Chapter 13
Remote Sensing

Introduction

Sensing from space can provide data invaluable for many purposes,[1] ranging from archaeology[2] to meteorology[3] (*infra*), to disaster management (*infra*), environmental[4] and other monitoring,[5] to the policing of agreements,[6] not to mention cartography and the delimitation of international boundaries.[7] Sensing

1 Commission on Behavioral and Social Sciences and Education (D. Liverman et al.), *Peoples and Pixels: Linking Remote Sensing and Social Science* (US National Academies Press, 1998): http://www.nap.edu/catalog.php?record_id=5963); R.R. Rowberg, 'Commercial Remote Sensing by Satellite: Status and Issues' (UN Cong. Research Services: 2002) (RL31218): http://www.licensing.noaa.gov/RL31218-RemoteSensing.pdf. See also http://rsd.gsfc.nasa.gov/rsd/RemoteSensing.html.

2 For NASA data see: http://wwwghcc.msfc.nasa.gov/archeology/. Google 'remote sensing' 'archaeology' 'satellite'. Results in March 2008 included: http://www.freerepublic.com/focus/f-news/1973759/posts (Guatemala); http://cipa.icomos.org/fileadmin/papers/olinda/99c506.pdf (Angkor); http://www.informatics.org/france/resarea.html (Burgundy). See also N. Short, 'The Remote Sensing Tutorial': http://rst.gsfc.nasa.gov/.

3 The US TIROS-I was launched in 1960 as the first Earth observation satellite. It gathered meteorological data.

4 C. Davies, S. Hoban and B. Penhoet, 'Moving Pictures: How Satellites, the Internet and International Environmental Law Can Help Promote Sustainable Development' (1999) 28 *Stetson L. Rev.* 1091–1153; Ginzky, *infra* n. 9.

5 See, for example, http://www.eyesondarfur.org/.

6 M. Onoda, 'Satellite Earth Observation and "Systematic Observation" in Multilateral Environmental Treaties' (2005) 31 *J. Sp. L.* 339–411. N. Peter, 'The Use of Remote Sensing to Support the Application of Multilateral Environmental Agreements' (2004) 20 *Space Policy* 189–95.

7 In the *Case Concerning the Frontier Dispute, Benin v Nigeria*, 2005 ICJ 90, Benin referred to SPOT data (para. 41) as did the Chamber to aerial photographs and SPOT (para. 116). In the *Case Concerning the Territorial and Maritime Dispute between Nicaragua and Honduras in the Caribbean Sea (Nicaragua v Honduras)* 2007 ICJ 1, Honduras apparently introduced a satellite photograph as part of its argument (see para. 276). The ICJ has referred to and accepted aerial photography and satellite imagery: e.g. the above cases, *Case Concerning Kasikili/Sedudu Island (Botswana v Namibia)* 1999 ICJ 1045 at para. 31, 33–6, and *Land and Maritime Boundary between Cameroon and Nigeria (Cameroon v Nigeria: Equatorial Guinea intervening)* 2002 ICJ 303 at paras 88, 90, 93 and 95. There seems no good reason to separate aerial from satellite imagery. Cf. the ICJ Chamber on the probative value of maps: *Case Concerning the Frontier Dispute (Burkina Faso v Republic*

for military purposes, whether reconnaissance, compliance with arm control agreements or 'confidence building', is hugely important, as indicated in Chapter 16.[8] The use of its product in municipal courts has increased, although this has been the subject of argument.[9] Technical progress has been massive since the early days of remote sensing, but lawyers were early interested in the regulation of the new facility.[10] However, when remote sensing from space came on the scene its legal problems were not novel.

of Mali) 1986 ICJ 554 at paras 54–6. Satellite photography has increased the reliability of maps (para. 55) but the weight to be put on maps depends on whether and how they express the will of states (paras 54–6). Photography can illustrate the changing course of a river, but the effect of that evidence will depend on other factors.

8 Here we simply cite: 1, Anonymous, 'Note: Legal Aspects of Reconnaissance in Airspace and Outer Space' (1961) 61 *Col. L. Rev.* 1074–1102; 2, C.M. Petras, '"Eyes" on Freedom – A View of the Law Governing Military Use of Satellite Reconnaissance in US Homeland Defense' (2005) 31 *J. Sp. L.* 81–115; 3. D.A. Koplow, 'Back to the Future and Up to the Sky: Legal Implications of Open Skies Inspection for Arms Control' (1991) 79 *Cal. L. Rev.* 421–96.

9 The admissibility of remote sensing data is subject to the requirements of a national court as to scientific data, including reliability, the chain of custody and data security. Different courts may apply different and different levels of requirements: cf. the US reasoning in *Daubert v Merrill Dow Pharmaceuticals Inc.* (1993) 509 US 579; 113 S. Ct. 2786; 125 L. Ed. 2d 469, 1993 US LEXIS 4408, and cases it cites in considering and departing from *Frye v United States* (1923) 54 App DC 46, 293 F 1013, 34 ALR 145 (*Daubert*, cert. denied, 516 US 869; 116 S. Ct. 189; 133 L. Ed. 2d 126). See H.A. Latin, G.W. Tennehill and R.E. White, 'Remote Sensing Evidence and Environmental Law' (1976) 64 *Cal. L. Rev.* 1300–446; L.J. Steele, 'The View from on High: Satellite Remote Sensing Data and the Fourth Amendment' (1992) 6 *High Tech. L.J.* 317–34; C Artz, 'Use of Satellite Imagery in Legal Proceedings' (1999) 24 *Air and Sp. L.* 195–203; H. Ginzky, 'Satellite Images in Legal Proceedings relating to the Environment – a US Perspective' (2000) 25 *Air and Sp. L.* 114–28; R. Abeyratne, 'The Use of Satellite Imagery as Evidence in Pre-Trial and Trial Hearings' (2003) 52 ZLW 221–36; S.H. Hodge, 'Satellite Data and Environmental Law: Technology Ripe for Litigation Application' (1997) 14 *Pace Env. L. Rev.* 691–732; R. Purdy, 'Legal and Privacy Implications of "Spy in the Sky" Satellites' (1999) 3 *Mountbatten J. Leg. Stud.* 63–79; R. Purdy and R. Mcrory, 'The Use of Satellite Images as Evidence in Environmental Actions in Great Britain' (2001) 51 *Droit Et Ville*, 70–8, and their 'Satellite Photographs – 21st Century Evidence?' (2003) 153 *New L.J.* (UK) 337–8.

10 N. Mateesco-Matte and H. De Saussure, *Legal Implications of Remote Sensing from Outer Space* (Leiden: Sijthoff, 1976).

The Technology

Remote sensing is the gathering of data from a distance by a variety of means.[11] Although the development of space systems has greatly increased remote sensing activity, its roots and legal regulation go far back. Relevant rules are to be found in a variety of municipal legal systems as well as in both terrestrial and international space law. In abstract theory simple ocular observation is a form of remote sensing,[12] but it is commonly accepted that the remote sensing we are to discuss involves the use of a mechanical recording medium. The invention of photography in the mid-nineteenth century was significant. Camera technology has since been consistently improved, most recently with the introduction of digital electronic photography. Flight, whether by free balloon, by dirigible balloon or by airplane afforded a platform from which camera observations could be made. Remote sensing from space at first depended on the use of orthodox film, canisters of film of Earth objects being ejected from satellites and recovered for processing. Now digital technology permits the transmission of data from satellites to ground stations for later analysis and interpretation. In all cases the acquisition of varieties of electromagnetic data is the material of the observation. Electromagnetic data may be emitted by an object as infra-red, 'normal' to human vision parameters or ultra-violet radiation, or diffracted or refracted by an object illuminated either by natural light or by artificial radiation (radar) being directed onto it and reflected.

Traditional 'film' systems involve the capture of data by the alteration of chemical layers on the film. Digital systems capture the wavelengths of radiation reaching the individual pixels of a sensor array,[13] with the advantage that that data can be transmitted by radio to a ground station, and then that data can be processed by appropriate computer programmes. Sensors used in space are either panchromatic (PAN) or multispectral (MS). Panchromatic sensors produce data in black and white, while multispectral sensors produce data in a variety of wavelengths that can be manipulated more easily to provide 'coloured' images.

The 'resolution' that a particular remote sensing system provides is extremely important. There are four aspects to 'resolution'. 'Spatial resolution' depends on the relation between an individual pixel and the object it represents.[14] The spatial resolution is the smallest dimensions that an object can have and still be distinguishable from another object beside it. Thus 'one metre resolution' means

11 P.J. Gibson, *Introductory Remote Sensing: Principles and Concepts* (London: Routledge, 2000).

12 Cf. Gunnery officers posted by US General Grant in the gondolas of tethered balloons to observe and calibrate the shelling of the Confederate trenches at Petersburg during the US Civil War; 'Balloons in the Civil War' http://www.centennialofflight.gov/essay/Lighter_than_air/Civil_War_balloons/LTA5.htm.

13 A 'pixel' is a single unit of data which contributes to an array of pixels, which if properly processed eventually produces an 'image' which human perception can interpret.

14 As to a 'pixel' see *supra* n. 13.

that one square metre is recorded by each pixel, and 'ten metre resolution' that ten square metres are so recorded.[15] Present commercial space remote sensing systems provide a resolution of down to two-thirds of a metre (2 feet) at a distance of two to three hundred miles. Half-metre (*c.* 19.5 inches) resolution will shortly be commercially available.[16] 'Temporal resolution' or 're-visit time' is the frequency at which data of the target may be acquired. This depends on the orbit, the sensing capacity and the periodicity of the remote satellite. 'Spectral resolution' is the narrowness of the radio frequency band that is employed for scanning. 'Radiometric resolution' measures the number of levels of grey that can be determined on a black and white image.

Sensing may be active or passive. Active sensing requires the sensing device to illuminate electromagnetically the target being sensed (usually by radar), and for the reflection of that illumination to be captured by its sensors. In passive sensing, the sensing device simply collects electromagnetic or other radiation emanating from the target whether that is reflecting radiation (e.g. sunlight) or originates in the target itself (e.g. heat, visible in the infra-red bands).

Basically there are two major manifestations of remote sensing. The first lies in the gathering of information by observation using the above techniques from aeroplanes. Indeed, remote sensing from aeroplanes remains a valuable data source. However, in the general imagination it is the second manifestation, remote sensing by satellites, that takes the attention, particularly through the availability of Google Earth to anyone with Internet access. Satellite sensing has developed from being the exclusive preserve of states to that of a mixed economy. States and intergovernmental organisations still run very active satellite systems and programmes, but there is an increasing input from commercial companies. Some of these handle data provided by the state systems. Others are now launching their own satellite systems and enter into contracts with states and other commercial entities to provide remote sensing services.[17]

15 The difference between resolutions is apparent in some of the images available through Google Earth (www.google.earth.com).

16 Two-foot resolution pixels show two square feet, and fifteen inch resolution fifteen square inches. DigitalGlobe launched its Worldview-1 satellite on 17 September 2007: see http://www.digitalglobe.com/. The first satellite of the Geo-eye series offering a spectral resolution of 16 inches (40 cm) in panchromatic and 57.5 inches (1.46m) in multispectral imaging, was launched on 6 September 2008. See http://www.geoeye.com. Others will follow.

17 J.I. Gabrynowicz, 'The Perils of Landsat from Grassroots to Globalisation: A Comprehensive Review of US Remote Sensing Law with a Few Thoughts for the Future' (2005) 6 *Chi. J. Int. L.* 45–67. See also various of the notes to this chapter.

Aerial Remote Sensing

Remote sensing from the air is a matter for both international law and the rules of the relevant municipal legal system. International Law has been concerned with such questions for over one-hundred years.

As indicated in Chapter 6, balloon flights crossing international boundaries provoked discussion in the 1890s and 1900s of the rights of states in and to the air-space above their territories. This was triggered in part for reasons of state security. The Paris Conference on Aerial Navigation of 1910 spent much time discussing what rules should apply to the new activities and produced a variety of sensible suggestions. However there was no final agreement on the text of a Convention.[18] The major failure to agree was on the nature of access of foreign aircraft to the air-space of a state: should access be permitted as a 'right of innocent passage', or should it be subject to the specific permission of the over-flown state because of its absolute rights in respect its air-space.[19] That military officers had been found to be carrying cameras aboard 'foreign' dirigible balloons that just happened to over-fly military fortifications was but a strand in the 1910 argument. The development of aviation spurred by the exigencies of combat in the First World War and the potential threat that that posed swept aside vacillation. The 'complete and exclusive' right of sovereignty of a state over its air-space was easily agreed and appears as Art. 1 of the Paris Convention on the Regulation of Aerial Navigation, 1919.[20] However, it is noteworthy that in Art. 1 the High Contracting Parties *recognised* the complete and exclusive sovereignty of '*every Power*'. The language of Art. 1 therefore purported to articulate customary law as to the 'complete and exclusive sovereignty' of all states, not just as between the parties to the Convention, and, while that notion may have been an overstatement at the precise time of its promulgation, it was swiftly accepted as being indeed a principle of customary law.

As a matter of law therefore, since Paris 1919 all states have had 'complete and exclusive sovereignty' over their own air-space, and that sovereignty has over the

18 Draft International Convention on Aerial Navigation, Paris 1910. See Appendix to Reports of the Civil Aerial Transport Committee, 1918, UKSP Reports, Vol. V, 17, Cd. 9218 (www.bopcris.ac.uk/imgall/ref8301_1_1.html). See also J.C. Cooper, 'The International Air Navigation Conference, 1910', in J.C. Cooper, *Explorations in Aerospace Law*, 105–124, and his 'State Sovereignty in Space, 1910–1914', ibid. 126–36.

19 It seems that the UK negotiators were persuaded of the desirability of relative freedom of access, but considerations of military security and sensitivity to fears of invasion from the Continent overruled. See the Reports of the Civil Aerial Transport Committee, 1918, above n. 18.

20 Convention on the Regulation of Aerial Navigation, Paris, 1919, 11 LNTS 173; 1922 UKTS 2, Cmd. 1609; 1 Hudson 359; 13 Martens (3d) 61; (1923) 17 AJIL Supp. 195; http://www.aviation.go.th/airtrans/airlaw/1914.html.

years been enforced, sometimes with disastrous results for intruders.[21] However, Art. 2 of the Paris Convention also provided as between its parties for the freedom of innocent passage of civil aircraft subject to compliance with various conditions. These included controls on what we would now call remote sensing. During the First World War aerial reconnaissance had been highly important and included the photographing particularly of enemy trench emplacements and mustering areas. It was therefore not surprising that Art. 27 of the 1919 Convention permitted states to regulate or forbid not only the use, but even the carriage, of photographic apparatus over their territory. Article 3 permitted states for military or public safety reasons to establish zones through which aircraft were not to fly, and Art. 15 required overflying foreign aircraft to follow prescribed routes. By Art. 32 foreign military aircraft required specific permission for entry to or transit of a state. Remote sensing by camera from the air could therefore be considerably constrained.

Similar provision is made in the now ruling Convention on Civil Aviation, that of Chicago, 1944.[22] Its Art. 1 repeats the 1919 general recognition of the complete and exclusive sovereignty of subjacent states over the air-space above their territory. Article 3.c requires over-flight by foreign state aircraft[23] to be authorised. Article 9 allows states to create prohibited areas, and by Art. 36 a state may regulate or prohibit the use of photographic apparatus in aircraft over its territory.[24] An addition to the 1919 provisions is that by Chicago Art. 8 no pilotless aircraft may be flown over the territory of a state without special authorisation. Aerial surveillance by foreign aircraft therefore depends on the consent of the over-flown state. Consent may be for a particular flight or flights or be more open-

21 See the facts behind *Aerial Incident of July 27, 1955 (Preliminary Objections) Israel v Bulgaria*, 1959 ICJ Rep 127, and *Aerial Incident (Pakistan v India)* Application, 10 August 1999, and Judgement, 21 June 2000, 2000 ICJ Rep. 12 (case dismissed for lack of jurisdiction). See also: 'Documents concerning the Korean Air Lines Incident' (1983) 22 ILM 1109, O.J. Lissitsyn, – 1, 'The Treatment of Aerial Intruders in Recent Practice and International Law' (1953) 47 AJIL 559; – 2, 'Some Legal Aspects of the U-2 and RB-47 Incidents' (1962) 58 AJIL 135; F. Hassan, 'A Legal Analysis of the Shooting Down of Korean Airlines Flight 007 by the Soviet Union' (1984) 49 *J. Air L. and Comm.* 555–90; M. Kido, 'The Korean Airlines Incident on 1 September 1983 and Some Measures Following It' (1997) 62 *J. Air L. and Comm.* 1049–70. Cf. Chapter 6, p. 159.

22 Convention on International Civil Aviation, Chicago, 7 December 1944 (1944) 15 UNTS 295; 9 Hudson 168; 61 Stat. 1180, TIAS 1591; 3 Bevans 944; (1953) UKTS 8, Cmd. 8742; (1945) 39 AJIL Supp 111; ICAO Doc. 7300/9, 2006: http://www.icao.int/cgi/goto_m.pl?icaonet/dcs/7300.html or http://www.luftrecht-online.de/regelwerke/pdf/ICAO-E.pdf.

23 'State aircraft' are defined as aircraft used in military, customs and police services: Chicago Convention, Art. 3.b.

24 The French text speaks of photographic apparatus 'á bord' an aircraft, which is clearer for our purpose than the 'in' of the English, Spanish and Russian texts.

ended.[25] Thus the Open Skies Treaty of 1992 provides for its parties to overfly the territories of other parties to carry out military inspections.[26] Such an agreement had been first proposed to Soviet Premier Khrushchev by President Eisenhower in July 1955.[27] These things take time.

The laws of various countries have dealt with remote sensing, or on occasion ignore it. Of course the balance between privacy and the requirement for information is a matter of concern.[28] In the UK some local authorities use cameras mounted on model aircraft to identify unlicensed building and other activity. The legal basis for this is unknown.[29] However, surveillance by state agencies for environmental purposes is possible. Over-flight is permitted by the UK Civil Aviation Acts, and

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26 Treaty on Open Skies, Helsinki, 24 March 1992, in force 1 January 2002; 2002 UKTS 27, Cm. 5539; US TS 102–37: http://www.state.gov/t/ac/rls/fs/12691.htm. The twenty-six states party to the Open Skies Treaty as at 2005 were: Belarus, Belgium, Bulgaria, Canada, Czech Republic, Denmark, France, Georgia, Germany, Greece, Hungary, Iceland, Italy, Luxembourg, The Netherlands, Norway, Poland, Portugal, Romania, Russian Federation, Slovak Republic, Spain, Turkey, UK, Ukraine and US. It was thought that Kyrgyzstan might ratify in 2006. At the option of the state to be over-flown one of its national planes may have to be used for such inspection. As to what may be seen, cf. on Google Earth (www.google.earth.com) the aircraft graveyard south east of Tucson, AZ, at roughly 32.10°N by 110.53°W. Of course in some countries there may be constitutional obstacles to be overcome: J. Boulden, 'Open Skies: the 1955 Proposal and its Current Revival' (1990) 13 *Dalhousie L.J.* 611–49; D.A. Koplow, 'Arms Control Inspection: Constitutional Restrictions on Treaty Verification in the United States' (1988) 63 *N.Y.U.L. Rev.* 229–359, and his 'Back to the Future and Up to the Sky: Legal Implications of Open Skies Inspection for Arms Control' (1991) 79 *Cal. L. Rev.* 421–96.

27 D.D. Eisenhower, 'Statement on Disarmament Presented at the Geneva Conference, July 21, 1955', Public Papers of the Presidents of the United States, Eisenhower 1955, doc. 165, 713–6, at 715–6 (U Michigan Digital Library, http://quod.lib.umich.edu/p/ppotpus/). See also R. Cargill Hall, 'The Origins of US Space Policy: Eisenhower, Open Skies and Freedom of Space', in J.M. Logsdon, ed., et al., *Exploring the Unknown: Selected Documents in the History of the US Civil Space Program* (NASA SP-4407, 1995) 213–29; J. Boulden, 'Open Skies: the 1955 Proposal and its Current Revival' (1990) 13 *Dalhousie L.J.* 611–49; D.R. Terrill, Jr, *The Air Force Role in Developing International Outer Space Law* (Maxwell AFB, AL: Air UP, 1999; UP of the Pacific, 2004) (http://aupress.maxwell.af.mil/Books/Terrill/terrill.pdf) at 6–9.

28 A.M. Froomkin, 'The Death of Privacy' (2000) 52 *Stan. L. Rev.* 1461–1543; Davies, *supra* n. 4 at 1141–4; famously, S.D. Warren and L.D. Brandeis, 'The Right to Privacy' (1890) 4 *Harv. L. Rev.* 193–220, and much subsequent discussion.

29 Entry into the air-space of a UK curtilage without authority or permission is unlawful: Cf. F. Lyall, 'The Maxim "Cuius Est Solum" in Scots Law' 1978 *Jur. Rev.* 147–69. Note also 'The Fly's a Spy', 358 *The Economist*, 3 November 2007, 99–100, and Leader at 16. It was announced in August 2008 that the UK may introduce unmanned aircraft for policing, planning and other reasons.

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in *Bernstein v Skyviews* [1977] All ER 902, interdict against the over-flight of a property for the purpose of taking photographs later to be offered for sale to the owner or others was refused.[30] In the US such questions involve consideration of the Constitution. Over-flight by aircraft above safety height is permitted,[31] as is over-flight for the purpose of surveillance by official agencies.[32]

Remote Sensing from Space

Sensing from space has many advantages over aircraft-based sensing. Once a satellite is in an appropriate orbit it is easily controlled and can regularly re-visit sites of interest. Subject to the arguments indicated *infra* it requires no permission for over-flight of territory and raises no questions of sovereignty. Depending on its equipment it can image a large area or provide significant detail for a smaller target. Nowadays, in that the satellite imagery is in digital form, it readily allows processing by computer to provide a vast quantity of data.

Given the position as to aerial surveillance (remote sensing) and the unwillingness of most states to permit it unregulated, the emergence of remote sensing by satellite was guaranteed to produce argument. However, that argument came late. The basic principles of space law had been formulated before the matter was directly addressed. As discussed in Chapter 3, the Outer Space Treaty 1967[33] provides that outer space and celestial bodies are free for use by all states without discrimination of any kind, on a basis of equality (OST Art. I para. 2) and that there is freedom of scientific investigation in space (OST Art. I para. 3). These notions, which have passed into customary international law, were sufficiently early to ensure that there was no obstacle to the inception of remote sensing programmes by the states which had the ability to engage in them, and in due course these activities became subject to the requirements of the treaties on Rescue and Return, Liability and Registration insofar as these were relevant.[34] The rules of the International Telecommunication Union as to the use of radio frequencies

30 *Bernstein* was a single-judge case, which is an unsatisfactory basis for an important legal principle. Perhaps a different result might be obtained were the later (UK) Human Rights Act, 1998, to be invoked. A number of UK private companies offer aerial photographs of houses and estates.

31 *US v Causby* (1946) 328 US 256.

32 *California v Ciraolo* (1986) 476 US 207; 106 S. Ct. 1809; 90 L. Ed. 2d 210; *Dow Chemical v US*, 476 US 227; 106 S. Ct. 1819; 90 L. Ed. 2d 226. The use of such evidence is subject to the restrictions of the Fourth Amendment to the US Constitution as to unreasonable search and seizure.

33 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space Including the Moon and Other Celestial Bodies, London, Moscow and Washington, 27 January 1967 (1968) 610 UNTS 205; (1968) UKTS 10, Cmnd. 3519; 18 UST 2410, TIAS 6347; (1967) 6 ILM 386; (1967) 61 AJIL 644.

34 As to which see Chapter 4.

were also developed and are complied with.[35] However, the actual lawfulness of what might be done by remote sensing was not raised until long after its practice was established. Space law permitted the passage of a satellite over any territory without permission, no state having formally protested over-flight by a satellite. Passage is one thing. What the satellite might be engaged in could be another.

As with direct broadcasting,[36] the argument as to remote sensing falls to be seen as part of the effort of the developing countries in the 1960s and 1970s to gain control over their own affairs and their own resources. Many had come into being and then found that by reason of contracts and concessions entered into by their former colonial masters they did not have the freedom to control and dispose of their natural resources that they wished. Sometimes the matter was resolved by negotiation: on other occasions recourse was had to nationalisation/expropriation. The United Nations was seen as a major forum in which to affirm the lawfulness of such efforts.[37] Amid all this an obvious question was whether information about natural resources formed part of those resources. Through information derived from satellite remote sensing systems a speculator might gain at the expense of a crop-grower in a developing country.[38] Another element was of general concern: military security. Not all states thought that allowing others to 'see' their military installations might contribute to peace rather than affording an enemy free access to useful information.

Article I para. 1 of the 1967 OST provides that the use of outer space should (must) be for the benefit of all states, without any kind of discrimination, based on equality of all states, and must be in accordance with international law. How might that be reflected in the regulation of remote sensing?

The first point to note is that no international treaty directly governs remote sensing. In 1968, one year after the OST, UNISPACE I indicated that remote sensing was a topic which would require consideration and the matter was put in the agenda of UN COPUOS. In 1970 Argentina pointed out that there was a need for international regulation. In 1978 the USSR sponsored a treaty that would have

35 See Chapter 8.

36 See Chapter 9 – 'Direct Satellite Broadcasting'.

37 'Permanent Sovereignty over Natural Resources', UNGA Res. 1803 (XVII) 1962; (1963) 57 AJIL 710; (1963) 2 ILM 223; Charter of Economic Rights and Duties of States, UNGA Res. 3281 (XXIX) 1974; (1975) 14 ILM 251. Cf. the New International Economic Order resolutions: the 'Declaration on the Establishment of a New International Economic Order' (A/9556) UNGA Res. 3201 (S-VI), 1974, and the related 'Programme of Action' UNGA Res. 3202 (S-VI), 1974. See also Christol, *infra* n. 41 at 5–6.

38 It is possible from satellite imagery to identify disease starting in, say, a coffee crop before that is noticeable on the ground. A speculator with that knowledge might enter into a fixed price contract with a coffee producer in a commercial 'futures' market, and then profit considerably when the crop fails and market prices inevitably rise. He has the right to buy from his supplier at the fixed price, and then to sell on the product at whatever the market price might then be. In the worst case the supplier would have to buy at the higher price in order to fulfil the fixed price contract.

en much of what the developing countries wanted,[39] but it attracted only eight ies and the law generally has gone on a different track.

'Principles Relating to the Remote Sensing of the Earth from Outer Space' e drafted in COPUOS. Discussions began in 1968, but the process took time. mal proposals were made in 1974 and, after prodding by the General Assembly, Principles were finally adopted as a General Assembly Resolution in 1986.[40]

From the very beginning of the discussions in COPUOS its members disagreed.[41] one extreme some states, particularly developing countries, were of the view t their property ownership in their natural resources included information as hose resources, and that other states should not sense their resources without mission. They were also concerned about military security. The argument was nded on the basic concept of state sovereignty. Thus they argued *inter alia* that note sensing should not occur without the prior consent of the sensed state. difications of the argument were that a sensed state should have priority rights satellite-acquired data of its territory and/or that data as to one state should not transferred or made available to others without its consent. At the other extreme argument ran that under OST Arts I and II, outer space was free for all users those uses including remote sensing. Prior consent with the implicit correlative ht to forbid sensing was not consistent with that freedom. Further, priority rights sensed states or rights to embargo the dissemination of data would also restrict free use of outer space guaranteed by the OST. Another strand of debate centred technology. Sensed states wanted to acquire relevant technologies together th the establishment of their own ground stations and processing facilities. nsing states wished to preserve their industries and intellectual property in the

39 Convention on the Transfer and Use of Data of the Remote Sensing of the Earth m Outer Space, Moscow, 19 May 1978; UN Doc. A/33/162; (2005) XXX AASL Part 141–5; *Space Law: Selected Basic Documents*, 2d ed., US Senate, Committee on mmerce, Science and Transportation, 95th Cong. 2d Sess., 480–96. Cf. G. Zhukov and Y. losov (trans. B. Belitzky), *International Space Law* (New York: Praeger, 1984) 141–51; S. Piradov, *International Space Law* (Moscow: Progress, 1976) 214–21.

40 'Principles Relating to the Remote Sensing of the Earth from Outer Space', 3 cember 1986; UNGA Res. 41/65. cf. (1986) 25 ILM 1334–6 with note at 1331–3. e Cheng, 572–97; Christol 720–64, and his 'Remote Sensing and International Space w' (1988) 16 *J. Sp. L.* 21–44, rep. C.Q. Christol, *Space Law: Past, Present and Future* eventer: Kluwer, 1991) 73–95; C.M. Haywood, 'Remote Sensing: Terrestrial Laws for lestial Activities' (1990) 8 *Bost. Univ. Int. L.J.* 157–85.

41 Cheng 572–97; Christol 720–810; C.M. Dalfen, 'The International Legislative ocess: Direct Broadcasting and Remote Earth Sensing by Satellite Compared' (1972) Can. YBIL 186–211; S. Mossinghoff and L.D. Fuqua, 'United Nations Principles on mote Sensing: Report on Developments, 1970–1980' (1980) 8 *J. Sp. L.* 103–53; D.A. eenburg, 'Third Party Access to Data Obtained via Remote Sensing: International Legal eory versus Economic Reality' (1983) 15 *Case W. Int. L. Rev.* 361–95; C.Q. Christol, lexican Contributions to the Development of Principles Relating to Remote Sensing of e Earth, its Natural Resources and its Environment' (1984) 14 *Cal. W. Int. L.J.* 1–21.

technology. Tenuous consensus in COPUOS was finally reached in 1985.[42] The original objective had been a treaty on remote sensing,[43] however the COPUOS delegates scaled back and settled for a UN General Assembly Resolution declaring international policy on remote sensing.[44]

The 'Principles Relating to the Remote Sensing of the Earth from Outer Space' are fifteen in number. Principle I begins by restricting their application. For the purpose of the Principles remote sensing is the sensing of the Earth from space, making use of the properties of electromagnetic radiation emitted, refracted or diffracted by the sensed objects 'for the purpose of improving natural resources management, land use, and the protection of the environment' (Pr. I (a)). Aerial remote sensing is excluded, as are military and other applications of the technology. Natural resources management, land use and the protection of the environment cover much, but are not exhaustive of the potentialities of the techniques. Not all commentators on the Principles, or those who appeal to them as constitutive of rights and duties regarding remote sensing data, appreciate this. In short the Principles do not cover all remote sensing.

Within these constraints the 'remote sensing activities' dealt with by the Principles comprise 'the operation of remote sensing satellite systems, primary data collection and storage stations, and activities in processing, interpreting and disseminating the processed data' (Pr. I (e)) – a very wide definition.

Principle I divides remote sensing data into three categories, the duties as to which may diverge. Raw, unenhanced 'primary data' are data acquired by the remote sensing satellite and transmitted or delivered to the ground by telemetry as electromagnetic signals, photographic film, magnetic tape or any other means (Pr. I (b)). 'Processed data' results 'from the processing of the primary data, needed to make such data usable' (Pr. I (c)). 'Analyzed data' is information resulting from 'the interpretation of processed data, inputs of data and knowledge from other sources' (Pr. I (d)). All three categories of remote sensing data, including their dissemination, constitute the 'remote sensing activities' for which the Principles have relevance.

Principle II begins by in effect quoting OST Art. I, requiring remote sensing to be carried out for the benefit and in the interest of all countries irrespective

42 C.Q. Christol, 'Remote Sensing and International Space Law' (1988) 16 *J. Sp. L.* 21–44, rep. in his *Space Law: Past, Present and Future* (Deventer: Kluwer, 1991) 73–95; S.M. Jackson, 'Cultural Lag and the International Law of Remote Sensing' (1998) 23 *Brook. J. Int. Law* 853–885 [Lyall/Larsen 69–502]; G. Catalano Sgrosso, 'International Legal Framework for Remote Sensing' Workshop on Legal Remote Sensing Issues, Project 2001, University of Cologne Institute of Air and Space Law (Cologne, 1999) 5–23; R. Jakhu, 'International Law Governing the Acquisition and Dissemination of Satellite Imagery' (2003) 29 *J. Sp. L.* 65–91.

43 Cf. H. DeSaussure, 'Remote Sensing by Satellite: What Future for an International Regime' (1977) 71 AJIL 707–24.

44 As to the legal significance and weight of a General Assembly Resolution, see Chapter 2.

of their degree of economic, social or scientific or technological development. However, it also makes the specific point that the needs of the developing countries should be given particular consideration. Principle III restates OST Art. III, that remote sensing shall be conducted in accordance with the UN Charter and other international instruments. Principle IV bundles together a number of ideas, not all of which are easily integrated into mutual coherence. The legitimate rights of all states under OST Art. I are recognised including the freedom of exploration and use of outer space on a basis of equality subject to the 'benefit' concept already quoted in Pr. II. However Pr. IV goes on to provide that remote sensing activities shall be conducted on the basis of respect for the principle of full and permanent sovereignty of all States and peoples over their own wealth and natural resources, with due regard to the rights and interests, in accordance with international law, of other States and entities under their jurisdiction' – statements acceptable to both sides of the COPUOS debate, but which may cancel each other out. Then, as if to avoid that potential elision and to underline the point that was a major concern of the developing countries, Pr. IV ends: '[s]uch activities shall not be conducted in a manner detrimental to the legitimate rights and interests of the sensed State'. The true interpretation of Principle IV is therefore unclear: it speaks from both sides of its mouth.

Principles V and following move to other concerns including co-operation and technology transfer.[45] States engaged in remote sensing 'shall make available to other States opportunities for participation therein. Such participation shall be based in each case on equitable and mutually acceptable terms' (Pr. V). To maximise the availability of the benefits of remote sensing states are encouraged to establish centres for data collection, storage stations and processing and interpretation facilities. Such could be regional facilities 'wherever feasible' (Pr. VI). On 'mutually agreed terms' sensing states are to make technical assistance available to other interested states (Pr. VII).

Principles VIII and IX give a role to the UN, Pr. VIII assigning it the international role of co-ordinating and promoting remote sensing, a task now undertaken by UN OOSA. Principle IX requires states to keep the UN Secretary General informed about their remote sensing programmes. Sensing states are also 'to the greatest extent feasible and practicable' to keep other states informed about relevant sensed data, upon the request of the sensed state and particularly to any developing country that is affected by a sensing programme. However, Pr. IX does not define exactly what information a sensing state shall provide to a sensed state.

Principle X recognises the importance of remote sensing for the protection of the natural environment. Sensing states discovering data capable of averting harm to the environment are therefore required promptly to make it known to endangered states. Principle X does not distinguish between the different categories of data.

45 But on the problems of such provisions cf. D. Yarn, 'The Transfer of Technology and UNCLOS III' (1984) 14 *Ga. J. Int. and Comp. L.* 121–54.

Unenhanced as well as enhanced data should therefore be supplied to endangered states although knowing when 'endangerment' is present is obviously impossible to establish at least in advance of an occurrence. Principle XI is more specific requiring sensing states to transmit processed and analysed data concerning natural disasters, actual and potential, to states that may be affected by them. In that connection practice has shown that remote sensing is increasingly important, for example, to allow authorities to monitor potential flooding and mitigate its effects.

Principle XII is a fundamental. It reflects an expectation that remote sensing data shall be openly available. By implication it expresses the right of states to sense other states by providing for the access to information about it in the possession of a sensing state. The sought-for requirement of prior consent by the sensed state is absent. Neither is the sensed information to be provided free of cost. However, 'the sensed state shall have access to [primary and processed data] on a non-discriminatory basis and on reasonable cost terms'. Likewise, the sensed state is to have access to analysed data concerning its territory in the possession of a sensing state on the same basis and terms, the needs and interests of the developing countries being taken particularly into account. While this language appears to guarantee all states access to data acquired by the remote sensing of their territory, as we will see, in practice sensing states withhold remote sensing data on national security and other grounds. Of course the data may simply not be available because some other organisation has bought it up.[46] And what does 'reasonable cost terms' mean? This is a question to which we will return. Another question implicit in Pr. XII is whether an endangered state can be refused remote sensing data regarding its own territory simply because it cannot pay for its cost.[47] There is also the problem of mutually hostile adjacent states, one of which initiates a programme which, coincidentally, remotely senses the border or a disputed region. Has the other state a right to access the imagery?[48]

Under Principle XIII sensed states have the right at their request to be consulted by a sensing state in order to aid co-operation 'especially with regard to the needs of developing countries'. Certainly one result might be the modification of a sensing programme to include the capture of data of interest to the sensed state and to which it would have access under Pr. XII. In practice, however, little consultation goes on. Because of the magnitude, variety and scope of remote sensing the needs of most states are already coped with. *Per contra* the exclusion

46 J.I. Gabrynowicz, Discussion paper, 'Expanding Global Remote Sensing Services', UNISPACE III, Proceedings of the Workshop, July 1999, at 97. Cf. R. Harris and R. Browning, *Global Monitoring: The Challenges of Access to Data* (London: Cavendish, 2005).

47 H. DeSaussure, 'Remote Sensing Regulation by National and International Law' (1989) 15 *Rutgers Computer and Tech. L.J.* 351.

48 India/Pakistan and Kashmir, and Israel and Syria are among the examples that come to mind.

of data is difficult to arrange and is better tackled at the post-sensing stage when analysis and interpretation is taking place. As we will see, 'shutter control' and national and military security are difficult matters.

Principle XIV is redundant as a matter of law, but politically usefully repeats the legal position that sensing states have international responsibility for the compliance of their remote sensing programmes with international law. Additionally compliance with the Principles is also insisted on. That said, Pr. XIV is to be 'without prejudice to the applicability of the norms of international law of State responsibility for remote sensing activities'.

Finally, Principle XV requires states to resolve their disputes about the application of the Principles through the established procedures for peaceful settlement of disputes.

So?

First it has to be said that evaluations of the Principles diverge. Some hold that the Principles have 'no significant limiting effect on remote sensing activities'.[49] Others consider that the Principles 'have already served to guide important remote sensing nations in many of their practices' and that the Principles are legally binding on nations because they have been negotiated, adopted, referenced and practised for twenty-five years.[50] It seems to us premature to suggest that *in toto* the UN Remote Sensing Principles constitute customary international law,[51] but it is true that states which have not adopted national legislation have only the UN Principles and general international space law as their guide.[52] A number of states have indeed adopted national laws and regulations on satellite remote sensing. While such national laws and regulations are broadly consonant with the UN Principles, many have deviated significantly from the Principles particularly to protect national security and political interests. One explanation is that the UN Principles were adopted when the available pixel resolution was coarse compared with that now possible. Security is a much more sensitive consideration if a potential enemy or a terrorist has access to resolutions of 2.5 metre or even

49 Jackson, *supra* n. 42, at 872. H. Feder, 'The Sky's the Limit. Evaluating the International Law of Remote Sensing' (1991) 23 *Int. L. and Pol.* 599–669.

50 Gabrynowicz, *supra* n. 46, at 103.

51 It has been suggested that 'most of' the Principles 'reflect customary law': *International Law Association, Space Law Committee*, Berlin 2004, 'Report on the Legal Aspects of the Privatisation and Commercialisation of Space Activities: Remote Sensing and National Space Legislation' at 4, and the subsequent *Report*, Toronto 2006 at 699 where it was noted that 'a majority' considered the UN Principles as 'declarative of customary international law' but others had some doubts as to certain of the Principles; F. Lyall in 'Some Legal Aspects of Remote Sensing', in A.P. Cracknell, ed., *Remote Sensing in Meteorology, Oceanography and Hydrology* (Chichester: Ellis Horwood; New York: John Wiley, 1981) at 205 was then of the view that there was no customary law as to remote sensing, but now considers that practice is constituting custom.

52 As the ILA states (previous note) the UN Principles do clarify relevant ideas found in the OST.

less compared with the 30+ metre resolution of the 1980s.[53] Again the data that can be acquired from satellite sensing has been considerably increased in recent decades as processing has become more sophisticated and computer applications developed.

The UN Principles relating to remote sensing are important. Although, as noted, they apply to remote sensing for only a limited range of purposes – improving natural resources management, land use and the protection of the environment – the fact is that a satellite simply scans and reports what is there. It cannot be instructed not to see military installations or other sensitive areas. Obscuring such can only be done at a different later stage of the process. The Principles are therefore more properly to be appreciated as setting out general policy with which states ought to comply and, in appropriate instances, incorporate into national regulation.

Circumstances have also changed since 1986. Back then, apparently, when the non-COPUOS developing countries first had sight of the proposed Principles they demanded that the matter be reconsidered and revised because they considered their interests were not sufficiently well-protected by them. That demand was faced down. The US and others which had reluctantly acceded to the wording as drafted stated that that was as far as they were willing to go. The matter would not be re-opened, and if that which had been drafted was unacceptable to the developing countries, the draft Principles would fall and sensing states would continue to sense using their legal right under the OST. The developing countries might have forced through an alternative set of Principles using their voting majority, but the experience of the UNGA adoption by majority vote of the Direct Broadcasting Principles of 1982 had shown that course to be self-defeating.[54] Accordingly the COPUOS draft was presented to the General Assembly and duly adopted without vote on 3 December 1986 as UNGA Res. 41/65. Some states and commentators consider that the Remote Sensing Principles are still open for renegotiation, but we consider this unlikely.[55] In their present form they seem to be working.

They seem to be working, but much of that is because circumstances have changed. Going through the Principles it is striking how many of the obligations indicated for the sensing state to provide data and opportunities to a sensed state are subject to qualification. What is 'practicable' or 'feasible' and its extent is a subjective decision for the sensing state to make. Similarly 'reasonable cost terms' and 'mutual agreement' are slippery notions. In the 1980s this terminology provided loopholes and escape hatches for the sensing states. However, as said,

53 For many areas two-thirds of a metre pixel resolution is available. See Google Earth.

54 'Principles Governing the Use by States of Artificial Earth Satellites for International Direct Television Broadcasting', UNGA Res. 37/92, 10 December 1982; (1983) 22 ILM 451; (1983) 77 AJIL 733–6. See Chapter 9 – 'Direct Satellite Broadcasting'.

55 Cf. V.S. Mani, 'The Emerging Legal Regime of Remote Sensing: A General Survey', in V.S. Mani, S. Bhatt and V.B. Reddy, eds, *Recent Trends in International Space Policy* (New Delhi: Lancers Books, 1997) 235–54.

circumstances have changed. Developing countries are coming together to establish their own remote sensing programmes.[56] Yet the most effective catalyst for change has been the privatisation of remote sensing. Now sensed states can use the levers of market competition to obtain the concessions they require, or even to commission and contract for their own remote sensing surveys.[57] As part of this they may insist on technical training in data handling, on the siting of ground stations within a commissioning state, on technology transfer and on training being provided by the remote sensing corporation.[58]

The same may apply to the question of costs for the provision of remote sensing data. Competition will drive down prices. The general tendency is toward the reduction or even total elimination of charges for certain remote sensing data down to a particular level of resolution. Originally the US provided Landsat data free on application, although now there is a low charge. Google Earth images are free to users. Australia also provides much sensed data free on the Internet. The policy of Japan is to charge very little. Thailand provides free data for educational purposes and for disaster monitoring.[59] ESA policy is the same.[60] Brazil is the largest provider of free remote sensing imagery for environmental purposes.[61] In most cases, however, more specialised data is to be paid for and, of course, the providers of commercial remote sensing data charge for their services. A question

56 Thus Vietnam and Brazil are co-operating in a remote sensing programme, as are various African states.

57 Cf. Art. 56.e of the Treaty Establishing the African Economic Community, 1991 (1991) 30 ILM 1241, text at 1245–82; Art. 31.2.h of the Revised Treaty of the Economic Community of West African States, 1993 (1996) 35 ILM 660, text at 663–97.

58 Of course some of this may be subject to control or direction by the national state of a commercial contractor.

59 See NOAA Survey, *supra* n. 38, at 17–18.

60 ESA divides its users into two categories, Category 1 being (roughly) scientific and technical users, and Category 2 operational and commercial. Material available is listed at http://eopi.esa.int/esa/esa?cmd=dataAcccess. Data policy is set by the ESA Earth Observation Programme Board – see http://eopi.esa.int/esa/esa?filename=esaDataPolicy&cmd=staticfile. For ESA policy see the draft 'Principles of the Provision of ERS Data to Users', Workshop on Legal Remote Sensing Issues, Project 2001, University of Cologne Institute of Air and Space Law (Cologne, 1999) 169–87; 'The Envisat Data Policy' 19 February 1998: http://eopi.esa.int/doc/download/envisat_data.pdf; 'Extract of the Earth Explorer Data Policy': http://eopi.esa.int/doc/download/EE_data_policy.pdf; 'Terms and Conditions for the Utilisation of Data under the ESA Category-1 Scheme' V15/01/08: http://eopi.esa.int/esa/esa?type=file&ts=1138616412484&table=aotarget&cmd=image&id=122. Data policy for the GMES project (*infra* n. 101) is under discussion. M. Ferrazzani, 'ESA Rules and Practices' Workshop (*supra*) 43–52. See also the ESA EOPI FAQ at http://eopi.esa.int/esa/docs/doc/download/FAQ.pdf. As to pricing see 'ERS Prices for Category 1 Use' and 'Envisat Prices for Category 1 Use' both of September 2008 and accessible from the Data Access site cited *supra* in this note.

61 J. Monserrat, Filho, 'Fifty Years of Earth Observation from Space and Space Law' (2008) *51 Proc. IISL* (forthcoming).

may therefore arise as to price differential as between different users. All that Principle XII indicates is that access by a sensed state to primary, processed and analysed remote sensing data shall be 'on a non-discriminatory basis and on reasonable cost terms'. Whether in this phrase 'and' is conjunctive or disjunctive is not immediately apparent. However, Principle XII ends that access is to take 'particularly into account the needs and interests of the developing countries'. In practice a differentiation is made between different users: discrimination in price and in access does occur.[62] As to the matter of price 'reasonable cost terms' does not imply that price must be uniform for all purchasers: it means a 'market price', which does allow for variation. Thus, ESA prices are lower for ESA members and their nationals than for non-ESA entities.[63] The justification is that ESA members have already contributed to the cost of acquiring the remote sensing data through their participation in the relevant ESA programmes. EUMETSAT (*infra*) is even more discriminating, pricing its product dependent on such factors as membership of the organisation, ability to pay, the purpose for which the data is requested (commercial or scientific) and intended distribution of the eventual product, but is also willing to waive charges for purposes such as disaster relief.

One area of controversy is the denial of access to remote sensing data which a sensing state may impose on grounds of its national security or at the request of an ally. Different countries act differently, and, given the normalities of international relations, what they may do is in practice not susceptible to effective international objection.[64] Total denial of access can occur, but, given the commercialisation of remote sensing and the Internet, that is not as effective as it used to be.[65] Another

62 Gabrynowicz, *supra* n. 46, at 109–10.

63 See ESA policies *supra* n. 60.

64 J.I. Gabrynowicz, 'Land Remote Sensing Laws and Policies of the National Government, a Global Survey for the National Oceanic and Atmospheric Administration (NOAA) by the Univ. of Mississippi National Center for Remote Sensing, Air, and Space Law' (2007), at 11–12 indicates that as at January 2007 the US, Canada, India, France, Italy and Israel had adopted formal regulation regarding denial of data. The Survey is at 'online resources' at www.spacelaw.olemiss.edu. See also *International Law Association: Report of the Space Law Committee*, Toronto 2006, 693–729.

65 The US and EUMETSAT have agreed that when in time of emergency the US restricts access to weather data, a list of public duty users in the US and EUMETSAT member states will continue to have real-time access to data from US instruments. EUMETSAT may be asked by NOAA to deny others access to direct read-out NOAA data or other global or regional products from US instruments on the MetOp satellites (polar orbiters). Authorised users may not further distribute data to unauthorised third-parties. The agreement is the Data Denial Implementation Plan approved by the EUMETSAT Council in 2004. See EUMETSAT 'Data Policy for MetOp Data and Products', Doc. EUM/LAD/DOC/05/0350 of 10 January 2007; EUMETSAT *Annual Report, 2004* at 36, and *Annual Report, 2006* at 50; Press Release, 22 February 2006: Cf. http://www.eumetsat.int/Home/Main/Media/Press_Releases/005264?l=en. See also *Space News*, 9 January 2006; http://www.space.com/spacenews/businessmonday_060109.html. For EUMETSAT see *infra* at n.84.

rategy is the localised degrading of satellite imagery. States do not view with quanimity the availability of imagery of sites in their territories that might be ubject to attack. Thus following negotiation, Google Earth has degraded images f sensitive sites in India.[66] US systems are forbidden to provide detail on the srael/Syria border,[67] and it does seem silly for publically available imagery to rovide clear detail of sites of interest to terrorists or other unwelcome visitors.[68] 3y analogy we return to these matters when dealing with the US law.[69]

The protection of remote sensing data remains another area of debate. Within Europe the rules of copyright are used to protect the interests of the relevant actors. t is normal for data to be supplied to users with a prohibition on resale or further lissemination. Technically the data is not 'sold' until it has been transformed r (more properly) transmuted into a form from which the original data is not ecoverable – an intriguing application of the old Roman doctrine of *specificatio*, he making of a new thing (*nova species*) from (or including) the property of nother.[70] Within the US copyright is used as a protective device as are patents, rademarks and the concept of 'trade secret'.[71]

The question remains open whether the 1986 Principles should be revised, or, preferably, replaced by an international treaty. Certainly the developing countries would like to see more specific obligations made binding upon sensing states and what they perceive as defects in the Principles repaired.[72] Whether such

66 See BBC Report: http://news.bbc.co.uk/go/pr/fr/-/1/hi/technology/6331033.stm.

67 C. Hanley, 'Regulating Commercial Remote Sensing Satellites over Israel: A Black Hole in the Open Skies Doctrine' (2000) 52 *Admin. L. Rev.* 423–42; R. Prober, 'Shutter Control: Confronting Tomorrow's Technology with Yesterday's Regulations' (2003) 19 *J. L. and Pol.* 203–52.

68 See http://news.bbc.co.uk/go/pr/fr/-/1/hi/world/middle_east/6357129.stm where Iraqis are reported to have used Google Earth to map areas and escape routes in Baghdad. The Google Street View service covering US locations degraded material relating to the house of the then US Vice-President Cheney and other senior politicians. The Pentagon has similarly banned views of military bases: http://news.bbc.co.uk/1/hi/world/americas/7282635.stm. Such 'exclusions' are understandable.

69 Text *infra* at n. 107.

70 The intellectual justification of 'specification' (to use the modern term) is controverted. See W.W. Buckland, *A Textbook of Roman Law*, 3rd ed. rev. P. Stein (Cambridge: Cambridge UP, 1976) 215–21; R.W. Lee, *The Elements of Roman Law* 4th ed. (London: Sweet and Maxwell, 1956) 134–5; B. Nicholas, *An Introduction to Roman Law* (Oxford: Oxford UP, 1962) 136–8. Cf. D. Carey Miller, *Corporeal Moveables in Scots Law* (Edinburgh: W. Green, 1991) 'Specification' 64–70.

71 S. Pace, B. Sponberg and M. Macauley, *Data Policy Issues and Barriers to Using Commercial Resources for Mission to Planet Earth* (Santa Monica, CA: Rand, 1999): http://www.rand.org/pubs/documented_briefings/2007/DB247.pdf; P.A. Salin, 'Proprietary Aspects of Commercial Remote-Sensing Imagery' (1992) 13 *Nw. J. Int. L. and Bus.* 349–73.

72 See e.g. J. Monserrat, Filho, ILA Report (*supra* n. 51) at 8–10 and the comments by other members of the ILA Space Law Committee.

developments are practicable is obscure. The detail now available through remote sensing makes the attainment of a common mind difficult. Sensing states are more likely to wish to preserve their freedom of action. Domestic rules are more likely to produce development than is international action, but that also means that individual national commercial and security policies will be major determinant factors in the future of remote sensing law.[73]

Specialised Sensing: Meteorology and Disasters

As noted, OST Art. I requires space to be used for the benefit of all. The UN General Assembly underlined the point by its 1997 Res. 51/122.[74] Remote sensing clearly can provide benefit, and among others both UN OOSA and ESA have conducted training programmes and spread knowledge of the technology. In two major related areas international institutions have been established which provide general benefit: meteorology and disaster management. Storms and tempests, earthquakes and other natural occurrences can be observed and appropriate action taken with the aid of remote sensing. So may be environmental changes and the threats caused by human activity, of which the Chernobyl incident of 1986 is a worrying example.[75] The UN Principles cover such matters. Principle X deals with the protection of the natural environment and Pr. XI with the protection of mankind from natural disasters. In both instances states in possession of relevant data are to transmit relevant information to any affected state as quickly as possible.[76] Whether this amounts to a legal duty to warn of approaching disasters may be a question, and whether there might be liability for failure to inform or failure to detect such occurrences if imminent is unclear. Another question is whether such circumstances should constitute a special waiver for the provision of data 'on reasonable cost terms' (Pr. XII). Finally we throw out here the question whether humanitarian assistance may be developing as a norm of customary

73 Cf. M. Williams, 'Comments and Conclusions from the Committee Chair', ILA Report 2004 (*supra* n. 51) 14; *International Law Association: Report of the Space Law Committee*, Toronto 2006, 693–729 at 699 – amendment of the Principles or their incorporation in treaty form is held unlikely in the absence of new or unexpected factors.

74 'Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries': UNGA Res. 51/122, 4 February 1997.

75 'Disaster' tends to be understood as a sudden occurrence. The slower degradation of the environment is also a set of disasters that remote sensing can observe and monitor.

76 When writing of the law as to dams and raised reservoirs in Scotland in the early 1990s for the *Stair Memorial Encyclopedia of the Laws of Scotland*, F. Lyall read that subsequent to the 1980s failure of two dams in Northern Italy with considerable loss of life, later scrutiny of remotely sensed imagery had shown evidence that the dams were failing. A continuing defect of remote sensing is that there is so much remotely sensed data that has not been looked at.

law. The broad area of humanitarian relief is of course of major interest to the UN as a whole as well as to other international organisations.[77] Within the UN the Department of Humanitarian Affairs operates a website, Reliefweb, as 'the global hub for time-critical humanitarian information on Complex Emergencies and Natural Disasters'.[78] Certainly it is a good source of information. However, we here consider other international arrangements that make clearer use of space facilities in warning, mitigation and coping with such matters.

Meteorology

Most meteorological satellites and weather services are operated by governments. Such information is important. Indeed Sec. 602 of the US Land Remote Sensing Act of 1992 prohibits 'any efforts to lease, sell, or transfer to the private sector, or commercialise, any portion of the weather satellite systems operated by the Department of Commerce or any successor agency'.[79] Other countries have moved in the direction of a wholly or partially privatised weather satellite service. For example Germany has established the German Meteorological Services which, apart from its official functions, sells weather information commercially while remaining under the administration of the German Ministry of Transport. The Ministry supervises the weather service staff, the organisation, budget, the development of tasks, represents Germany in principal international negotiations, and takes the final decision on issues of principle. However it is for the Service to employ staff and it has its own separate budget together with limited authority to enter into private contracts.[80]

Meteorological satellites sense the Earth's atmosphere and are crucial in modern weather forecasting. Advance warning of hurricanes, snow, storms, drought, temperature fluctuations and so on can be provided, sometimes by reliance on

77 D.P. Fidler, 'Disaster Relief and Governance after the Indian Ocean Tsunami: What Role for International Law?' (2005) 6 *Melb. J. Int. L.* 458–73; T.R. Saechao, 'Natural Disasters and the Duty to Protect: From Chaos to Clarity' (2007) 32 *Brook. J. Int. L.*, 663–707; A. de Urioste, 'When Will Help Be on the Way? The Status of International Disaster Response Law' (2006) 15 *Tulane J. Int. and Comp. L.* 182–206; P. Macalister-Smith, *International Humanitarian Assistance: Disaster Relief Operations in International Law and Organisation* (Dordrecht: Nijhoff, 1986).

78 Reliefweb: http://www.reliefweb.int/. See also 'Strengthening of the Coordination of Emergency Humanitarian Assistance of the United Nations', UNGA Res. 51/194, 10 February 1997.

79 HR 6133, Public Law 102–555; 15 USC Chap. 82, Sec. 5671. The National Oceanic and Atmospheric Administration (NOAA) is the major US weather agency: http://www.noaa.gov/.

80 M. Koester, 'Legal Framework Regarding the Commercialization of the German Meteorological Service', Workshop on Legal Remote Sensing Issues, Project 2001, University of Cologne Institute of Air and Space Law (Cologne, 1999) 53–79.

the satellite data alone, and in other instances by the concurrent use of land-based sensors and data collection. Meteorological history also contributes to the analysis. And, of course, the study of climate change has been facilitated.

The World Meteorological Organization (WMO) was established in 1947 to co-ordinate, standardise and improve world meteorology and related activities.[81] As such it took over from the International Meteorological Organisation of 1879, itself a product of a previous Permanent Committee established 1873 to co-ordinate the work of existing European meteorological services.[82]

As of 2008 WMO had one-hundred and eighty-two members together with six associated territories (Art. 4). Its supreme body is the World Meteorological Congress which meets every four years and is responsible for general policy (Arts 7–10).[83] It also deals with membership. A thirty-seven member Executive Council is composed of twenty-seven elected by WMO Congress, a President and three Vice-Presidents also elected by Congress, and the presidents elected by each of the six regional associations into which WMO divides the world (Art. 13). It implements programmes agreed by the Congress and supervises the activities of the organisation (Art. 14). A Secretary General and a Secretariat carry out the day-to-day functions of the Organisation (Arts 20-22). Much of the work of WMO is done through a variety of Technical Commissions which study and make recommendations to the Congress on any subject within the purposes of the organisation (Art. 19). The WMO co-ordinates the environmental satellites services employed in WMO programmes and those of its members, providing international guidance on their use. It seeks to improve the collection of data and the use of satellites for the operation of the Global Observing System (GOS). For the purpose WMO consolidates satellite observations, develops space-based elements of the GOS, improves access to satellite weather data and to satellite services and enhances user ability to apply the products of weather satellite systems.

The European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) was established in 1983 and started functioning in 1986.[84] It has an avowedly commercial aspect. European interest in such matters had begun with the inception of the European Space Research Organisation (ESRO) Meteosat

81 Convention of the World Meteorological Organisation, Washington DC, 11 October 1947. 77 UNTS 142; 1 UST 281, TIAS 2052; 1950 UKTS 30, Cmnd. 7989; 4 Bevans 638. The Convention has been amended several times. The current clean text is at http://www.wmo.ch/pages/governance/policy/documents/wmo_convention.pdf.

82 D.D. Smith, 'The Conclusion of International Agreements by International Organisations: A Functional Analysis Applied to the Agreements of the World Meteorological Organisation' (1971) 2 *Loyola U. L.J.* 27–68 at 35–6.

83 The Fifteenth World Meteorological Congress met in Geneva in May 2007.

84 Convention for the Establishment of a European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), Geneva, 24 May 1983; 1434 UNTS 3; 1990 UKTS 32, Cm. 1067; The amended Convention of 1991 (amendments at 1991 UKSP Misc. 16) and other documents are in *EUMETSAT Basic Documents* (2 vols) at http://www.eumetsat.int/Home/Basic/Legal_Information/SP_LEGAL_BASIC_DOC.

programme in 1976.[85] This was taken over by the incipient European Space Agency (ESA).[86] Discussions as to the creation of a separate organisation to handle such matters began in 1981. The purposes of the EUMETSAT organisation are to provide Europe with a comprehensive satellite weather service and to co-operate to establish services that its members could not afford individually. Operational European meteorological satellites are established and maintained, contributing *inter alia* to climate monitoring and the detection of global climate changes (Art. 2.1). In this advantage is taken of European technologies (Art. 2.3(a)) and as far as possible the recommendations of the WMO are taken into account (Art. 2.1). The organs of EUMETSAT are its Council and a Director General who is assisted by a specialised staff (Art. 1.4). The Council is composed of not more than two representatives of each member, one of whom should be the head of each national meteorological service (Art. 4.1). Council meets at least once a year (Art. 4.3). Membership of EUMETSAT consists of the states participant in its preparatory conference and those later acceding to the Convention with the consent of the Council. The Organisation operates through mandatory and optional programmes (Arts 2.6–8 and 3), the financing of the organisation reflecting this division. As the provider of meteorological data to Europe and elsewhere EUMETSAT is an important contributor to our understanding of the world eco-system. That said, we note that, as in so many circumstances, the possession of information is important. The NOAA-EUMETSAT agreement on the Data Denial Implementation Plan is understandable, however much the need for it is to be regretted.[87]

Disasters

We now turn to international arrangements which are based on a marriage of remote sensing and telecommunications and are directed more particularly to disaster and its avoidance. International systems and organisations have been established for the special management, mitigation and avoidance of disasters both natural and man-made. These find their roots in general humanitarian principles, but, for example, more directly reflect Prs. X and XI of the UN Remote Sensing Principles as well as such as Pr. 18 of the Stockholm Declaration of 1972[88] and Prs. 18 and 19 of the Rio Declaration of 1992.[89] States ought to warn each other

85 On ESRO see Chapter 1, p. 26.

86 On ESA see Chapter 1 p. 23.

87 See *supra* at n. 65.

88 'The Declaration of the UN Conference on the Human Environment', Stockholm, 1972; http://www.unngocsd.org/documents/stockholm1972.pdf or http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=97&ArticleID=1503; (1972) 11 ILM 1416.

89 Report of the UN Conference on Environment and Development, 1992 (The Rio Declaration) UN Doc. A/CONF.151/26; http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm; http://www.unep.org/Documents.Multilingual/Default.Print.asp?DocumentID=78&ArticleID=1163 (1983) 22 ILM 455. Cf. N.B. Robertson et al., eds, *Agenda 21 and the UNCED Proceedings*, 6 vols (New York: Oceana, 1992–3); F. Lyall, 'Protection of the Space Environment and Law' (2000) 42 *Proc. IISL* 472–82.

of impending disasters both natural and man-made, as well as assisting states that have been harmed. Meteorology may, of course, provide warning of imminent disaster sufficient to allow some avoidance measures to be implemented.[90] In other instances what is required is assistance after an occurrence.[91] In all cases two essentials are information and a swift and accurate communications system.[92]

The International Charter on Space and Major Disasters is a result of UNISPACE III.[93] An inter-agency agreement, the 'Disasters Charter', became operational in 2000. The organisation functions through a Board on which all parties are represented, and a Secretariat (Art. III.3). Its members are national space agencies with responsibility for remote sensing and national or international space system operators who can usefully contribute to the purposes of the Charter.[94]

90 Many lives were saved in Bangladesh when, before the arrival of Cyclone Sidr on 15 November 2007, cyclists with megaphones were sent out to warn the population to seek safety on higher ground. Contrast the inaction of the Burmese authorities when warned of Cyclone Nargis in May 2008.

91 Article XXI of the Liability Convention (as to which see *supra* Chapter 4) makes special provision were a space object to cause damage presenting a 'large scale danger to human life' or 'seriously interfering with the living conditions of the population or the functioning of vital centres'. In such a case on its request all states party to the Convention (and in particular launching states) are to examine the possibility of rendering appropriate and rapid assistance to a state which has suffered that damage whether that state is a party to the Convention or not. Principles 5 and 7 of UNGA Res. UNGA Res. 47/68 of 14 December 1992 on 'Principles Relevant to the Use of Nuclear Power Sources in Outer Space' deal with notification of the re-entry of a satellite with a nuclear source on-board, and assistance to affected states. See Chapter 10, at *c.* n. 60.

92 When the December 2004 Indian Ocean tsunami happened the US detected what was occurring but was unable to identify who or which agency to contact in countries that were likely to be affected by the tidal wave.

93 'The Charter on Cooperation to Achieve the Coordinated Use of Space Facilities in the Event of Natural or Technological Disasters', 2000, www.disasterscharter.org/charter_e/html. A.A. Severance, 'The Duty to Render Assistance in the Satellite Age' (2006) 36 *Cal. West. Int. L.J.* 377–400.

94 As of 2008 governmental agency members are the Argentine Space Agency (CONAE), the Canadian Space Agency (CSA), the Chinese National Space Administration (CNSA), the Indian Space Research Organization (ISRO), the Japanese Aerospace Exploration Agency (JAXA), the US Geological Survey (USGS), the US National Oceanic Research Administration (NOAA), the British National Space Centre (BNSC), the Nigerian National Space Research and Development Agency (NASRDA), and the Algerian Space Agency (ASAL). As well as governmental agencies other space system operators may become signatories on the recommendation of the Board and with the unanimous consent of existing parties (Art. VI). As of early 2008 there were eight such members.

Participation in the Charter is voluntary and no funds are exchanged between the parties (Art. III.1). Each makes available information about their space systems, and in case of crisis makes the systems themselves available (Art. IV). In the case of a natural or technological disaster the aim is to provide to authorised users (our term) a unified system of space data acquisition and delivery so as to allow the anticipation and management of potential crises, and reconstruction and subsequent operations.[95] The organisation also analyses recent crises to see what contribution space facilities could have or did provide, and what improvements could be made (Art. IV.2).[96] Authorised users are parties to the Charter and 'associated bodies'. These latter are institutions or services responsible for rescue and civil protection, defence and security under the authority of a state having jurisdiction over a party, a member of ESA, or any other international organisation that is a party (Art. V). When a party and a relevant associated body identify a crisis a request for aid goes to other parties, to co-operating bodies and/or to the Secretariat (Art. III.4–5). In effect, through the Secretariat one single communication will bring the resources of the parties to bear in the matter. An authorised user therefore need only make one contact in order to receive both space- and ground-based information from the entire battery of member agencies. The duration of the co-ordinated emergency response to the crisis includes the time period immediately before and after the emergency (Art. I – Definitions). The definition of the 'crisis' period normally does not include the period of reconstruction after an emergency.[97] However, under no circumstances do the Charter arrangements prevent parties from intervening in a crisis on their own initiative (Art. III.4 fin). The Disasters Charter has no provision as to the settlement of any dispute nor as to the effect of any failure of its systems.

The duration of the Disasters Charter was five years in the first instance (i.e. from 2000), with automatic renewal for similar periods thereafter (Art. VII.2). It may be terminated at any time by consent of the parties, but until that termination occurs the withdrawal of a party is competent on one-hundred and eighty days' notice (Art. VII.1). That said, the Disaster Charter system seems to be working, as is apparent from the information on its recent activations that is available from its website.[98]

95 'The term "natural or technological disaster" means a situation of great distress involving loss of human life or large-scale damage to property, caused by a natural phenomenon, such as a cyclone, tornado, earthquake, volcanic eruption, flood or forest fire, or by a technological accident, such as pollution by hydrocarbons, toxic or radioactive substances' (Art. I – Definitions).

96 The Secretariat designs and proposes to the Board 'scenarios' for each type of crisis (Art. IV.2).

97 J. Ito, 'Indian Ocean Tsunami: Highlighting Issues Relating to the Use of Space Technology for Disaster Management', *Proceedings of the ISRO-IISL Space Law Conference 2005*, at 3/9.

98 *Supra* n. 93.

The Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations was adopted in 1998 on the initiative of Finland, the ITU and the UN Office for the Coordination of Humanitarian Affairs (OCHA). The Convention came into force in 2005.[99] Its root is Art. 46 of the ITU Constitution under which there is a duty on states to receive and communicate distress messages and take necessary actions. The purpose of the Tampere Convention is to improve and co-ordinate communications services in the mitigation and relief of disasters. While recognising the sovereignty of states as to their control over telecommunications in their several territories, and therefore their right to control any relief activities conducted in their territories, the Convention seeks in time of emergency relief to reduce the regulatory and other barriers which may apply at other times. However it is noticeable that throughout the Convention the obligations and rights which it deals with remain ultimately at the option and control of the states concerned, and any party may terminate assistance granted under the Convention at any time (Art. 6).

The Tampere Convention establishes the UN Emergency Relief Coordinator as its international co-ordinator (Art. 2). Participating states undertake to make telecommunication resources available for disaster prediction, mitigation and relief (Art. 3), a provision which expressly includes satellite telecommunications. Article 4 deals with the organisation of the provision of telecommunication assistance from the time of request (whether made directly or through the co-ordinator) to its delivery. Privileges and immunities are to be given to incoming personnel providing assistance, to the extent that national law permits (Art. 5). Article 7 provides that the cost, if any, of the telecommunication services provided in accordance with equitable principles is to take into consideration the nature of the disaster, its location and the area affected, the capacity of the state involved and the special needs of developing countries. The Convention seeks the reduction or waiver of regulatory barriers to the export or import of telecommunications equipment, its use for disaster mitigation and relief, to the movement of foreign personnel in connection with its use, and the elimination of delay in any of these objectives (Art. 9). At present, however, the Convention has a disappointing insufficiency of parties. Its success will depend upon it becoming more widely accepted, and compliance with it becoming no longer voluntary.[100]

The programme 'Global Monitoring for Environment and Security' (GMES), a 1998 initiative of ESA and the Commission of the European Communities, is

99 Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations, 18 June 1998: http://www.reliefweb.int/telecoms/tampere/icet98-e.htm.

100 Fidler, *supra* n. 77, at 471–2 and n. 74; Sachaeo *supra* n. 77, at 671 n. 51. The Convention has been signed by seventy-five states, but required thirty ratifications to come into force which it did in 2005 – seven years from its initial adoption.

still in its implementation phase (2004–2008).[101] Its website indicates that GMES 'represents a concerted effort to bring data and information providers together with users, so they can better understand each other and make environmental and security-related information available to the people who need it through enhanced or new services'. In this remote sensing provides an important source of information and nodes of international communication and procedures are crucial. GMES will collaboratively provide data on which national institutions will be able to take their decisions – the better the data, the better the decisions. The ideal is that national institutions will be able to anticipate, intervene and control in environmental and security matters, data from both aerial and satellite remote sensing being used for this purpose.[102] Structurally GMES operates through an Advisory Council and a Bureau.[103]

Finally we note UN SPIDER. The 'United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER)' was established pursuant to UNGA Res. 61/110 of 14 December 2006, implementing one of the recommendations of UNISPACE III.[104] UN-SPIDER provides an integrated space-based global information system for the prevention of natural disasters, the mitigation of natural disasters and for disaster relief. Remote sensing and telecommunications are involved in a structure of international co-operation.[105] UN-SPIDER has been activated, and has already had significant accomplishments.[106]

101 'Global Monitoring for Environment and Security' (GMES): http://www.gmes.info/. See 'The Graz Declaration' (2007) 23 *Space Policy* 57–9.

102 'Global Monitoring for Environment and Security (GMES): Establishing a GMES capacity by 2008 – (Action Plan (2004–2008))', Communication from the Commission to the European Parliament and the Council, COM (2004) 65 final. Cf. http://news.bbc.co.uk/1/hi/sci/tech/7347028.stm. GMES data policy is still under discussion.

103 See the GMES website: http://www.gmes.info/.

104 Resolution adopted by the Third United Nations Conference on the Exploration and the Peaceful Uses of Outer Space: The Space Millennium: Vienna Declaration on Space and Human Development, Vienna 30 July 1999, http://www.oosa.unvienna.org/unisp-3/res/html/viennadecl.html.

105 'United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER)', Report of the Secretary General, 11 September 2007, A/AC.105/893, and the related work plan for 2008–9, A/AC.105/894. See also http://www.unoosa.org/oosa/en/unspider/about_us.html.

106 Reports on UN-SPIDER activities are at http://www.unoosa.org/oosa/en/unspider/docs.html.

US Regulation of Remote Sensing

States which have adopted national remote sensing regimes take authority to control what is done by use of the technology.[107] This implements their duty under OST Art. VI to authorise and supervise space activities over which they have jurisdiction. Of these regimes the US has enacted the most detailed national regulation and it is instructive to consider it. The US system is a compromise between a governmental need for remote sensing for national purposes (including national security) and a wish to promote commercial remote sensing by US enterprises. In 2003 the US President announced a new US commercial remote sensing policy favouring the private sector.[108] The US Government, 'to the maximum extent possible, will rely on US commercial remote sensing space capabilities for filling imagery and geospatial needs for military, intelligence, foreign policy, homeland security, and civil users'.[109] The US Government operates remote sensing only when commercial remote sensing is not available. The US National Geospatial Intelligence Agency (NGA) buys commercially generated remote sensing data from both subsidised and unsubsidised commercial satellite imaging companies.[110] The NGA also uses reconnaissance satellites operated by the US National Reconnaissance Office (NRA). NGA policy is to use a variety of remote sensing providers (both US and non-US providers, mainly US allies) in order to assure future supply. The National Oceanic and Atmospheric Administration (NOAA), part of the US Department of Commerce, also makes extensive use of satellite imagery from a number of sources, commercial and otherwise.[111]

A greater distinction between enhanced and unenhanced data exists under US national regulation than under the UN Principles. The US regulations[112] were

107 Gabrynowicz, NOAA Survey, *supra* n. 64.

108 US Commercial Remote Sensing Policy, 25 April 2003 (http://www.fas.org/irp/offdocs/nspd/remsens.html); R.A. Williamson and J.C. Baker, 'Current US Remote Sensing Policies: Opportunities and Challenges' (2004) 20 *Space Policy* 109–16.

109 US Commercial Remote Sensing Policy, 25 April 2003 (*supra* n. 108), Sec. II, 'Background': 'Vital national security, foreign policy, economic, and civil interests depend on the United States ability to remotely sense Earth from space. Toward these ends, the United States Government develops and operates highly capable remote sensing space systems for national security purposes, to satisfy civil mission needs, and to provide important public services. United States national security systems are valuable assets because of their high quality data collection, timeliness, volume, and coverage that provide a near real-time capability for regularly monitoring events around the world.'

110 The US National Geospatial-Intelligence Agency is part of the Department of Defense- http://www1.nga.mil/Pages/Default.aspx.

111 The National Oceanic and Atmospheric Administration (NOAA): http://www.noaa.gov/.

112 15 CFR Part 360, 71 Fed. Reg. 24474, 25 April 2006.

adopted pursuant to the US Land Remote Sensing Policy Act of 1992.[113] These define unenhanced data as

> remote sensing signals or imagery products that are unprocessed or subject only to data pre-processing. Data pre-processing may include rectification of systems and sensor distortions in remote sensing data as it is received directly from the satellite; registration of such data with respect to features of the Earth; and calibration of spectral response with respect to such data. However, conclusions, manipulations or calculations derived from remote sensing data do not qualify as un-enhanced data.

In its current incarnation the US regime is the product of the history of the involvement of the US in remote sensing.[114] The US began remote sensing with the Landsat series of satellites which were government built, and at first government-operated. Data was provided free to users. Then, in a change of policy the marketing of US remote sensing data was turned over to private commercial companies under the Land Remote Sensing Commercialization Act of 1984.[115] This attempt to commercialise remote sensing, however, proved to be a handicap to rather than a promotion of US remote sensing, residual governmental concern as to US national security interests being a barrier to international trade in the data.[116] Elsewhere the French commercial remote sensing company, Spot Image, and other commercial operators, swiftly developed and prospered because they operated with greater freedom. Consequently, the US Congress enacted the 1992 Land Remote Sensing Policy Act in order to give the US remote sensing industry a similar freedom.[117]

All US private operators are now required to obtain a licence in accordance with the US regulations before engaging in remote sensing.[118] The licence is subject to a number of conditions and restrictions, one of which will require the provision of material for the US National Satellite Land Remote Sensing Data Archive.[119] The application for a licence must contain a detailed description of the

113 15 USC 5601 et seq.

114 See materials, *supra* n. 42; C.C. Joyner and D.R. Miller, 'Selling Satellites: The Commercialisation of LANDSAT' (1985) 25 *Harv. Int. L.J.* 63–102; M.A. Roberts, 'US Remote Sensing Data from Earth Observation – Law, Policy and Practice' (1997) *Air and Sp. L.* 30–49.

115 The Land Remote Sensing Commercialization Act, 1984, 98 Stat. 451; 15 USC § 4201 et seq.

116 Jackson, *supra* n. 42, at 861; Joyner, *supra* n. 114.

117 The Land Remote Sensing Policy Act, 1992, 15 USC § 5601 et seq., Jackson, *supra* n. 42, at 865.

118 15 CFR § 960.1–15, 'Licensing of Private Remote Sensing Systems'. See also Gabrynowicz, NOAA Survey (*supra* n. 64), Williamson (*supra* n. 108) and Chapter 15.

119 Under § 502 of the US Land Remote Sensing Policy Act, 1992, the US Secretary of Interior maintains a long-term archive of basic global land remote sensing data. The archive serves 'historical, scientific and technical purposes, including long-tem global environmental monitoring'. The Department of Interior consults with users of remote sensing data to obtain their advice and guidance about their future data needs. The Archive of Remote Sensing Data contains Landsat data as well as data collected by foreign remote sensing systems. After the expiration of any exclusive rights, the data enters the public domain and is accessible subject to cost recovery. Unenhanced data in the archive may be distributed by any licensee on the condition that the data not be reproduced or sold by the purchaser. Japan intends to establish a national archive of remote sensing data to facilitate user access and to improve its circulation: Gabrynowicz, NOAA Survey, *supra* n. 64 at 31.

applicant's planned remote sensing business. The government annually audits the licence to assure the operator's compliance with all government rules, regulations, conditions and restrictions. Non-compliance may result in termination of the operating licence.

Licensing is dealt with by the Department of Commerce, through the Administrator of National Oceanic and Atmospheric Administration (NOAA).[120] The Commerce Department is, however, required to consult and co-ordinate its actions with the Department of Defense and the State Department.[121] These last are very concerned to ensure that US national defence and its international relations are not endangered by the licensing of remote sensing providers, a concern that continues even after a licence is issued.[122]

A licensee is required to apply for an amended licence if a foreign purchaser acquires an interest in it in excess of 10 per cent. An amended licence is also required should a foreigner acquire assets of a US remote sensing company on default of a security interest or as a precondition for obtaining a loan.[123] In either case NOAA

120 See http://www.licensing.noaa.gov. NOAA Reference Materials as to the 'Licensing of Commercial Remote Sensing Satellite Systems' are at http://www.licensing.noaa.gov/reference.html.

121 15 USC § 5621 et seq. Also see 5 USC § 552 which gives agency heads the authority to withhold the disclosure of remote sensing data. A Memorandum of Understanding between the Departments of Commerce, Defense, State, Interior, and the US Intelligence Communities of 25 April 2006 is at 71 Fed. Reg. 24490.

122 The US Commercial Remote Sensing Policy, 25 April 2003 (*supra* n. 108) states that 'because of the potential value of its products to an adversary the operation of a US commercial remote sensing space system requires appropriate security measures to address US national security and foreign policy concerns'. See also 'Licensing of Private Land Remote-Sensing Space System: Final Rule', 15 CFR 960.1. The NOAA 'General Conditions for Private Remote Sensing Space System Licenses' in the 'Reference Materials' (*supra* n. 120) state that the licensee must use a data downlink from its satellites that will allow the US to access and use data 'during periods when national security or international obligations and/or foreign policies may be compromised'. Cf. the 2006 US National Space Policy statement Secs 5–7: (2007) XXXII AASL 475–86, http://www.ostp.gov/html/US%20National%20Space%20Policy.pdf, and Presidential Decision Directive 23 (1994).

123 Cf. Chapter 15.

will prescribe appropriate conditions to protect US national security interests.[124] Furthermore, a licensee is to inform NOAA if the licensee intends to conclude an agreement with a foreigner. In such case NOAA consults with the Departments of State and of Defense in order to provide appropriate restrictions on foreign control of remote sensing data to ensure the licensee's continuing obligation to submit data to the National Satellite Land Remote Sensing Data Archive and to comply with requirements as to reporting and the keeping of records.

A remote sensing licence is normally valid until the end of the licensed operation, until the licensee violates its terms or until US national security interests requires its termination. A licensee must inform the US Department of Commerce of its insolvency, or of the dissolution or discontinuance of its business, in which case the licence will be terminated. Notwithstanding termination of a licence, the licensee remains obliged to provide existing data to the US Land Remote Sensing Data Archive, and to make data available to a sensed state, subject to any existing data distribution conditions.[125]

The 2003 US Commercial Remote Sensing Policy statement further provides: 'The United States Government may condition the operation of US commercial remote sensing space systems to ensure that appropriate measures are implemented to protect US national security and foreign policy interests'.[126] The approach has been to issue licences allowing a system to gather data anywhere, imposing temporal and geographic limits only when necessary. National security institutions are less comfortable with this approach for commercial systems using newer technologies, like hyper-spectral and radar instruments, and have begun to apply new ones. The new approaches attempt to control individual products more than remote sensing operations. Remote sensing technology is developing rapidly and the US shutter control policy has developed along with the technology. This pertains particularly to the higher resolutions that are now available and those that will become available. The US now usually imposes a twenty-four hour delay on the distribution of high-resolution images in order to give its Executive time to decide whether to permit that distribution.[127] However in the case of disaster the

124 15 CFR § 960.7. See also Chapter 15 regarding US controls on non-US participants in remote sensing systems.

125 See n. 119, and *infra* as to access to data.

126 Sec. IV, 'Licensing and Operational Guidelines for Private Remote Sensing Space Systems', US Commercial Remote Sensing Policy, 25 April 2003 (*supra* n. 108).

127 71 Fed. Reg. at 24475 (2006). Shutter control reduces the private remote sensing operator's market for data services and the operator may be denied access to certain markets. US law allows US licensed private operators to recover for lost market opportunities: 15 USC § 5621. 'If, as a result of technical modifications imposed on a licensee ... on the basis of national security concerns, the Secretary [of Commerce] in consultation with the Secretary of Defense or with other Federal agencies, determines that additional cost will be incurred by the licensee, the Secretary may require the agency or agencies requesting such technical modifications to reimburse the licensee for such costs, but not for anticipated profits'.

US will make space-based capabilities immediately available for disaster warning, monitoring and response activities and facilitates 'open access to government environmental date on equitable terms'. Thus the US Government waived its twenty-four hour waiting period in the case of access to remote sensing data during the Indian Ocean tsunami of 2004.[128]

The US has specific law allowing shutter control. Section 1044 of the 1997 National Defense Appropriation Act[129] (the Kyl–Bingaman Act) prohibits a US Government agency from issuing of any licence permitting a private operator to collect or disseminate satellite images of Israel, unless the resolution of such images is less that the resolution of images regularly available for sale in the commercial market.[130] This restriction places statutory limits on non-discriminatory access to remote sensing and in turn on the business opportunities of US private operators. Operators and providers are disadvantaged *vis-à-vis* foreign competitors who can freely produce high-resolution images of Israel for the international market. The statute clearly establishes a precedent for discriminatory access to remote sensing data.[131] The statute also permits the US President to prohibit remote sensing of other designated areas and localities. Such provision conflicts with Principle XII of the UN Remote Sensing Resolution which provides for non-discriminatory access to all remote sensing data at reasonable cost.

While the US exercises shutter control over US private remote sensing operators for national security purposes, it does not have a similar control over foreign operators. Thus US national control over its domestic operators and providers may

128 See http://www.prh.noaa.gov/ptwc/. Cf. US Space Policy Statement, 2006, *supra* n. 122, Sec. 6, 'Civil Space Guidelines', *ad fin*: 'The United States will utilize government and commercial space-based and related capabilities wherever feasible to enhance disaster warning, monitoring, and response activities; and take a leadership role in international fora to establish a long-term plan for co-ordination of an integrated global Earth observation system and promote the adoption of policies internationally that facilitate full and open access to government environmental data on equitable terms'. The US National Geospatial-Intelligence Agency (NGA) assumed responsibility for providing remote sensing information for natural disasters such as the Hurricane Katrina disaster in New Orleans.

129 Now included as 15 USC § 5621.

130 The applicant for a licence is required to submit a plan showing that the applicant can control collection and distribution of imagery in order to satisfy the Kyl–Bingamen Act. The Act requires the Department of Commerce to make a finding regarding the level of detail or precision of images of Israel available on the commercial market. To determine commercial availability the Department of Commerce uses foreign availability for export control purposes as the model. Based on this test the Department of Commerce determines whether an item is comparable in quality to an item subject to US national security export controls and available in sufficient quantities to make US export control ineffective. The applicant for a licence can free itself of this restriction on its commercial enterprise by proving that the remote sensing data in question are commercially available from foreign remote sensing operators. See 15 CFR 768.

131 Gabrynowicz, *supra* n. 46, at 109–10.

be undercut by foreign operators and providers who can supply the world market (including the US market) with high-resolution data as well as with data from geographical areas prohibited by US laws, such as Israel. International controls or standards regulating remote sensing of sensitive areas would necessitate the negotiation of a new international agreement. Further technological and political developments would dictate the nature of such agreement and should include effective international enforcement. However, a binding international agreement as to the sensing of sensitive areas seems less likely than some provision modelled on the familiar voluntary agreements on weapons control.

Chapter 14
Space Activities and Internatio

Introduction

In the immediate post-Sputnik era space commerce w
regulated by governments. Except in science fiction there
in outer space. In the 1980s the nature of space industries
thanks to developments in the regulatory environment,
commercial strategies and consumer demand. In parallel
developed. Government deregulation and agreement
Organisation (WTO) on basic telecommunications boos
that sector of space commerce.[1] Increasing launch capab
and capacity of satellites including the number of transp
decreasing costs of manufacturing, launching and operat
the entire space industry.[2] Demand for space services gre
and more reliable. Remote sensing services became com
started to make money. The consequence was an increa
satellite infrastructure and satellite service companies.
developed. In particular privately operated satellite netwo
contract laws but may require a new private international l
for private contracts relating to securities over space asse

In the absence of relevant international law, inter
assets is governed by national domestic laws and choic
contracts.[3] The general products of the UN Commission
Law are also not irrelevant, their various model laws b

1 World Trade Organisation: Agreement on Telecommu
Protocol to General Agreement on Trade in Services), Geneva,
36 ILM 354; http://www.wto.org/english/tratop_e/serv_e/4pro
Commercial Use of Telecommunications under the Framework
and Sp. Law, 303–28.

2 J.L. Reed, 'The Commercial Space Launch Market and B
in Space Launch Services' (1997) 13 *Am. U. Int. L. Rev.* 157–2
International Trade in Launch Services: the Effect of U.S. Laws,
its Development (Leiden, 1999).

3 Examples of 'choice of law' treaties include the Conve
Recognition of Rights in Aircraft, 310 UNTS 152, and the
on International Financial Leasing, Ottawa, 1988; http://
conventions/1988leasing/main.htm.