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INTERNATIONAL MAPPING FROM SPACE

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ABSTRACT

The paper outlines first the reasons, why mapping from satellites is a necessity (lack of adequate map coverage in developing continents, lack of timely updates). Secondly it describes the changing philosophy of the ISPRS Working Group "International Mapping from Space". Thirdly it lists all current and planned satellite missions capable of providing data for mapping from space. The development of new satellite systems with increased performance by many space nations is an indication that operational use of space mapping is to be expected widely soon.

1. INTRODUCTION

ISPRS is the international and scientific organization principally concerned with data acquisition for mapping. Aerial Photogrammetry, in fact, became the only efficient tool to solve the World's mapping program in priority areas. Presently 1/3 of the land area of the World is topographically mapped at the scale 1:25 000, 2/3 at the scale 1:50 000 and 95 % at the scale 1:250 000. Thematic maps are based on topographic mapping. The advantage of the mapping system based on aerial photography is that it easily reaches planimetric and altimetric requirements of ± 5 m, if adequate geodetic control exists, and it permits to detect objects larger than 1 m on the ground.
The disadvantage of the current system lies in the fact that updating is on a world average not carried out more often than every 20 years for the scale 1:25 000, every 45 years for the scale 1:50 000 and every 30 years for the scale 1:250 000. Only few areas of the world (e.g. Europe) have a more satisfactory situation, while the developing continents (Latin America, Africa) have a lesser progress, because the current mapping system is too costly in comparison to other national priorities.

Satellite remote sensing, as a new tool, is capable of offering relief, if accuracy specifications can be met for planimetry and height, and if object detectability is sufficient for the particular mapping scale (e.g. 1-2 m Pixel for 1:10 000, 3-5 m Pixel for 1:25 000, 5-10 m Pixel for 1:50 000; for photo-graphic systems a relation of 1 lp = 2 to 3 Pixel should be assumed).

Restitution by satellite imagery is by a factor of 2 to 4 less costly, and it can lead to much faster results, especially for map updates, which are the real bottleneck.

2. THE ISPRS WORKING GROUP

The ISPRS WG IV/2 is the heir to initial activities within ISPRS during the Hamburg (1980), Rio (1984) and Kyoto (1988) Congresses under A. Colvocoresses. At that time the objective was to show to the space community, that from the point of view of the mapping community the resolution of available earth resources satellites, like Landsat, was too coarse in resolution, as to provide a tool for mapping and map updating. An exception were the experimental efforts by Germany (Metric Camera in 1983) and by the USA (Large Format Camera in 1984).

However, due to the experimental nature of these systems, the satellite uses for mapping never took off. This changed in 1986 with the launch of Spot 1, however, the programming of the satellite became a handicap for obtaining stereo imagery from two different orbits.

The aim of the WG effort before the Kyoto Congress was, therefore, to design a satellite system with parameters, suitable for mapping at medium and small scales. Such a proposal was prepared as "Mapsat" by the US Geological Survey with the endorsement of the Working Group.
At the Kyoto Congress in 1988 the Intercommission Working Group I/IV "International Mapping from Space" was created. At the Commission I Symposium of 1990 in Manaus, Brazil, a series of papers was produced and published, which made recommendations regarding the following topics:

- legal aspects regarding an open skies policy, not limiting spatial resolution
- the suggestion to the United Nations and the international multidonor community for technical and economic cooperation to developing countries to internationalize efforts

- the criticism of space agencies designing platforms - sensors and uses according to the top down principle, while a user oriented bottom-up strategy was needed.

It is noteworthy that the first international presentation of the USSR space efforts with cameras such as the MKF 6, the KATE and the KFA 1000 cameras took place during the Commission II Symposium in Leipzig in 1986. This really opened up international discussions.

At the Washington ISPRS Congress of 1992 a new situation had arisen. The US Landsat Commercialization Act had taken its full effect, and hopes for international cooperation in the provision of high resolution satellite data for a price everyone could afford had vanished. This brought about an era of international competition, but it also entered an era where supplementing satellite data products became available from many space agencies around the world.

This tendency will even increase in the next congress period. Moreover, while governments or bilateral or multilateral groups of governments have entered the provision of space data, they are now becoming supplemented by commercial satellite data providers. Mapping from space has thus become an international concern.

WG IV/2 has had the following events during the 1992-1996 Congress Period:

- Workshop and Conference, University of Hannover, Germany, September 1993
- 2 sessions at the Commission IV Symposium, Athens, Georgia, June 1994
- Workshop and Conference, Anna University, Madras, India, November 1995.

Proceedings of the 1993 Workshop and the 1994 Symposium were published. They are in preparation for the 1995 Workshop.
In these proceedings the rapid progress has been documented. The progress is not only in the provision of satellite imagery by stereo systems, by multispectral systems, by coherent radar systems, but perhaps, even more significantly, by progress made in automated digital data extraction for stereo image matching to derive digital elevation data, in classification and object retrieval of multispectral, multitemporal and multisensoral data after geocoding, and in generating elevation data from interferometric radar signals.

3. SUMMARY OF CURRENT SATELLITE SYSTEMS AVAILABLE FOR USE IN MAPPING

The currently available satellite data systems useful for mapping are summarized in tables 1 and 2.

Table 1: Currently available civilian satellite systems for mapping

Country	Program	Sensor	no. of bands	IFOV (m/l)	swath width	launch date	stereo
USA	NOAA 12 to 14 Landsat 5	AVHRR TM	5 7	1,1 km 28 m VIS, IR 120 m TIR	2400 km 185 km	1991 1984	none none
France	Spot 3	HRV	1 pan 3 XS	10 m 20 m	60 km	1993	cross track
ESA	ERS 1 to 2	SAR	C Band W	25 m	100 km	1991 1995	Interferometry
Japan	JERS-1	OPS SAR	7 L Band	18 m	75 km	1992	along track, small base
India	IRS 1A, 1B IRS 1C	LISS 1 LISS 2 LISS 3 WIFS	4 4 4	72 m 36 m 5,8 m pan 23,5 m VIS, IR 70,5 m SWIR 188 m	148 km 148 km 774 km	1988 1991 1996	none cross track
Canada	Radarsat	SAR	C Band HH	10-50 m	50-500 km	1996	Interferometry
Germany	MOMS 02/D2	Stereo MOMS	7	4,5 m pan 13,5 m VNIR	37 km 78 km	1996	along track
Russia	Resurs 1-3 MIR (Priroda) Okean Almaz	KFA 1000 MK 4 Kate 200 KWR 1000 MSU-SK	2 MS pan MS	5 m 7,5 m 20 m 2 m 15 m		1998 1994	

Table 2: Currently used military satellite systems (as far as known)

Country	Program	IFOV (resolution)	swath width	launch date
USA	KH 11, KH 12	0,15 m ?	10 km	1970's
France	Helios 1	3 m	10 km	1990's
China	Panoramic camera	~ 10 m		1985
Russia	KFA 3000 Panoramic camera	0,7 - 1,5 m		1990

4. SUMMARY OF PLANNED SATELLITE SYSTEMS USABLE FOR MAPPING

Systems currently under preparation are listed in tables 3, 4 and 5.

Table 3: Civilian satellite data systems usable for mapping in preparation by governments

Country	Program	Sensor	no. of bands	IFOV	swath width	launch date	stereo
USA	Landsat 7	Enhanced TM	1 pan 7 MS	15 m 28,5 m	185 km	1998	none
	EOS-AMI	Aster	14	15 m VNIR 30 m SWIR 90 m TIR	60 km	1998	along track
France	SPOT 4	HRV	1 pan 4 MS	10 m 20 m	60 km	1997	cross track
	SPOT 5	HRV	1 pan 4 MS	5 m 10, 20 m SWIR	60 km	1999	cross ? track
ESA	Envisat					1998	
Japan	ADEOS	AVNIR	4	8 m pan 16 m VNIR	80 km	1996	cross track
	ALOS		4	2,5 m pan 10 m MS, L Band Radar			
India	IRS 1D	LISS 3	4	5,8 m pan 23,5 m VNIR 70,5 m SWIR	148 km	1997	
	IRS P6	WIFS CARTOSAT 1,2		188 m 2,5 m/1 m pan	774 km 10 km	1999	along track
Canada	Radarsat 2	C Band radar HH		10-50 m	50-500 km		
Germany	MOMS 02 P	Stereo-MOMS	7	5 m pan 15 m VNIR	45 km 90 km	1996	along track
Russia	Almaz 1B-OES Meteor 3 M			2,5 - 4 m		1997 1997	
Brazil	Inpe	CBERS				1998	

Table 4: Military satellite data systems in preparation

Country	Program	Sensor	IFOV	swath width	launch date
France	Helios 3		1 m	10 km	
	Osiris	X-Sar			
USA	8 X		0,15 m ?	150 km	2002
Israel	Offeq 3		2-3 m		
China	FY-1C				

Table 5: Commercial satellite data systems in preparation

Country	Company	Sensor	no. of bands	IFOV	swath width	launch date	stereo
USA (Japan, Italy)	Earth Watch (Ball)	Early Bird Quick Bird	1 pan 3 MS	3 m 15 m	6 km 30 km	1996	along track
USA (Saudi Arabia)	Orbital Sciences	Orb View 1	2 pan	1 m, 2 m	8 km	1997	along track
USA (Japan)	Space Imaging (Lockheed Martin)		1 pan 4 MS	1 m 4 m	11 km 11 km	1997	along track and cross track
USA	Resource 21(Boeing)	6 satellites	MS	10 m			

5. CONCLUSIONS

Satellite data acquisition systems for mapping are now in the state of rapid development. This will not only make images available to the mapping community, but it will also add a boost to value added technology development. New techniques of stereo-satellite-image matching for DTM generation will compete with radar interferometry, and geo-coding of satellite images will compete with digital orthophoto mapping via digitized aerial photos in the integration of image data into geographic information systems.

This is an exciting time for photogrammetry. ISPRS is called for in comparative testing of the widely differing technologies now becoming available for use.

The sequence of papers in the 3 sessions of the WG IV/2 at the 18th ISPRS Congress will document these developments.

REFERENCES REGARDING WG IV/2

[1] Publication series of the Institute for Photogrammetry and Engineering Surveys, University of Hannover, Volume 15: "Proceedings of the ISPRS-WG IV/2 Workshop: International Mapping from Space", Hannover, Germany, September 1993.

[2] Publication by Anna University Madras, India: "Proceedings of the ISPRS WG IV/2 Workshop: "International Mapping from Space", Madras, India, November 1995.