REMOTE SENSING TECHNOLOGIES AND INSTRUMENTS USED IN RISK MANAGEMENT OF NATURAL HAZARDS. CLASSIFICATION AND ANALYSIS.

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Many remote technologies, units (satellites, aircrafts, etc.) and monitoring devices of different types are in everyday use for the observations, registrations and warning systems about the different natural hazards. Classification based on the philosophy "before", "during" and "after" the disaster occurrence have been created. Most popular remote techniques and units are included giving the end users a possibility to use them for the comparative analysis between the different technologies and remote methods used. The generalization about the different types of the natural hazards is performed based on the principles of the generation mechanisms, physical properties and negative consequences they could create.

It's clear that for some natural hazards the remote techniques are high effective, for others not so, for the rest – not at all. Our purpose was to create the comparative tables easy for use, especially about the not wade range of the professionals with different orientation.

Keywords: remote sensing technologies, natural hazards, classifications

1. INTRODUCTION

Despite enormous progress in the science and technology, most of the natural hazards and disasters are still unpredictable events and continuously brings people's life loses and cause huge damages all around the world.

During the last years, the space technologies (especially earth observing satellites) get wider application in research of natural hazards/disasters. For example – the prediction of the most of the meteorological hazards is unthinkable without the use of the meteorological satellites.

The potential of the remote sensing for the monitoring of the Earth environment, risk application and their key role in risk management process are well known and largely used. Most of the remote sensing data are used in general by few people – mostly specialists of the observation and monitoring systems. Our objective is to made classification of the remote sensing technologies and units used about natural hazards, according their usefulness and applicability in the different phases of the risk and disaster management (process) and to crate comparative tables easy for use, especially about the wide range of the non-professionals and non- specialists with different practical applications. Most of the space units have combined applications – to follow up not only the natural, but as well as the man-made accidents, pollution, other catastrophes. In this study we limited our task and focused only on the natural hazards.

2. Classification and Analysis of the Remote Sensing Technologies about Natural Hazards and risk Management

For our purposes two tables and two charts have been created.

The first table is not presented. It is includes relatively small part of the earth observing satellites in orbit, which are of great help for disaster mitigation studies. Attention is paid to the communications satellites and Search and Rescue System (COSPAS/SARSAT).

For each type satellite in table are shown some orbital parameters, instruments carried on board, frequency band, spatial resolution and instrument swath. Most of those sensors have applications in disaster mitigation practice, though depending of the physical properties of the objects on Earth and the nature of the disaster itself.

Table 2 is created on the basis of table 1.

In table 2 the different instruments and their usefulness and applicability in risk management process of natural hazards/disaster are described.

The table shows that different instruments, depending on their type, band and resolution are applicable for different hazards at the different stage of the hazards observations and the risk management process.

Thee levels of applicability (low, medium and high) and 14 hazards had been selected including global phenomenon as climate change, El Nino and La Nina.

The classifications is based on the philosophy "before", "during" and "after" the disaster occurrence. "Before" means – preparatory stages, early warnings, vulnerability and risk assessment; "During" means – disaster monitoring in real or near-real time when it is possible; "After" means – damage assessment, modeling the negative effects of the past of future events.

However, there is not yet a specific or complex platform or sensor that is dedicated to retrieve information on a particular type of disaster(s). The result of this situation is the need of retrieving information simultaneously from several systems, which implies problems and hardens the process of production of the needed information.

Some space techniques, such as those of weather forecast, have become operational and are used in the everyday practice. These weather forecast techniques permit early warnings and monitoring for some of the weather hazards, such as tropical cyclones, hurricanes, typhoons. On the contrary, the management practice of the other disasters only by satellite technology is on a research phase. The general reasons are that in case on rapid onset disaster and in disaster situation (and emergency management) the data should be easily and timely acquired.

That is why the aerial aerospace laboratories, rescue helicopters and other similar devices information and ground data are still of crucial important. For that reason in figure 1 the applicability of the aerospace data is presented. Figure 2 shows suitability of the ground data and information.

Tabl. 2. Typology and applicability of the different satellites to the stages of the natural hazards

Satellite	Instrument	Before	During	After
Ikonos (USA)	camera system	(1),2,3,7,(8),9,10,11	(1),((8)), 9, (12)	1,2,3,7,8,9,10,11
Quick Bird	BGIS 2000/	(1),2,3,7,(8),9,10,11	(1), ((8)), 9, (12)	1,2,3,7,8,9,10,11
Spot 5 (France)	HRG HRS Vegetation	1,2,3,7,8,9,10,11 1,2,7 (7)	1,(8),9,12,14 9	1,2,3,7,8,9,10, 11 8,9
Landsat 7	ETM+	1,2,(4),3,7,8,9,10,11	1,8,9, (12),14	1,(2),3,7,8,9,1011
DMC	ESIS, MSIS	1,2,3,7,8,9,10,11	1,8,9,(12),14	1,(2),3,7,8,9,10, 11
ERS-2 (ESA)	AMI (SAR Scatterom.) RA ATSR2 (IRR MWR) GOME	(1),(2),3,(4),7,(8),(9),10,11 4,6,(9),10, (11), 12 ((1)),((2)),((3)),4,6,(9),10, 12 1,6,(8),(9),(10) ((4)),(10),(11) 	(1),7,(9),10,11,(12),13,(14) 6,10,12 6,(9),10,12,13 1,6,8,(9) (10), (13) 1,5	(1),2,3, 9,10,11 ((3)) (1),(8) 1
Envisat (ESA)	AATSR ASAR MERIS RA-2 MWR GOMOS MIPAS Sciamachy	1,6,((4)),(8),(9),(10) (1),(2),3,(4),7,(8),(9),10,11 ((4)),((7)),8,9,((11)),((12)) ((1)),((2)),((3)),4,6, (9),10,12 ((4)),(10),(11) (4) (4)	1,6,8,(9),(14) (1),7,(9),10,11,(12),13,(14) ((8)),9,(12), (13),(14) 6,(9),10,12,13 (10), (13) 1,5 (1), (5) (1), (5)	(1),(8) (1),2,3, 9,10,11 8,9,((11)) ((3)) 1 (1) (1)
Radarsat	SAR	(1),(2),3,(4),7,(8),(9),10,11	(1),7,(9),10,11,(12),13,(14)	(1),2,3, 9,10,11
AURA (EOS) A-Train	(As whole) HIRDL MLS OMI TES	4	1,5 1 1,5	1 1 1
AQUA (EOA; NASA) (A-Train)	(As whole) AIRS AMSU-A HSB AMSR-E MODIS CERES	4,(9),10,11 4 6,(4),((7)),((8)),(9),10,11,12 (1), ((2)), ((4)),((6)),(7),(8), (10),(11) (4)	(9),10,11 6,((7)),(9),10,11,12,13 1, ((6)),8,9,(12),14	1 1, 8,9,(10),(11)
Calipso (A-Train)	CALIOP	4	1,8	1,8
Parasol (A-Train)	Polder-P Lidar	4	1,8	1,8
CloudSat (A-Train)	CPR	4,10,11	1,8,10,11,12	1,8
IceSat	GLAS	4	(1),(8),13	(1),(8)
Jason-1	RA	((1)),((2)),((3)),4,6, (9),10,12	6,(9),10,12	((3))
TOPEX/ Poseidon	ALT	((1)),((2)),((3)),4,6,(9),10,12	6,(9),10,12	((3))
GRACE	K-band	Geodesy, Oceanography,((2))		

GPS		1,2	7	1,2
Lageos	Laser refl.	((1)), (2)		((1)), (2)
TERRA	ASTER	1, 2, (3), (4),((6)),7,8,9,10,11	1, ((6)),8,9,((11)),12,14	1,(2),(3),8,9,1011
	CERES	(4)		
(USA,	MISR	(4)	((8)),9,14,(12),14	1,8,
Canada,	MODIS	(1),((2)),(4),((6)),(7),(8),	1, ((6)),8,9,(12),14	1, 8,9,(10),(11)
Japan)		(10),(11)		
	MOPIT	((4))		
ADEOS	AMSR	6,(4),((7)),((8)),(9),10,11,12	6,((7)),(9),10,11,12,13	
MIDORI	GLI	(1),((2)),(4),((6)),(7),(8),	1, ((6)),8,9,(12),14	1, 8,9,(10),(11)
(Nasda)		(10),(11)		
	Scatterom.	4,6,(9),10, (11), 12	6,10,12	(1)
	ILAS-II	((4))	(1),(5)	
	POLDER			
NOAA/	(As whole)	4,6,(7),8,9,10,11,12	6,(7),8,9,10,11,12	
POES	AVHRR/3	1,((7)),(8),(9), 10	1,8,(9),10,(14)	(1),(8)
series	HIRS/3			
(USA)	AMSU-A			
	AMSU-B			
	MHS			
	SBUV/2		1,(5)	1
	SARSAT	Search and rescue system		
	SEM/2	Space weather		
MetOp	(As whole)	4,6,(7),8,9,10,11,12	6,(7),8,9,10,11,12	
(ESA,	AVHRR/3	1,((7)),(8),(9), 10	1,8,(9),10,(14)	(1),(8)
EUMET	HIRS/4			
SAT,	AMSU-A			
NOAA	MHS			
CNES)	IASI		(1), (5)	(1)
	Scatterom.	4,6,(9),10, (11), 12	6, 10, 12	
	GOME-2		1,5	1
	GRAS			
	SARSAT	Search and rescue system		
	SEM-2	Space weather		
NOAA/	(As whole)	4,6,(7),8,9,10,11,12	6,(7),8,9,10,11,12	
GOES	Imager		((1)),((8))	
Series	Sounder			
(USA)	SEM	Space weather		
	SARSAT	Search and rescue system		
MeteoSat	(As whole)	4,6,(7),8,9,10,11,12	6,(7),8,9,10,11,12	
(second	SEVIRI		((1)),((8))	
genera-	GERB			
tion)	SARSAT	Search and rescue system		
Telecommunication:				
Eutelsat (Europe)			1,2,3,7,8,9,10, 11,12,14	1,2,3,7,8,9,10,
Voice and data (Intelsat				11,12,14
Globalstar, Iridium)				

Legend: 1 – Volcano activity; 2 – Earthquakes; 3 – Tsunamis; 4 – Climate change, research and modeling;5 – Ozone hole; 6 – El Nino, La Nina (ENSO) – SST; 7 – Landslides; 8 – Forest fires; 9 – Droughts; 10 – Storms, hurricanes (incl. high rain rates, strong winds); 11 – Floods (river), flash floods (incl. snow melt); 12 – Winter storms; 13 – Polar ice sheet; 14 – Global land coverage (incl. deforestation and desertification); (( )) – low applicability; ( ) – medium applicability; without bracket – high applicability

3. VISUALIZATION OF THE TYPOLOGIES

For the easier interpretation and better orientation of the end users, the graph plots of the data and information synthesized in the tables are presented as graphics. The first graph (Fig. 1) presents the suitability of the remote sensing data about the practical use before, during and after the natural hazards action stages. The natural hazards are grouped as in the previous tables and 3 levels of use are defined – low – 1; medium – 2; and high – 3. These levels show the possibility to obtain reliable data for the practical use, according the reliability and usefulness of the information retrieved by the respective remote sensing devices in general. Low - means limited use and effectiveness less then 20%; 2 – means effectiveness up to 50% and high means – more than 50%. These statistics are extracted from the theoretical assumptions and practical observations, by the different case studies, expert considerations, etc.

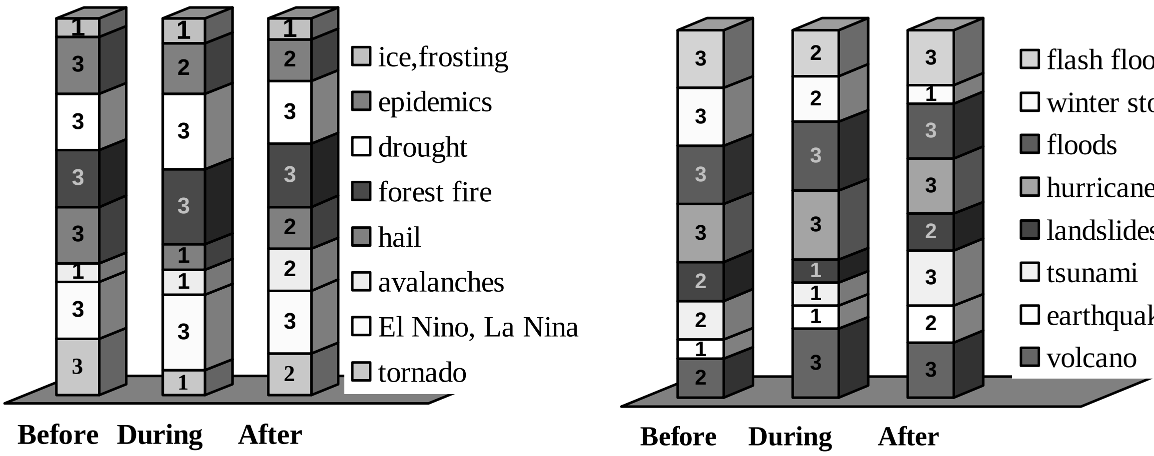

Fig. 1. Applicability (usefulness) of remote sensing (aerospace) data in the risk management process: "before" means – early warning, preparedness, risk and vulnerability assessment, (including modeling); "during" – monitoring and fast response; "after" – damage assessment, (including modeling); 1 – low; 2 – medium; 3 – high.

The use of the ground data and information is still the leading tendency in the recent practice. To compare the usefulness of the remote sensing data and the land installed devices the summary of the ground data effectiveness is made. The levels of use are defines by the same way as before; low – 1; medium – 2; high – 3.

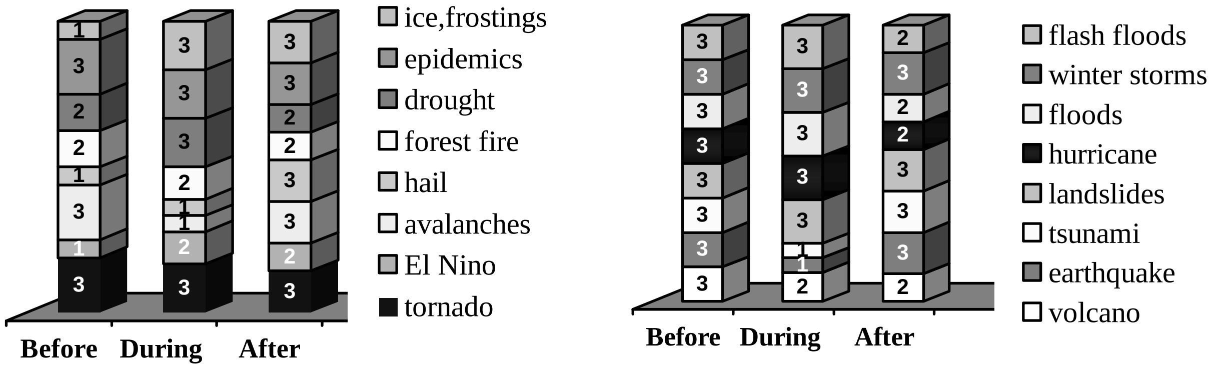

Fig. 2. Applicability (usefulness) of the ground data and on land observations in the risk management process: "before" means – early warning, preparedness, risk and vulnerability analysis, (includes modeling); "during" – monitoring and possible fast response; "after" – damage assessment, (includes modeling as well as); 1 – low; 2 – medium; 3 – high

4. Conclusions

Several classification and typologies are created about the recent satellites in use for the observations, monitoring, hazards, vulnerability and risk assessment, which could be of practical use of the decision makers and rescue teams. The tables of the different satellites, their equipment and suitability for the risk management process contain data and information about the practical abilities of all these devices.

Graphical expressions about the possible use of the different space and land technologies for the "before", "during" and post disaster stages are presented, thus making easier interpretation and visualization of the devices in use.

Such kind of classifications and typologies are targeted to the everyday practice of the risk managers, decision makers and the rescue teams and could be implemented in their everyday practice.

The analysis shows that the most critical points are connected to the fast communication of the data retrieved, the visualization and the automatic analysis, which could support the decision making process.

With a review of the satellites in orbit the present work provides an insight to the suitability of satellites and instruments to their applications due to the different natural disasters.

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