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International issues in remote sensing

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Abstract. Starting with the initial aim of reconnaissance technical developments in remote sensing have progressed sufficiently for the large-scale realisation of practical benefits. During the eighties a number of countries will have remote sensing satellite systems in operation. There are however a few technical, legal, political and economic issues that still remain unresolved. The resolution of these issues would facilitate practical applications especially in developing countries. Apart from the purely technical and economic issues such as the ability to compare data from two different satellites, the cost of the data etc one of the major hurdles in the application of this technology is the establishment of an international regime governing the activities of states in remote sensing. This is particularly important in view of the link between surveillance and remote sensing. Even though discussions have been going on for quite some time at the United Nations, the prospects of reaching agreement remain bleak.

The main problems precluding agreement are national security, commercial and sovereignty concerns of the developed and developing countries. The key issues relate to the right of countries to conduct remote sensing over other countries, the right of countries collecting remote sensing data (over other countries) to distribute this data freely and the modalities of how the "sensitivity" aspects of remote sensing for surveillance and economic espionage can be reconciled with a legal regime that emphasises international cooperation. A critical analysis of existing international space law seems to indicate that there are two kinds of remote sensing—passive and active. In passive remote sensing the satellite sensor detects the sun-reflected or self-emitted radiation from objects on the ground. In active remote sensing a pulse of electromagnetic radiation is transmitted from the satellite and its reflectance or scattering by objects on the earth's surface is measured. A strict reading of existing legal principles on space seem to imply that passive sensing is legal while active sensing could be interpreted as violating the sovereignty of the sensed state. Agreement on remote sensing can be reached if a resolution or a range of resolutions can be defined to discriminate between "sensitive" and "non-sensitive" data.

The only international agreement in this area between the USSR and a group of nine socialist countries uses a resolution limit of 50 m. Available information on the subject seems to indicate that the range is from 25–50 m.

One other aspect dealt with relates to the use of satellite data for verification of arms control measures, for crisis monitoring and the prospects of setting up an International Satellite Monitoring Agency (ISMA). It appears that the huge expense that this would entail would be justified only if the ISMA can monitor the superpowers and the arms race between them.

Keywords. Remote sensing; reconnaissance; International Satellite Monitoring Agency (ISMA); disarmament; resolution; space photographs; space treaty.

1. Introduction

October 1957 marked the beginning of the space age with the launch of *Sputnik* by the USSR. For the first time in history, a man-made object was circling the earth, covering different regions and countries of the world from its vantage point in space. *Sputnik* being tied to the earth as a whole, had no special preference for any one part of it in its

orbit around the earth. A new frontier had been opened, a frontier which recognised not the narrow parochial bounds of individual nation states, but rather the oneness of man and his unique position on this tiny blue-green planet of ours.

The early promise of the new frontier was soon belied by subsequent events. National interests and rivalry between the two big space powers have resulted in a gradual erosion of this spirit. As a result, the world is today confronted with the frightening spectre that the third world war if and when it starts may well start in space. In discussing international issues in remote sensing it is important to keep this background in mind, since the reaching of an understanding of any kind on an international regime in this area, is intricately tied up with the issue of militarisation of space.

2. The international scene in remote sensing

The years following the launch of *Sputnik* were the "cold war" years and the years of the "missile gap". The US was particularly interested in knowing the exact number of ICBMS that the Soviet Union possessed. It was logical therefore to think of satellite-borne sensors for reconnaissance. The first US effort for this purpose was made with the launch of the *Discoverer* series in early 1959 (Kenden 1978). This used a camera system with a recoverable film capsule. The first successful recovery was made with *Discoverer* 13 in August 1960. The development of an area surveillance system (SAMOS) was also initiated and the first successful flights took place in 1961. The Soviet Union in response, initiated its own programme and the launch of *Kosmos* 4 in 1962 marked the beginning of the Soviet recon effort. Subsequent technology developments have resulted in both countries having full-fledged operational reconnaissance systems (Johnson 1980; Kenden 1982). Satellite reconnaissance by these two countries over each other and over the rest of the world is now routine and are recognised as legitimate by both countries, though not necessarily by the other countries of the world. They form a part of the verification element in the SALT treaty under the euphemism "national technical means of verification" (Treaty 1976; US Senate 1976).

Transition from a predominantly military use to civilian use was only a matter of time. The first pictures of the earth for civilian uses were mainly for meteorological purposes. The early manned flights of both the USSR and the US, photographed the earth using hand-held cameras. Recognising the potential of these images, the US conceived the LANDSAT system of satellites, the first of which was launched in 1972. These satellites carried two kinds of instruments—a multispectral scanner which imaged the earth with an instantaneous field of view of 80 m in four spectral bands and a return beam vidicon TV camera system which had three bands with a field of view of 40 m in LANDSAT 1 and 2 and two panchromatic cameras with a field of view of 30 m in LANDSAT-3.

The Soviet Union also experimented with and developed the MKF-6 camera system which has routinely carried on many manned missions. These were photographic systems having resolutions of between 20 and 30 m. The USSR also developed the *Meteor* series of sun-synchronous satellites which carried multispectral scanners.

The seventies also saw the launch of SEASAT the first civilian satellite carrying a radar system. Even though this failed after three months in orbit the data clearly demonstrated the utility of synthetic aperture radar (SAR) imagery. This has been

subsequently confirmed by the imaging radar carried on the second shuttle flight. Both the US and the USSR are reported to have developed active radar systems for ocean surveillance (Kenden 1978; US Senate 1976).

The civilian remote sensing programme was essentially an US and an USSR effort in the seventies. These countries made the data from their satellites available to a large number of countries around the world at extremely reasonable costs. As a consequence the use of such data has become common the world over.

However, the eighties is going to present quite a different picture. France, Japan, India and China all have plans to launch their own satellites. The US has already launched its second generation LANDSAT-D satellite. All of them will have resolutions higher than the earlier LANDSAT satellites. These range from the 10 m field of view of the French SPOT (CNES 1978) to the 50 m field of view of Japan's marine observation system (MOS) (Kiyoshi 1983).

The European Space Agency (ESA) also plans to launch ERS-1 in 1987 which will carry a high resolution radar system (Duchossois & Honuault 1980).

One can reasonably assume that the USSR will also have improved systems to offer to the international community during the current decade.

The eighties will also see an increase in the commercialisation of remote sensing data. The US has already hiked up the price for direct reception of LANDSAT-D MSS data by a factor of 3 from 0·2 to 0·6 million dollars. Exact estimates for direct reception for the thematic mapper are not available. The US is, in addition, introducing a royalty fee for every picture or CCT sold by a country receiving data from LANDSAT. The rates for the French SPOT system are likely to be comparable. ESA is also likely to market the data from ERS-1 at prices which are similar if not higher.

On the recon and military side a number of developments are planned on the shuttle (Kenden 1978). While not much information is available on the USSR effort in this area, it is likely that similar developments would take place there also.

Thus the following trends in remote sensing are likely during the eighties:

—higher resolution data are likely to be available for civilian uses; these would range in IFOVs from 10 to 50 m;
—satellite data services would be available from a large number of countries;
—there will be an increasing tendency towards commercialisation of the data; consequently the prices for the data are likely to be significantly higher;
—military and recon functions are likely to continue and the clear line of demarcation that distinguished the passive reconnaissance function from active "aggressive interference" during the seventies is likely to get blurred.

One other element requiring special mention is a French proposal for the establishment of an International Satellite Monitoring Agency (ISMA) (Note Verbale 1978). The effort initiated by the French President, proposed the use of high resolution reconnaissance data from satellites for monitoring various arms control/disarmament agreements and for crisis monitoring. A detailed well-documented study by a group of international experts is available (UN Doc 1981) where political, technical, legal, organisational and financial aspects are extensively discussed. There is a possibility that the international community may decide to create such an agency during this decade. The implications of this are discussed in detail in §8 of this paper.

3. Legal framework for a possible international regime

It was not long after the receipt of the first images from space, before the international community woke up to the potential and dangers of remote sensing from space. The first United Nations Conference on the Peaceful Uses of Outer Space convened at Vienna in 1969 served to focus attention on this new technology. The issue was first formally raised in the United Nations General Assembly in 1969 when the Committee on the Peaceful Uses of Outer Space (COPUOS) was requested to study possible international cooperation in this field (UN General Assembly 1969). COPUOS in turn referred the matter to its Scientific and Technical (S&T) Sub-Committee where the issue was first considered in 1970.

On further instructions from the General Assembly, a Working Group on remote sensing was established by the S&T Sub-Committee in 1971. The legal implications of remote sensing were discussed for the first time by the Working Group in 1973. The legal aspects were also referred to the legal sub-committee of COPUOS in 1973 which has been considering it from then onwards till date. The original S&T Working Group created by the General Assembly resolution of 1971 submitted a report which studied in detail the capabilities of remote sensing to provide information of value in the management of natural resources.

After nearly ten years of work, the legal Sub-Committee is yet to come out with a set of principles governing international activities in remote sensing. Over the years this has been whittled down and what is now accepted as a basis for agreement is only a set of guiding principles. This does not of course have the same legal sanctity as a treaty.

Before venturing to discuss in depth the issues related to remote sensing it is worthwhile to look into some elements of international law as they relate to space.

Over the years COPUOS has formulated several treaties on space. These are:

—Treaty on principles governing the activities of states in the exploration and use of outer space including the moon and other celestial bodies (outer space treaty);
—Agreement on the rescue of astronauts, the return of astronauts and the return of objects launched into outer space;
—Convention on international liability for damage caused by space objects (liability convention);
—Convention on registration of objects launched into outer space (registration convention);
—Agreement governing the activities of states on the moon and other celestial bodies (moon treaty).

The first four treaties have been ratified and are in force. The fifth treaty "the moon treaty" has been signed by many countries but is still awaiting ratification by the minimum number of countries before it enters into force.

Among these treaties, the most important one is the outer space treaty of 1967. This treaty provides broad guidelines for the conduct of activities on outer space. Some of the essential elements of this treaty as they relate to remote sensing are:

—Outer space is not subject to national appropriation. In other words it is free to be used by all countries. This implies that every country has an equal right to orbit satellites around the earth; (Article-II)

—countries that use outer space are responsible to the international community for all their actions in space. This means that activities in outer space can only be carried out under a national framework; (Article-VI)

—the moon and celestial bodies are to be used "exclusively for peaceful purposes". As far as outer space is concerned while the stationing of nuclear weapons and weapons of mass destruction is prohibited the words "exclusively peaceful" appear to be intentionally left out with regard to activities in outer space. This could be interpreted to mean that military activities including the stationing of non-nuclear, non-mass destruction weapons are legitimate and are not banned by the treaty; (Article-IV)

—the treaty does not define "outer space". The line of demarcation between "air space" (which is subject to national sovereignty) and "outer space" (which is international and for use by all) is therefore not clear. The general interpretation is that any object that orbits the earth is in outer space. Discussions on the definition of outer space have been going on for several years with no success. The problem is once again military in nature since missiles especially ICBMs have to fly through a part of outer space on their way towards their targets.

The implications of these on the legitimacy of remote sensing are:

—since outer space is international, all activities that do not directly affect the sovereignty of states are legitimate;

—the sensing or detection of the radiation reflected by objects from the sun's rays incident on it is permissible since no active intrusion into the sovereignty of the country involved takes place;

—in a similar way the passive radiation emitted by objects by virtue of their being at temperatures above 0°K can also be sensed with no violation of sovereignty;

—however, in the case of active sensors such as a laser or a radar an electromagnetic pulse is transmitted from the satellite and its reflectance/scattering etc are measured. There is, therefore, an element of intrusion into the sovereign air and land space of the sensed country. This issue has not directly been addressed in any forum due to its obvious military nature;

—even though sensing of the natural reflected radiation (from the sun) and self-emitted radiation of objects (over another country) may be legitimate, the analysis and use of this information could be construed to violate the sovereignty of the sensed country. In other words "while sensing may be legitimate the outcome of sensing may not be legitimate". The problem becomes more acute when data that is collected is freely distributed to all countries and when such data has obvious economic, strategic or national security value;

There is one other treaty that is relevant to any discussion of remote sensing. The Convention on the registration of objects launched into outer space, requires that the orbital characteristics and purposes or functions of any object launched into outer space be registered with the United Nations. While in principle this would mean that a recon satellite or even a weapons testing satellite should be registered as such this is obviously never put into practice. Much of the information on reconnaissance, weapons testing etc is therefore inferred from the orbital characteristics of these satellites and from other sources of information the legitimacy of which is sometimes doubtful.

4. Major issues in remote sensing

For the sake of convenience the issues on remote sensing can be grouped into two parts. One part relates to the technical and developmental aspects involved in the use of this technology and the possibilities of cooperation between countries mainly in the technical areas. The other part deals with the political, economic and sovereignty considerations of nation states and the realisability of an international regime to regulate the activities of different countries.

These are obviously interconnected issues and while the absence of an international regime has so far not hampered developments this may not be so in the future. If the current trends of higher resolution sensors and commercialisation continue, some regulation is required if the interests of the developing countries have to be preserved.

4.1 *Technical, economic issues*

As has been mentioned earlier, a number of countries or groups of countries are planning to have their own satellite systems. Each of these systems is designed to meet certain specific needs of the countries concerned. The spectral bands, swaths and the ground trace projections of the LANDSAT-D thematic mapper, the SPOT high resolution camera, the IRS sensors, ESA's ERS-1 and the Japanese MOS system have many differences and some commonalities. While international regulations limit the frequencies for remote sensing data transmission to only a few (in the "S" band and in the "X" band) the individual telemetry formats and modulation schemes are likely to be different. The individual swaths, the orientation of the image on a typical map projection as well as the basic pixel sizes will also be different.

Thus even though data sources are likely to be many, the problem of being able to effectively use these sources in conjunction with one another is exceedingly complex. Developing countries are at a particular disadvantage since the development effort to simultaneously use data even from two satellites is substantial. When the number is as large as four or five the problem is bound to be more complex. One area where a well-coordinated international programme is likely to yield positive benefits to all countries relates to how data from all these sources can be used in combination. The fruits of this effort should be freely available to all countries preferably at no cost. This is one area where international effort is necessary if remote sensing is to really take off.

Another area where some coordination may be required relates to the visibilities of different remote sensing satellites over an earth station. The local time of equatorial crossing for each of these satellites (in technical terms the right ascension in inertial coordinates) should be so chosen that a typical ground station does not have two or more satellites simultaneously visible over it. This is necessary if the investment in the ground station in terms of antenna, reception chain etc is to be minimised. (If two satellites are simultaneously visible then two ground stations are necessary for receiving the data.) This requirement is particularly important for developing countries who cannot afford to duplicate antennae, reception chains etc in order to receive data from more than one satellite. Coordination amongst the various satellite operators can ensure that this does not happen. The technical problems associated with this are minimal.

One element that has not received much international attention is the use of data

acquired from photographic cameras onboard manned stations. The recent advent of the shuttle and the successes achieved by the USSR *Salyut* station clearly indicate that photographs of cartographic quality could be acquired from such platforms on a routine basis. This is of particular interest to many developing countries who have been using aerial photographs for many years and have acquired necessary equipment and manpower skills for preparing maps from such photographs. The use of photographs also obviates the need for acquiring expensive digital interpretation equipment and sophisticated software. If such data could be made freely available, many countries may not need to set up their own earth stations for the reception and processing of digital data. Large scale use and development efforts for use of such photographs have been precluded so far because of non-availability of data. The higher resolutions achievable with photographic systems also has attendant with it some sensitivity problems and this could be one of the reasons why such data has not been used more extensively. The potential is however great, especially in developing countries. This is one area where a sustained international effort could result in substantial immediate benefits to developing countries. This aspect has not been addressed in sufficient depth internationally and deserves greater attention.

One other issue of particular concern to developing countries is the cost of acquiring the data. With the recent increase in the cost of LANDSAT data and the tentative projections available for the cost of SPOT data, it appears that remote sensing data may be so priced that many poorer countries of the world cannot afford to buy data. In addition use of the data for effective management requires expensive infrastructure and sophisticated skills. Some adaptation and innovation may also be called for to meet country-specific needs. These are likely to make remote sensing a fairly expensive proposition. While regional stations for data reception may alleviate the problem to some extent, it would still not be a cost-effective solution for many countries mainly because of their inability to effectively use all the data. A major experimental phase is necessary if data utilisation is to take off and the various technical, organisational, managerial issues resolved. The high prices of the products may result in a situation where only a few of the countries can afford the experimental phase necessary for large-scale use.

To ensure availability of data at reasonable prices is one of the responsibilities of the international community. Indications are that in view of the serious economic problems faced by many of the advanced countries data will no longer be available at prices everybody can afford. Suitable mechanisms either through the UN or through other bodies must be found if this technology is to be used by all.

There is one final issue (possibly the most important) which relates to guaranteed access to data for a certain minimum duration of time. Many developing countries after making the necessary investment in ground facilities face the problem that continued data access is not guaranteed due either to a cutback in the programme of the country providing the satellite services or because of a malfunction of the satellite with no prospects of an immediate replacement.

The availability of a large number of satellites from different countries could in principle help in resolving this problem. The cost of this option is likely to be high since a country will have to pay more for having the required access to two or more satellites. As mentioned earlier use of data from two sources has attendant with it a whole host of problems. There is therefore a case for an international system which provides standard interchangeable services. The development of such a system is however likely to take

some more time since international availability of data is currently a spin-off from meeting purely national needs and is constrained by the availability of technology. The cost-benefits of remote sensing are also not clear and make it difficult to justify the financing of an international system. It appears obvious that some subsidy has to be provided by the developed countries if this technology has to take off. All international bodies including the UN have a role to play in preserving the option for a future international system. The developed countries should also ensure as far as possible continuous data access till the experimental phase is over and remote sensing becomes truly operational among the developing countries of the world. At that time countries could seriously consider setting up an international system.

4.2 *An international regime for remote sensing*

Based on the discussions so far the focus for the evolution of an international regime would be mainly on the following issues:

—surveillance and civilian applications are linked. This link should be recognised and taken into account;
—the right of a state A to sense over a state B is confined to measurements of radiation reflected by objects from the sun or to the self-emitted radiation of objects. The use of active systems such as radars/lasers can be construed as violating the sovereign rights of the sensed states;
—while sensing of the sun reflected and self-emitted radiation of objects may be legitimate, the use of information derived from this could in principle violate sovereign rights of states over their natural resources. It could also affect "national security" interests of the sensed state. It is therefore necessary that the country A, which has been sensed by country B, be consulted by B before data over A's territory is supplied to a third country C;
—at the same time there are certain classes of data such as meteorological data which are non-sensitive;
—the key towards the solution of the remote sensing question is whether there are any technical parameters that would permit the classification of remote sensing data into "sensitive" and "non-sensitive" categories. Such a classification would permit the free dissemination of "non-sensitive" data and the "controlled" dissemination of sensitive data;
—given this scenario is there a possibility that an International Satellite Monitoring Agency can be created which would facilitate disarmament and prevent conflicts as proposed by France.

Some of these issues are dealt with at length in the subsequent sections.

5. The right to sense

As discussed earlier measurements of the sun-reflected and self-emitted radiation of objects do not appear to violate sovereign rights of states. Thus they would appear to be legitimate.

However, the use of any active system such as a radar or a laser does involve intrusive

radiation into the air and land space of the sensed state. This need not be construed as legitimate by existing international law.

The draft principles under discussion at the United Nations (COPUOS) are blissfully vague about what constitutes remote sensing. A USSR suggestion that remote sensing be defined, has never been acted upon. The only international treaty on remote sensing that exists is between the USSR and a group of socialist countries (UN Document 1978). According to this treaty remote sensing is defined as

> "For the purposes of this Convention
>
> (a) the term "remote sensing of the earth from outer space" means observations and measurements of energy and polarization characteristics of self-radiation and reflected radiation of elements of land, ocean and atmosphere of the earth in different ranges of electromagnetic waves which facilitate the location, description of the natural and temporal variations of natural parameters and phenomena, natural resources of the earth, the environment as well as anthropogenic objects and formations". This is the same definition proposed by the USSR in the legal sub-committee meeting (USSR Working Paper 1979).

As against this definition the 1982 draft principles on remote sensing at COPUOS define remote sensing as:

> "the term remote sensing of the earth" means remote sensing of the natural resources of the earth and its environment.

It is clear that while the USSR definition is better than the definition in the COPUOS draft principles, the distinction between active and passive sensing is intentionally vague. Any set of principles or a draft treaty in this area should take note of this distinction and define a legal regime suitably. In any case while a few developed countries contend that no consent is required to conduct remote sensing there are a large number of countries who believe that even the sensing of sun-reflected and self-emitted radiation is illegal. It is important that the differences between active and passive sensing be recognised in the definition of the "legal regime".

6. The right of free dissemination versus sovereignty of states over natural resources

The US and other Western powers are the ardent proponents of the free dissemination of data. In their view, the development of this technology would be fostered by an approach where there is no restriction on the distribution of data.

The developing countries on the other hand are concerned that this approach would enable other countries to acquire information of economic value over their territories. It is possible that the same information would not be available to them due to lack of adequate infrastructure to use the data even in case the data was available. There is also a possibility that the data would be priced in such a way that many countries would be unable to purchase it.

The surveillance aspect has not been directly mentioned except by India (UN Document 1980) and by the USSR indirectly (UN Document 1978). But at the back of every country's mind this seems to be the crucial issue. Even the US with all its talk of

free disssemination does not make available the data from their recon satellites. It would therefore appear to be logical to conclude that certain classes of data are indeed sensitive and that if these could be clearly identified prospects of reaching some kind of agreement would definitely improve. The only international treaty on remote sensing (between the USSR and a group of nine Socialist countries) has successfully resolved this issue by adopting the principle that remote sensing data with a resolution that is coarser than 50 m can be freely distributed, whereas data with a resolution finer than 50 m should be distributed only with the consent of the sensed state. The question of resolution and methods of classifying remote sensing data are dealt with in the next section.

7. Classification of remote sensing data

This subject has been under extensive discussion and a number of studies have been carried out (NASA 1980; COSPAR 1978). The following seem to be reasonably clear:

—the instantaneous field of view (IFOV) of a "scanner" instrument does not correspond directly to the resolution obtained by converting the scanner image into a photograph. In other words the IFOV of a scanner does not coincide with the resolution of the photograph obtained from it;
—the photographic resolution is about a factor two to three times coarser than the scanner IFOV (the exact number depends upon factors such as the contrast in the scene, atmospheric attenuation etc;)
—available studies indicate that for the recon function required photographic resolutions range from 1 to 10 m depending on the kind of end use;
—resolutions typified by the 20 m IFOV of SPOT 36 m IFOV of the Indian remote sensing satellite and 30 m of LANDSAT-D would provide information of economic value especially in areas like forestry, agriculture, geology. When combined with aircraft and ground information they are a very powerful tool for providing valuable and useful commercial information.

The debate on resolution has been going on at the United Nations for quite some time. A study by COSPAR (COSPAR 1978) provided a good technical insight into the problem. The USSR proposed in 1977 a resolution limit of 50 m for the free dissemination of remote sensing data (UN Document 1977). The US which was against this limit cited the *Skylab* photographs which had resolutions of 15–20 m as an indication that even at these resolutions the data could not be deemed sensitive. However, an analysis of *Skylab* imagery (Kenden 1978) does indicate that information of strategic value can be obtained. Analysis of simulated space photographs using aircraft data also indicates the economic and national security value of the imagery.

From all these it would appear that the resolution limit for any international regime of remote sensing would be in the range of 25–30 m (photographic) or if the Soviet proposal is taken into account between 25 and 50 m. Thus this could be used to distinguish "sensitive" from "non-sensitive" data even though like many measures it does not adequately reflect the range of information available from such data. This arises essentially because there are a large number of variables that determine what is seen and what is not seen in a particular scene.

8. The possibility of an international satellite monitoring agency

As mentioned earlier the President of France in his address to the first Special Session of the General Assembly on disarmament proposed the creation of an agency that would use images and data acquired from satellites for furthering arms control and disarmament measures as well as for resolution of conflicts. By a General Assembly resolution (33/71 J) a Working Group of intergovernmental experts was set up to study the technical, legal and financial implications of establishing an International Satellite Monitoring Agency (ISMA). The group of experts submitted its report in June 1981 (UN Document 1981) and this was considered by the General Assembly at its special session on disarmament in 1982. This report addresses all the issues at great depth.

In view of the controversies on the "right to sense", "the right to disseminate" and the ambiguity with regard to what constitutes remote sensing, is there a possibility that an ISMA can come about? Would the two big powers permit an intrusion into their world monopoly on surveillance?

One can generally foresee the following trends:

—amongst the group of medium space powers (Europe, Japan, China and India) technical capability exists to design, build and launch such a system;
—however such a system would be expensive (about a billion dollars) to create;
—on the institutional side its role in monitoring existing international arms control/disarmament agreements is at best marginal (UN Document 1981). It could help in crisis monitoring situations in third world countries. However, is the price tab of a billion dollars worth the monitoring of a crisis? Would any developing country accept an independent superpoliceman created at exorbitant cost to resolve a small conflict in a small country;
—the superpowers are unlikely to support this initially. They would also ensure that they do not contribute technically or financially to such a system.

Given this background what are the likely actions that could ensure an effective ISMA. These appear to be the following:

—developing countries should see in ISMA a positive contribution to global disarmament. The major problem in the world and the greatest danger to it is the arms race between the super powers. The expenditure of a billion dollars can only be justified if it can contribute to global and general disarmament. The monitoring of the super powers by a third force would be a useful tool to realise these;
—any international system will compromise Sovereign interests; this would be acceptable only when the developing countries perceive ISMA to have a "noble" objective such as global disarmament an essential component of which is the monitoring of the two big space powers;
—the monitoring of crises in the other countries of the world can be an useful appendage; it cannot be the primary purpose of ISMA. Neither can its primary purpose be verification of existing international treaties on disarmament/arms control;
—countries which have the capability should get together and commit resources for its creation, at a suitable stage they can offer it to the UN;
—it should be clear that ISMA should be under the UN umbrella; only such a system would be acceptable to most developing countries;

—the system should be able to respect the confidentiality of the information; security of data is important and in this regard the existing UN system may be inadequate; if this cannot be changed the system may never come about;
—a commercial approach of cost recovery should be avoided; this is to avoid discrimination between countries which can pay and countries cannot pay; thus the system would have to be a subsidised one;
—the group of countries who create the system should be acceptable to the world community; they should have an appropriate mix of Western, Socialist and developing countries as well as suitable regional representatives.

If these conditions can be ensured it is possible that an ISMA can come about and promote the cause of global disarmament. It is also likely that once the superpowers see that the coming of the system is inevitable, they would reconsider their present stand and join ISMA. It may appear that their interests are better served by an institution which they can influence than by an independent third body.

9. Likely developments in the future

Given this background of events what is likely to be the future trend with regard to developments in remote sensing? Is it at all likely that an international legal regime governing remote sensing activities would emerge? Could developing countries afford the high cost of data unless there is some kind of regulation or control over prices? How does one ensure the reconciliation of the surveillance and the civilian aspects of remote sensing? Is there a possibility of an early creation of an ISMA? These are a few of the obvious questions that arise and one shall try to outline possible developments.

Discussions at COPUOS have reached a stalemate and unless some new initiative comes about there is not likely to be much progress. These draft principles have already been discussed for over ten years and progress at the Legal Sub-Committee has been excruciatingly slow.

The only known international treaty on remote sensing is the "Convention on the transfer and use of data of remote sensing of the earth from outer space" signed in Moscow in 1978 (UN Document 1978). The parties to this Convention are Bulgaria, Hungary, the German Democratic Republic, Cuba, Mongolia, Poland, Romania, the Soviet Union and Czechslovakia. This convention identifies a resolution of 50 m as the limiting resolution that differentiates between sensitive and non-sensitive data. The treaty does not directly deal with the aspects of the "right to sense". The emphasis is on data dissemination while the right to collect data is implied to be legitimate. In spite of this limitation it is the first effort at reconciling the differences between the principle of "freedom to disseminate" and the principle of "sovereignty over natural resources". This convention could be used as a basis for the finalisation of the draft principles at the United Nations.

However, for success to be achieved it is important that the following be recognised by COPUOS:

—the key to the reaching of an agreement is the question of "resolution limit" that distinguishes "sensitive" and "non-sensitive" data; this would appear to be in the range of 20–50 m (assuming the USSR projection as the upper limit); in discussions on

this it is better that the entirety of remote sensing applications including surveillance be addressed openly and directly;

—a clear definition of remote sensing and explicit mention of active and passive sensing is necessary; one need not take the approach that active sensing should be banned; rather, the limits or conditions under which it should be carried out must be made explicit; if this is not clear there is a possibility that legal experts may interpret even a "laser weapon" in space as remote sensing;

—if the resolution limit can be agreed upon and active/passive sensing clarified, then the sovereignty issue can be reconciled with the issue of right to sense.

Any new initiative at the UN should consider the above issues. It is imperative that the developing world tries to establish some kind of international regime as soon as possible. With the improved resolution of civilian remote sensing, the borderline between "sensitive" applications and "non-sensitive" applications is bound to become more diffused. The commercial push for remote sensing both in the US and in Europe is also going to result in the widespread availability of such data. Thus there are real dangers that countries which can afford to pay will be better off than countries which cannot pay. The US approach so far has been to ensure that civilian satellites do not have resolutions that are sensitive. But what the US considers "sensitive" is likely to be quite different from what a third world country considers sensitive. The US monopoly is also likely to be broken by a number of countries. This would mean that the dangers of misuse can be very real. Thus a new approach and a new initiative at the UN is vital to the third world.

It is also necessary to consider the role of the UN in activities related to remote sensing. While it may be premature to think of an UN agency for this purpose the UN can play an effective role in coordinating various national/international programmes and ensure the widespread use of this technology.

The creation of ISMA appears to be unlikely purely on financial grounds. However, if a third country (or a group of countries) should create such a system there is a possibility that it would be offered to the international community for use. With the improved resolution of civilian remote sensing systems there is a possibility that for some applications, data from civilian systems can also be used. Whatever be the developments, a real challenge lies before the UN and the international community if the organisational, political, legal and national security concerns of individual countries have to be reconciled with what is good for the world as a whole. One can hope that the nations of the world will respond to this challenge.

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