has been refined to a point where some degree of differentiation between crops is feasible, permitting selective measurements by crops. The degree of accuracy of acreage measurement required in the U. S. is not essential for AID purposes in less developed countries. As noted in a recent analysis by USDA's Economic Research Service, present inaccuracies in LDC [less developed countries] crop estimates often exceed 30%, so there is little question that satellite photography such as KH-4 and KH-7 can provide significant improvements. What is insufficiently known at this point is the amount of supplemental 'ground truth' information required to achieve a stated level of accuracy in crop and acreage estimates."

2. Population Estimates

"Based on tests over U. S. areas, remarkable demographic estimates have been obtained from aerial photographs augmented by limited ground sample information. These estimates have covered a variety of dwellings and urban configurations. They have included estimates of net population size, changes in population size due to migration and changes due to the birth and death process. All are of interest to AID. The full extent to which satellite photography and photointerpretation techniques may be used in the LDC's remains to be determined; but vast improvements in demographic estimates can be expected. This would constitute a major breakthrough in an area of vital concern to AID and other donor organizations, as was underscored by the President's Science Advisory Committee's report of May 1967 on the World Food Supply which states that "There are not recent censuses for many Asian, African, and Latin American countries... [For example] Pakistan's population, according to one estimate, was undercounted by nearly 8 million (7.6 percent of total population) in the census of 1961... Of even greater significance to a study of the future relationship of population and food supply is the rate at which the population is growing. Unfortunately, estimates of present growth rates for much of the world are of doubtful reliability or are simply not available..."

3. Tax Base Information

"Satellite photography, covering very large regions, or in some cases, entire countries, constitutes unique source material for arriving at fiscal estimates of income under various tax assessment formulae. Whereas individual properties, except for very large holdings, could not be positively identified on such photography, areal measurements of current land use can be extracted. Applying assessment criteria to the various classifications of current land use would permit national estimates of potential revenue to be computed quickly. Since few or none of

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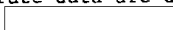
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the LDC's are covered completely by aerial photography, there are no means of developing, realistically, estimates on revenues that could accrue from a national real estate tax program. Such evaluations would, furthermore, locate areas of greatest potential income from real estate taxation which could be realized by initiating a bona fide fiscal cadastral survey employing large-scale aerial photography at which time individual property ownership would be determined and land recordation accomplished."

IT WAS RECOMMENDED THAT

For each of these areas ~~where ground measurements are required~~ a "live problem" be studied to more precisely define the accuracy with which these tasks could be accomplished.

Snow Coverage Measurement

~~For the purpose of~~ Snow coverage in the mountain areas is presently measured by the Soil Conservation Service, the U. S. Weather Bureau and the Forest Service by means of ground measurement and some aircraft photography. "These techniques are costly and time consuming; more accurate data are desirable for flood and water yield forecasting. By using KH-4 pan  photography it should be possible to gather this needed information on a rapid and timely basis." As an example of this application the authors referred to the problem faced by California during the late spring of 1967. "Late storms had deposited record snow depths and water equivalents for so late in the year. Daily forecasts of snow melt and long range outlooks of total water remaining in the snow pack were called for... Very limited data were available and daily or even weekly ground surveillance was almost impossible to obtain. So, very rough estimates had to be made based on very sparse data. As a consequence, a considerable amount of water was wasted by being released to run to the sea which could have been stored if more accurate data had been in the hands of the forecasters..."

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Another example refers to the problem often faced in the plains areas of the Midwest when a heavy mantle of snow is deposited. "Limited observations of snow depth and water equivalent hamper the preparation of adequate river forecasts in cases where rains combine with rapid warming to melt the snow in a very short period of time. This snow melt water contributes materially to the total runoff and has many times resulted in disastrous local flooding which is largely unpredictable. Good high resolution photography over large areas which would be available from space vehicles could provide information to assist the flood forecaster in his evaluation." At the same time the authors caution that "a careful study which compared efficiency, costs, etc., of space systems photography to high altitude airplane photography must be undertaken prior to making any decision about the merits of obtaining such information from satellites."

Domestic Forest Survey for the Department of Agriculture

~~Space photography~~ As a data source, the KH-4 and KH-7 system imagery does not measure up to the conventional aerial photography currently being used and ~~the~~ separating forests from other major vegetation is possible but moderately difficult with KH-4. ~~Some of the major forest types are not~~ ^{HOWEVER,} this photography and aircraft imagery can supplement each other to give more effective use in forestry applications. As an example, ~~the~~ the nation wide forest inventory program, which is conducted by the Department of Agriculture, ~~is~~ "if KH-4 panoramic

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imagery were made available on an annual basis, ~~it is not possible to change the existing program.~~ The land use base could be updated and trends easily identified. Most timber depletion could be pinpointed and efficient sampling procedures developed."

Water Resource Planning

~~Hanshaw, Ogrosky, and [redacted]~~ The KH-4 panoramic photography as being a good data base for water resource development plans such as those developed by the Soil Conservation Service, the Bureau of Reclamation or the Corps of Engineers. ~~The [redacted]~~ The cartographic delineation of flood plains, as is frequently done by the U. S. Geological Survey, the Soil Conservation Service and the Corps of Engineers is one of the immediate uses to which existing KH-4 pan  material could be put.


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Other Applications

A number of other uses are also mentioned. ~~DeRycke, Hanshaw, Ogrosky and [redacted]~~ agree that the KH-4 panoramic and higher resolution systems would be useful for sea ice studies, monitoring and forecasting. The hydrologists conclude that one-time coverage of all ice areas would provide data for more accurate determination of the global water balance, and weekly coverage would provide data on sea ice conditions and forecasting which is of great interest for commercial operations.

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~~Hanshaw et al. point out that~~ The low resolution of current weather satellites precludes their use for detailed study of cloud structure and small storm systems. They conclude that Talent-Keyhole photography could open up wide vistas in these studies. This data should be exploited as soon as possible.

~~DeRycke~~ the use of  photography for provisional geodetic control of developing countries and ~~such~~ such "geodetic control data cannot be obtained in any other manner in an acceptable time frame."

WAS RECOMMENDED

~~DeRycke believes that~~ Existing KH-7 strip imagery could find practical use in the revision of shoreline and land features of the U. S. Coast and Geodetic Survey charts.

~~Wilson concludes that~~ KH-4 panoramic supplemented by KH-7 strip coverage would be useful for urban analysis, land use analysis and transportation studies.

~~White, Wilson and Shelton~~ that Index photography can be used for regional studies involving landforms, general land use and drainage. ~~DeRycke, Wilson, Carter, Shelton, Hanshaw, Furbide and Ogrosky~~ concur on the usefulness of DAFF, index and KH-4 panoramic for mosaics as a broad planning tool or as a data base.

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