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CHAIRMAN,
ISRO.

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ISRO HQ.

FEBRUARY 5, 1981

Earth Observation Programme of the
Indian Space Programme.

1. As Chairman desired an overview on the matter especially in terms of programme direction, user interface development, advanced research, transfer of useful applications to the users (including State Government agencies), training courses, and planning for 'other' applications, I address all these issues comprehensively in this note - in sufficient detail to provide technical clarity and at the same time to keep the contents at sufficiently high level of (system) aggregation at which Chairman operates.

2. Though I can hairsplit the legal-bureaucratic wordstructures like ISRO, DOS, Secretariat, HQ, Programme Office, SAC, NRSA etc to complexify clear technical issues as is getting popular in some quarters nowadays, I have purposely refrained from doing so in view of the task enunciated in para 1 above. Nor have I taken a view that NRSA & ISRO programmes are different immiscible entities - though organisationally permeable walls have yet to develop between these two entities. There is however no excuse at the highest levels to consider SAC or NRSA foreign to the Indian Earth Observations programme though problems of personalities, histories and bureaucratic (rule based) maze may be real. Hence at the level of a policy paper, as a first approximation I have taken a "bird's eye-view" and pointed out a few of the "worms' eye-views" so that pointers for practical techno-managerial (political) decisions are feasible.

EXISTING SCENARIO

3. Under the term earth observations I am restricting the present note to those areas dealing with:

(a) Collection of imageries & data (in situ or otherwise) from space, aircraft, rocket, balloon & ground borne equipment.

(b) Analyses of these data & imageries in various forms such as visual, optical/electronic means etc.

and (c) Using these analysed data with other collateral information required for various application of "resources management" and meteorology.

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In dealing with the above one has to necessarily deal with engineering equipment, data processing equipment & software, data dissemination to a wide range of users, logistics related to data collection/collateral data generation and the management/methodology of a system to provide for meaningful user interaction (which is not merely a Committee mode with ex-officio representation & views ratified on Ministries' basis, but also development of a system with some general consensus).

3.1 It would be useful to dwell a bit on this question of meaningful user interaction a little more in depth at this stage and note the significant differences between the other users of the Space Programme. For telecommunication - domestic or otherwise - there is a well developed Ministry to talk for users; though some of its targets for telephone expansion etc are bureaucratically fixed (i.e not necessarily based on finance management/business etc) it is a fairly well working system. At best the Space Department can cite a few examples here & there, request their participation etc. In most cases they know their minds. In the field broadcasting the issues are very complex - tied with the entire political-ideological structure of the country - and therefore operational decisions would necessarily have to be 'nebulous' purely looked upon on the basis of number of direct reception sets etc. In this area the decisions are necessarily political & therefore one has to go essentially by the "progress of papers" by the I&B Ministry. Even in this area earlier catalitic action by Space right from NASCOM days upto recent INSAT approval was of some value. (See Appendix-1 for further data). In connection with the Meteorological Department the situation is complicated; its research wing and activities being what they are, IMD is just able to say a few things on new operational aspects; but it lacks the courage to speak out; not does the bureaucracy sitting on its top, viz., the Ministry of Civil Aviation & Tourism in a position to grow it to modernity. In various aspects of satellite meteorology (not just the VHRR imagery utilisation but in aspects concerning data from Vertical Temperature Profile Radiometer, Earth Radiation Budget Monitors, Microwave Radiometers etc) they are very much backward. But they have a chief who has a desire to do new scientific things; Space can utilise that goodwill soon in a formalised way. ISRO & IITM have fortunately some nuclei which has done real research work in Satellite Meteorology.

3.2 Coming now to the Resources Management aspects of Remote Sensing, we have already touched on one vital element viz meteorology. Other uses practically span all departments of the Government and apply to various situations; the limitations are only the imagination on the part of scientists and more importantly

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the desire and will to get into nitty-gritty technical details to establish methods of useful application by hard empiricism. (Special stress is given to the word "methods of useful applications"; not just useful applications. The fact that remote sensing can be useful for various applications ranging from agriculture to geodesy is well accepted even among Indian 'user scientists', technocrats & administrators from these agencies. To make a point about this has no longer any meaning. What is required at this stage is to find out methods of using remotely sensed data in quantitative or qualitative form in the information system available to the decision makers - be it some data on snow cover or crop yield or ground water potential. Some risk taking is involved on the user side and some sympathetic consideration of cost & efforts to be put in (by users) are involved on the part of Remote Sensing scientists.) It can thus be seen that the all-pervasive-applications of remote sensing need to be developed empirically and by dint of hard technical work by the scientists/managers and mere administrative fiats would not help the situation. So some method(s) by which (i) the hard work by scientists can be ensured in a direct & sustained manner (with some broadly fixed targets monitored objectively both for technical realisation & time targets) and (ii) also provide for administrative okays by the power-that-be, Can be blended at a national apex level is (are) required for evolution & implementation of remote sensing application to various aspects of national resources management.

3.3 Specifically the organisations/agencies which will be involved in the use of Remote Sensing are:

- Ministry of Agriculture (including irrigation)
  - o Its scientific agencies like ICAR Institutes, IARI, National Bureau of Soil Surveys
  - o State Agricultural departments.
- Ministry of Petroleum
  - o ONGC
- Dept of Mines etc
  - o GSI
- Central Ground water boards
- Snow cover studies with IMD & Min of Agriculture
- Forest departments of States
- DST : Ocean studies
  Environment

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- Dept of Environment
  Environment studies
- Other smaller agencies with specific interests
- Planning Commission & State planning boards.

4. DATA GENERATION

4.1 As regards technology development for reception of data/imagery for remote sensing viz., conduct of aerial flights, reception of data from foreign satellites & Indian satellites, construction of aerial sensors & satellite sensors including their platform instrumentation, the two agencies who are equipped well to handle this are SAC & NRSA - the former having capability in onboard sensor development also. Some limited capability in ground system for Earth Observation exists etc at DEAL, Dehra Dun & for onboard sensor (at least for System Engineering) at ADE. Experience with Microwave imageries/data however is very limited.

4.2 Data interpretation:

Both NRSA & SAC/SHAR have capability in data product generation of remotely sensed data: VTRR, imageries etc. As regards software for thematic interpretation of imageries, many agencies besides SAC, NRSA/IPI in the country like NBSS (ICAR), GSI, ONGC, IISc, University groups & many others including State Govt agencies have capability in visual interpretation of aerial/satellite imageries as can be seen in a few publications (Ref 1,). This capability in visual interpretation is vital to the remotely sensed resources management system since this is going to be the bread-and-butter of the system and probably one of inexpensive tools of interpretation. This form of interpretation is predominantly a science-based-skill tempered with field experience. However the published works, & reports from the Indian scientists do not show an orientation to quantify the effectivity of such visual interpretation in terms of accuracy of the tool for further applications to resources management nor does it show orientation in terms of operational procedures for day-to-day utilisation. Attempts at standardised keys for whole or part of India are lacking. (Standardised key may also give a fillip to standardised equipment).

In the area of computer based interpretation system, the efforts are more or less limited to NRSA & SAC. Some attempts are being made by ONGC. Quite a few

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university groups & user agencies have shown interest in computerised processing techniques. Probably these desires have not materialised due to expenses involved, computer procurement delays and perhaps more importantly due to lack of formation of viable multidisciplinary groups with specialities ranging from computer hardware engineering to knowledge in user oriented disciplines. Such an interaction of human skills & experience with interactive computer systems are required to develop useful packages.

On the side of mastering of computer software & hardware one can resonably assume a high level of skill both at SAC & NRSA. The comments regarding limitations of not-attempting to quantify the accuracy of interpretation, orientation to an operational etc are all the more relevant here since the costs involved in computer based information system are quite high - at least initially. Considerable thought should also be given as to what should be an optimal mix with visual interpretation systems & conventional techniques. Otherwise we may be unleashing an Frankenstein of information processing on us with no tangible output.

4.3 User interface development:

But for the limitations of scientific/technical methodology in terms of its orientation to actual uses as observed in paras 4.1 & 4.2 above, considerable progress has been done by SAC & NRSA in terms of user development. The former has been more successful in doing joint projects with the users as ARISE, Idukki landuse planning etc (Ref 2, 3, 4). However it is to be analysed & understood as to why some of these techniques are not being pursued by the user agencies as a routine (albeit supplementary) tool for their applications.

But an important plus point to be noted is that over the past decade a reasonably good group of scientists in universities, user (scientific) agencies, SAC, NRSA/IPI etc have been developed with some experience in the application of remote sensing techniques to certain limited aspects of resources management and these groups are interested in pursuing these activities further. However, since investment in these activities are increasing and also since the skills/experience have increased considerably it is time to channelise at least some of these talents to focussed uses. Really the task ahead is no longer user development but use development.

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4.4 Specific use identification:

With the above background one can clearly see that the national efforts on identification of specific uses are not particularly satisfactory. Here the term use is used in the context of ultimate use. For example, some good prediction on snow cover from NOAA imageries are being sent to IMD etc by NRSA; how well these are used in flood prediction/control or weather prediction or irrigation? Why not the ARISE type data not even been experimented on a major scale by ICAR/Min of Agriculture for crop identification? What happens to the various thematic maps produced by SAC, NRSA etc? Well the important aspect of R&D in remote sensing techniques & learning curve for users etc are not underestimated.

But the question to be posed for answer is that whether remote sensing techniques are being blended (or being used ab initio) in tackling national problems of vital interest (in resources management)? Years pass by with droughts & floods with interesting suggestions in scientific forums (by higher level authorities & active scientists) about the usefulness of remote sensing?; Few sporadic proposals are written and vanish in the humdrum of scientific activities. So it happens on pollution monitoring; fisheries & so on.

An attempt at least was made recently by GSI & others in putting together various elements relating to the hydrological and snowcover studies (Ref 5). Even this document lacks precise definition of goals & objectives in an operational sense.

In the context of present situation in the country in terms of resources management especially using earth observation systems it would be most useful to spell out a few sub-projects with clear definition of objectives and goals which can be measured later after the conduct of studies/experiments/analyses etc done with specific time targets. This issue is discussed in some detail in a subsequent para of this note (See para 6, Task-2).

4.5 Training Programmes, Transfer of Technology etc:

Training programmes are being conducted by NRSA, SAC, IIT-Bombay, IISc etc in terms of Seminar, Workshops, organised courses etc. These are good generally to percolate the techniques of remote sensing interpretation. Mostly these courses have been confined to visual based interpretation. Though in a general way such training

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programmes are very fruitful, concentrated efforts should be made to train user scientists/managers working on identified sub-projects or who have potentials for the same. Such an orientation will have the effect of accelerating specific uses in an operational sense.

Technology transfer can be thought in two forms: one the experience transfer including software packages and two in terms of transfer of technology to industry/ agencies of specific equipment developed for remote sensing such as colour additive viewer, spectral radiometer etc.

Regarding the former at least between the Government or Government aided agencies in the country there should be minimum restrictions, if any, of information or software package(s) flow. Regarding the hardware the usual processes of technology transfer can be applied. However in the interest of maximising indigenous products in this promising area of commercial marking some pro-acting as against reative mode of transfer would be useful.

4.6 'Other' areas of application:

The national security aspects of earth observations are well known & some studies have been done by relevant agencies. While the potentials for this technology are well appreciated and desires expressed to realise such systems indigeneously it appears that the following areas which have direct impact on data utilisation of such observations systems appear to be grossly underestimated:

(i) Collection of ground truth regarding objects of interests (including the camouflage considerations)

(ii) Tracking of satellites doing such observation as ephemeredis generation with such fast changing orbits are not easy to produce with very small reaction times.

This area is addressed elsewhere in a separate note.

4.7 Advanced research:

This can pertain to advanced sensor system, newer bands of electromagnetic spectra being utilised for remote sensing, newer data processing models and so on. While one does not underestimate the role of advanced research it should be noted that in the present context after about

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a decade of efforts by various agencies with remote sensing techniques, immediate efforts need to be given to operationalising some identified uses - probably some of the best minds should spend their energies in this so that there is a base for investment for future. Presently there is nothing going on in the country which can be named advanced research. Probably some identified sub-projects will trigger off new ideas.

5. BUDGETARY LEVELS

ISRO budget for remote sensing & meteorology leaving aside the sensor development is about Rs.40 lakhs per annum. RESPOND remote sensing funding comes to about Rs.15 lakhs per annum. NRSA budget leaving aside the administrative overheads will be about Rs.150 lakhs. Miscellaneous expenditure by other agencies like DST, ICAR, State Government agencies, UGC etc will amount to about Rs.70 lakhs. Thus totally earth observation component of resources management system in the country has a direct expenditure of about Rs.3 crores per annum. Investment in the space segment for Earth Observations (i.e Bhaskara, IRS etc) would amount to about Rs.6 crores per annum. It is very difficult to assess at this stage whether such an investment is commensurate with the benefits that will accrue from the remote sensing technology to the national resources management system. A very preliminary attempt (Ref 6) shows that this will be so even considering only a single application out of an Indian Remote Sensing Satellite. One should, therefore, infer that with multiply identified applications (for which plenty of scope seem to exist) for an IRS satellite and also utilising data from foreign satellites like NOAA, TIROS, Meteor, LANDSAT, SPOT etc & also making use of such an infrastructure (built for satellite imagery interpretation) for utilisation of aerial imagery etc the benefits from the National Remote Sensing System to National Resources Management System (See Fig. 1) would indeed be manyfold and benefits in the long run will pay off the investment done so far not merely in quantitative terms but also in qualitative terms (i.e. by raising the level of quality and timeliness of information available to the decision makers to a newer level).

With this scenario, it is more difficult to answer a question as to whether the present level of investment (i.e. about Rs.3 crores per annum in interpretative aspects and Rs.6 crores per annum in the space segment) for a country like our with immense potentials in resources and therefore having great many problems to solve in resources management. This is not just a

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rhetoric to justify more expenditure in remote sensing activities. This is a serious question worth answering soon: the country has lost its lead in various fields like electronics, atomic energy etc having had a head-start in these areas when they started elsewhere in the world. We need not repeat the same or similar mistakes in remote sensing applications too. Besides remote sensing is tied closely with various aspects of resources, knowledge about which is very vital to a developing country (why even for developed countries).

6. SOME TASKS AT HAND

Tasks at hand invariably relate to the needs of immediate future and have strong correlation (in terms of practical possibility) to what was done in the immediate past (and therefore the present capabilities). Some of the tasks projected at a fairly aggregated level can be seen in a recent report (Ref. 7). As can be seen in the referenced report, effectivity of the activities would really be judged from the thoughtfulness given to the micro-tasks and more importantly the care with which they are executed. Really the philosophical question (and therefore higher level operation question) is to see the forest in totality without losing sight of (care of) individual saplings. Some suggestion for this would be done in the following.

Task-1:

It is not possible to entirely deviate from the current stream of activities being executed by SAC and NRSA in terms of collection of aerial data, spacecraft imagery and certain joint experiments with the user agencies. Nor will it be desirable since one cannot wait for a new pattern to emerge but rather orient the existing stream of work towards a new pattern, which we are in a position to conceptualise now. The present aerial campaigns have all been oriented only towards visual interpretation in terms of techniques and they almost pervade all activities of applications ranging from agriculture soil survey to geology. Some experiments from these aerial flights can be selected to attempt quantified use levels, without seriously disturbing their current plans; also a few experiments can be selected from these to combine multiple data (such as satellite imagery, aircraft imagery & ground data) and also use of multiple techniques, (namely, computer processing, visual interpretation and also statistical models). What are the best ones to be experiment upon can be decided by detailed Working Committees. However a broad general guideline can be

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given that as a minimum these experiments should compass the following end uses:

(i) Agricultural yield type of experiment

(ii) Agriculture crop identification experiment

(iii) Water resources/drought type situation monitoring

(iv) One experiment assessing the soil conditions quantitatively

(v) One in forest monitoring in whatever form, and

(vi) One for a geological/mineral type application.

If the above are attempted with full vigour with some user scientists and also some economists/statistician type of persons to evaluate critically the uses, good examples can be set up for future modelling for resources management, based on concrete Indian experimentation. I suggest that this is done by a Committee involving the Space programme Headquarters, NRSA, SAC and a few selected user scientists.

Task-2:

In addition to the above which are based on a little bit of tinkering with the existing mode of activities, 4 or 5 major experiments can be given a project mode almost in the same fashion in which NASA organised LACIE or snow cover experiments.

The suggested areas for such projected major experiment are the following:

(a) Prediction of wheat crop in India: the utilisation of the remotely sensed imageries for this and comparison of analyses through actual experiments. The conclusion of the experiments should inclue evaluation of the effectivity of the various models and also determination of the cost factors and operational constraints in inducting these into the user system.

(b) Monitoring of forest resources in the country in terms of growth, recycling and deforestation: Evaluation of models for the same (including cost factors/operational constraints).

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(c) Development of a methodology for predicting ~~drought~~ drought in advance and also identification of likely water resources in drought prone areas. Utilisation of satellite imagery, aircraft imagery and other means of data collection through satellite should be specifically studied as to their role in such a monitoring system. Specific quantification in terms of possibility of prediction in advance and uncertainty should be brought out. Should end with a critical evaluation of the experiment.

(d) Monitoring of the coastal lines and water bodies in the country especially from the view point of environmental pollution monitoring.

(e) Utilisation of satellite imagery, aircraft imagery and other data for providing information to fishermen regarding fish availability in the coastal areas.

(f) Utilisation of satellite imagery, aircraft imagery etc with other information for identification sources for mineral resources (which mineral it should be, can be determined in consultation with GSI and others).

Utilisation of IRS/Landsat etc can be weaved in suitably in the above - as these are only selected few.

The above six items are only examples. It may be specially noted that other than these broad aspects no specific quantifications or targets are defined in this note. This is best done by a group of scientists in the first instance and decided at a higher level by a group of top scientists and decision makers.

The above topics when identified in concrete terms would really become a few sub-projects of a Programme at a national level. If these are executed well, then the country will be ready with a mechanism not only in technical terms but also in managerial and operational terms, to deal with the question of national resources management in which remote sensing or earth observation will be a strong component. Then the system can become self-generating. For these selected experiments (sub-projects), it will not be fair to cut a slice from SAC or NRSA but it will be best raised as projects for which

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separete funding is provided by the Ministries concerned or by the Department of Space; perhaps these subprojects can be raised as Single Programme for which Cabinet approval can be obtained with separate sanctions as for MONEX. (Each of the subproject will cost at the most Rs 2 Crores - about Rs 1 Cr per annum. 6 projects can be run for three years with about Rs 5 Cr. p.a. expenditure.

Task-3:

The third task would be to energise various State Government agencies and other agencies inthe country to be aware of remote sensing techniques and utilise them wherever possible. This would also include training programmes in addition to the ones which are already on going with NRSA and SAC. These should be done in a more systematic fashion than had been done hitherto and also the list of agencies should carefully made not just because they are interested but because in certain areas activities need to be energised in the country. This may also include placing of a few persons from the Government Ministries with the appropriate State Government agencies to conduct joint experiments so that appropriate training and management culture imparted.

Thus the tasks ahead would essentially be three pronged as under:

1. Continue the activities of SAC & NRSA as such without disturbing them seriously but selecting a few of the on going experiments to orient them for concrete quantified operational goals. This need be done by a group of working scientists brought together through discussions with also injection of clear cut management inputs through economists, statisticians and general administrators.

2. Defining of some major sub-projects similar to LACIE etc at the national level and fund them separately at the National Level which can really generate the nucleus of the Resources Management System. (These experiments will be similar to SITE, STEP & ARVI for satellite communication but with a new dimension due to the complexity of the problem).

3. Even while the above two are taking place there has to be concerted attempt but more selectively for spreading the remote sensing technology & management culture into the various parts of the country.

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7.0 A MANAGEMENT MECHANISM

The above tasks will suggest that the tasks at hand are quite enormous involving various disciplines and more importantly various administrative Ministries, Agencies, etc. This would necessarily mean a good deal of technical coordination, technical analysis, 'jargon management' between various disciplines and more importantly getting commitments from the powers-that-be which will involve necessarily top level administrators. No doubt the agencies for data generation namely NRSA & SAC have to be involved at various levels since they will not only generate data from satellites and aircraft but also will have a capability to manipulate them in terms of visual interpretation, data processing etc. But they need be supplemented with user interests, the will to bend for user needs and also to introduce research component wherever needed while at the same time not go in an open ended part, are also the required features. This cannot be achieved by administrative fiats but only through through a concerted work pressure by a group of scientists who are again kept under pressure by a top management-cum-administrative set up.

Thus the Indian space programme can have a nucleus structure with representatives from NRSA, SAC, ISAC, ISTRAC & IMD and Space Headquarters to plan and do technical analysis of various activities so that position papers or status papers can be created for various disciplines or applications. This along with the HQ direction of the space programme will form the nucleus for the programme generation. It will be best that this group is convened or chaired by a person in HQ to energise, activise and coordinate the activities. Of course details of the many of the execution responsibilities will vest with NRSA, SAC and other identified agencies but any 'interference' (if it may be termed so) at the planning and monitoring-in-between will have to be done by this core team and by HQ. For individual applications like agriculture soil management, geological applications etc, selected sub-committees with a greater predominance of users and certain statistician/economists would be necessary for detailed planning of user experiments/applications and also monitoring and evaluating the experiments. These user sub-committees will feed to the Core Committee. Here again, the Space Programme HQ will have a crucial role in terms of coordination and bringing together various persons. For the three tasks mentioned in para 6 will have to be overviewed by a committee made up of a top manager/scientist and some major agencies' chiefs - some at the level of Director-General level some at the level of Secretary, Govt of India.

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This top committee can perhaps be termed as National Space Resources Management Committee. The chairing of this should be done either by Secretary, DOS (preferably) or by a Member of the Planning Commission should he be an eminent scientist who can grapple with this multidisciplinary problems. At the present, it would appear that Dr M S Swaminathan would ideally fit this role. The other members for this committee could be:

Secretary, Agriculture
Director-General, ICAR
Director-General, GSI
Director-General, IMD
Director, NRSA
Director, SAC
Chairman of the Central Water Board
Secretary, Department of Environment
Secretary, DST
Chairman, ONGC
Chairman, UGC

and perhaps a few others (like Prof Pisharoty). (See Fig. 2)

Since the top committee is fairly heavy the meeting of the Committee can take place only thrice a year. But at least three meetings in a year are required to have some control. It should be noted that the time scales of introducing remote sensing technology in the country are very small and frequent monitoring only will ensure that things are going on right path. The Space HQ can provide the secretarial support for this Top Committee. The core committee (with HQ, NRSA, SAC etc) will do lot of paper work some of which will be filtered carefully and raised to the Top Committee. The Convenor or Chairman of the core committee (HQ person) should also have some authority to correspond with the user agencies when necessary or getting some of the Directors to get together to produce status report, position papers etc for the Top Committee. The Top Committee will review the general progress and decide on few cases as the best course of action. While the corresponding Ministries and agencies cannot be totally bound by these decisions, there should be reasonable amount

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of authority vested to the Top Committee to enable these decisions to be implemented. The Space Programme secretariat should do the necessary job of this coordination. In some select cases Chairman of the Top Committee and/or the Secretary, DOS might have to take a spot decision even in the intervening period when the Top Committee has not met. This may include conducting of a special experiment or certain emerging international opportunities and so on.

With regards,

(Y S Rajan)

Encl: as above.

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Ref-7 : The ISRO Remote Sensing Programme (January 1979 Doc No ISRO:RS:01:79).

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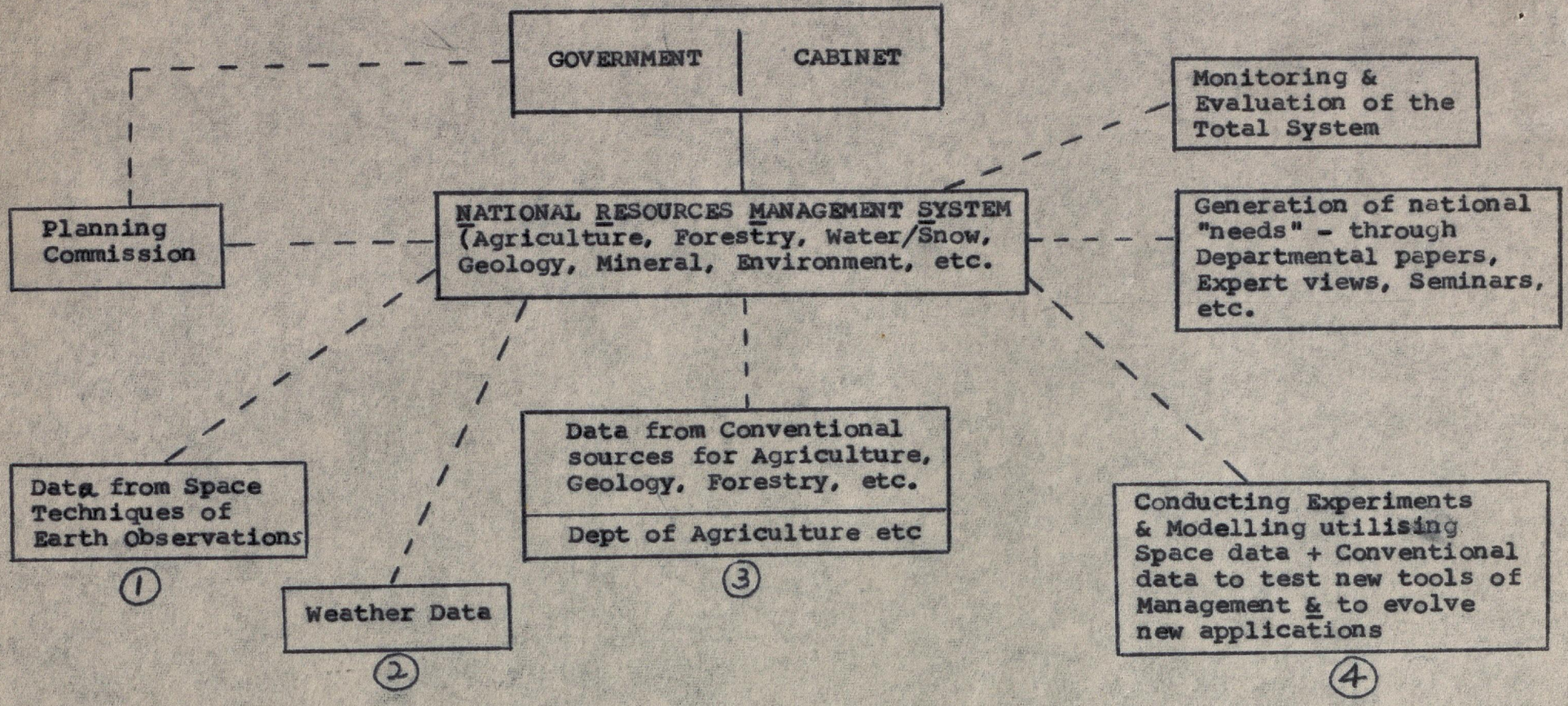

Fig. 1: National Resources Management System with stress on Space Components.

Note: While National Resources Management is a Big Task, a Space related Top Committee can ensure some 'integration' of ①, ②, ③, ④ & ⑤ to give working packages - at least good operational examples - to the National System.

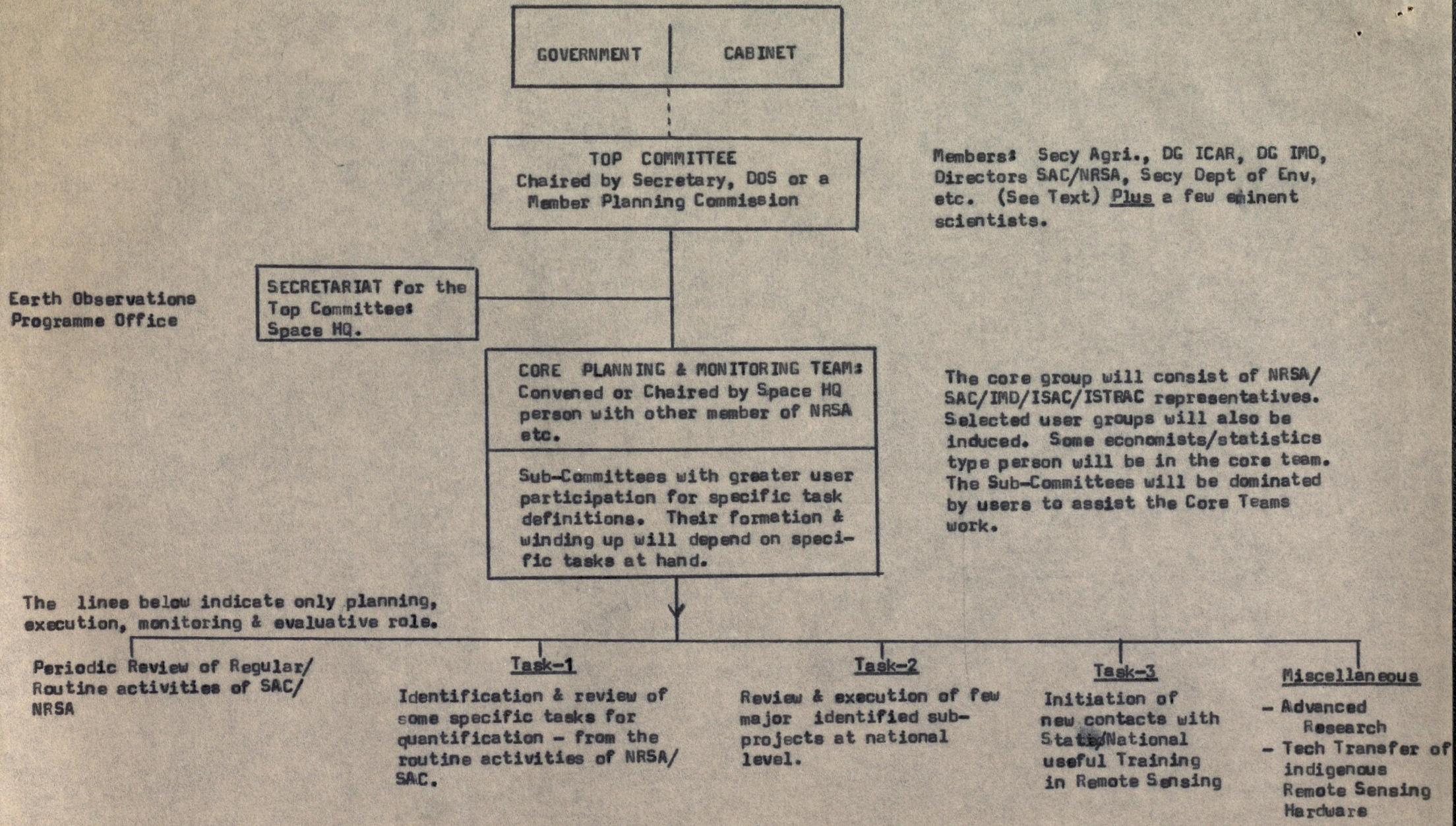

FIGURE 2: THE NATIONAL "ORGANISATION" OF RESOURCE MANAGEMENT WITH SPACE TECHNIQUES

APPENDIX - 1

USER DEVELOPMENT FOR SPACE APPLICATIONS

(A Brief Overview)

Satellite communication user interaction - from the beginning to INSAT Coordination Committee	Remote Sensing User Communication
1. In the early days of space programme around 62-63 satellite communication especially direct broadcasting television was conceived as an important application though generally user ministries were not so responsive.	1. Remote sensing in India was conceived as an application only in the later part of 60s. The major documentation from the then Chairman-ISRO was for the UN conference for Space in 68.
2. Experimental Satellite Communication Earth Station (ESCES) was built under UNDP assistance by ISRO to gain experience in satellite communication technology. User participation was almost nil. Again as a follow-up ARVI was built in the country with some indigenisation with fairly stiff resistence from users.	2. In 1970 experimentations did start. There were also some user interactions but rather weak.
3. In the same period a national satellite communication study group (NASCOM) was formed mainly to define SITE type of experiment.	3. 74-75 witnessed some joint experiments such as ARISE.
4. Krishidharshan experiment was formed around 65-66 with some user involvement but mostly scepticism.	4. SEO utilisation experiment energised some user participation but mostly from the academic community and not from big user agencies.

Satellite communication user interaction - from the beginning to INSAT Coordination Committee	Remote Sensing User Communication
5. Around 67 NASA-DAE agreements proceeded on SITE with some involvement of users but still with user scepticism.	5. Joint Experiments Programme was initiated around 77 following the formal presentation by Secretary, DOS to various user ministries/ departments. These have picked-up somewhat well.
6. Studies with user participation for INSAT system with GE, Hughes and Lincoln Lab were initiated.	6. Various user comments on the profile indicating Indian Remote Sensing Satellite have been very positive and has led to general broad programme profile for Indian Remote Sensing Satellite.
7. SITE continues to proceed with user interaction on software, etc.	7. The user interaction for NRSA also has been by and large good in terms of technical products. However, there has been a general lacuna both from ISRO and from NRSA side regarding the actual utilisation of the products to the ultimate users. This has been partly due to the nature of the technology itself and not always due to the administrative mechanisms.
8. A National Seminar was arranged by ISRO on various satellite applications and Space Research in August 72.	8. On the satellite meteorology side some activities have been done at IITM and SAC though general interface with IMD on satellite meteorology utilisation has been poor. Quite a bit of theoretical aspects of algorithm and software generation need to be energised since remote sensing or resources management are coupled closely.

Satellite communication user interaction - from the beginning to INSAT Coordination Committee	Remote Sensing User Communication
9. Planning Commission Study Group on INSAT formed around 72-73	9. In view of the formation of IRS Project which is a major investment, and operation of the ground station of NRSA, and also a fairly good investment at SAC and NRSA for remote sensing generation, it will be most appropriate now to have a higher level coordination committee or coordination mechanism for integrating the remote sensing efforts in the country programmatically. Also some of the user agencies like Ministry of Agriculture, ONGC and GSI have built in considerable expertise and/or also interested in it. It is time now to optimise the national investment to utilise the infrastructure and expertise built with Users & Space.
10. INSAT generally turned down by Planning Commission. Various studies continued.	
11. Around 75-76 formally Working Groups of Planning Commission were energised to define INSAT system resulting in a Cabinet decision in 77. In the meanwhile, major satellite communication experiment namely SITE & STEP successfully conducted. These experiments did to some extent pave way.	
12. INSAT Coordination Committee was formed.	

This rough comparative chart will give some idea about the path followed on two major applications of Space, namely, satellite communication and satellite remote sensing though the content and context are different.

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