The Application of Remote Sensing to Climate Change in Lebanon

United Nations/Indonesia International Conference on Integrated Space Technology Applications to Climate Change

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Global Climate Change

* Climate is usually defined as the "average weather" in a place. It includes patterns of temperature, precipitation (rain or snow), humidity, wind and seasons. (The American heritage & Science Dictionary)

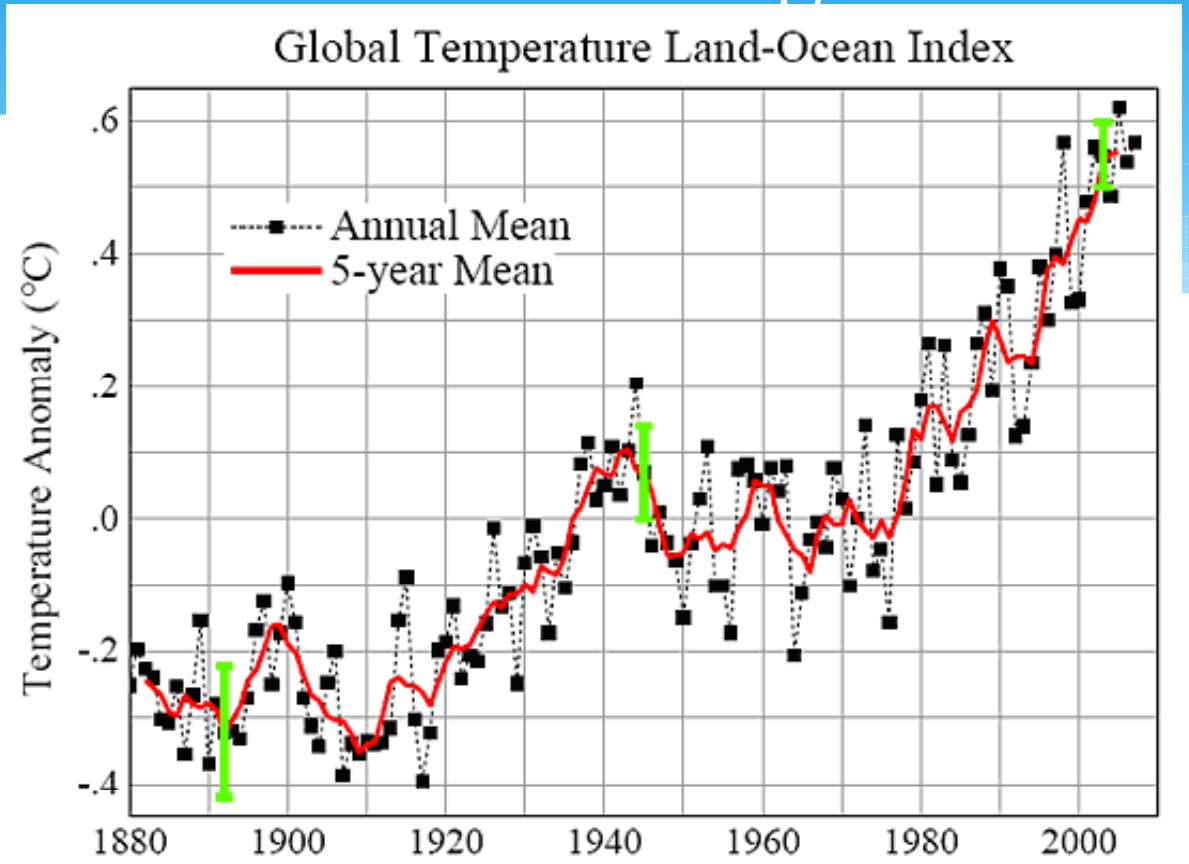
* Our climate is rapidly changing with disruptive impacts, and that change is progressing faster than any seen in the last 2,000 years.

Global Climate Change-Cont'd

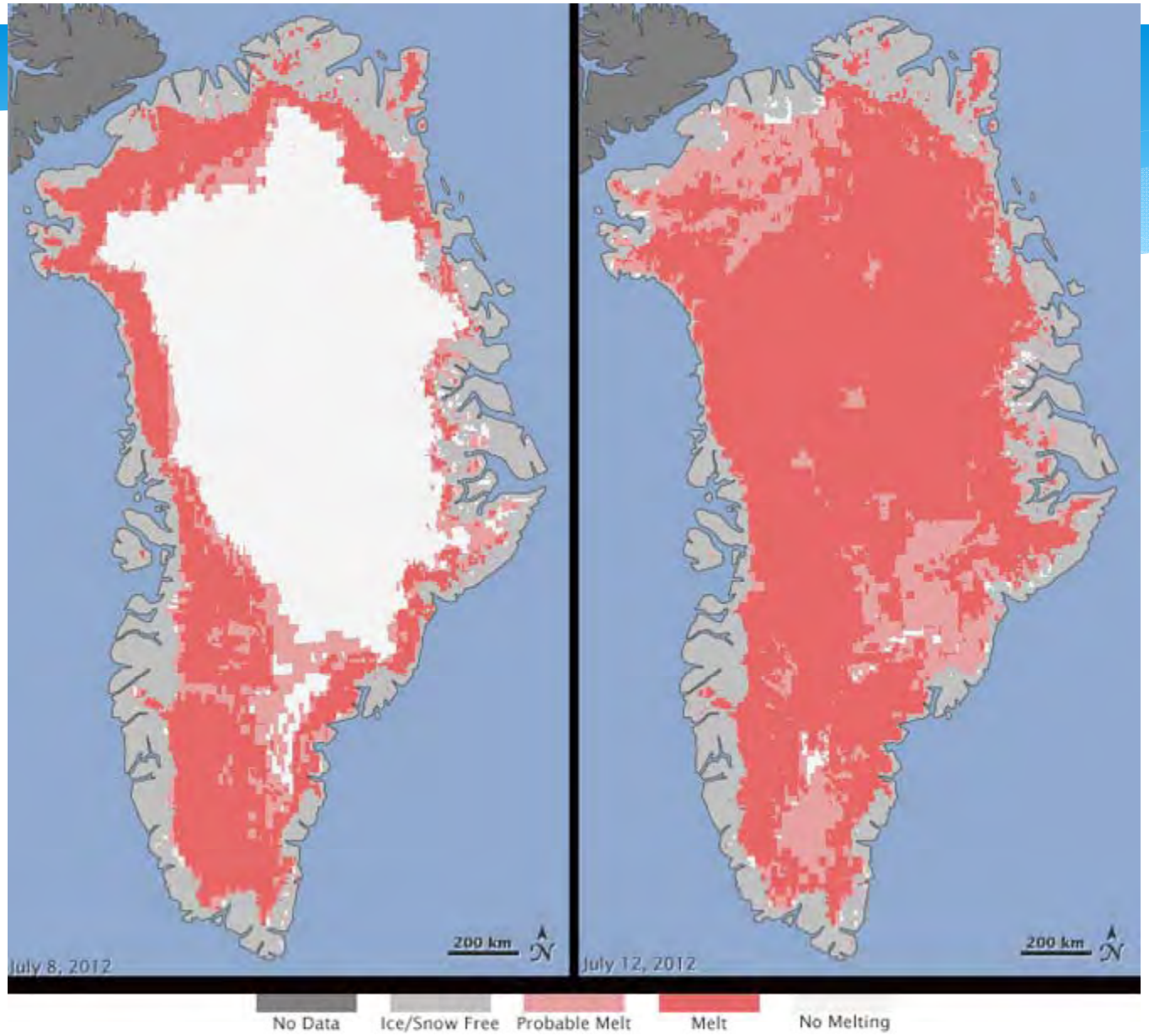
* According to the report, "Preparing for a Changing Climate[1]", rising levels of carbon dioxide and other heat-trapping gases in the atmosphere have warmed the Earth and are causing wide-ranging impacts, including rising sea levels; melting snow and ice; more extreme heat events, fires and drought; and more extreme storms, rainfall and floods.

* [1]https://fortress.wa.gov/ecy/publications/publications/1201004b.pdf

Global Climate Change-Cont'd



Source: NASA Goddard institute for Space Studies. (January 11, 2008)



Shades of pink represent melted ice in satellite pictures of Greenland taken in 8th of July (left) and 12th 2012 Nicolo E. DiGirolamo and Jesse Allen, NASA

How does Lebanon contribute to Global warming?

Fossil Fuel

* Gases emission from different sectors is the main contributors to the global warming

Sector	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Energy	11678.694	1.3794	0.1157	54.0959	473.7119	87.3411
Industry	1924.063	NO	NO	0.01112	0.0003	273.888
Solvents	NE	NE	NE	NE	NE	NE
Agriculture		7.97862	3.0147	0.00146	0.04306	
Land-use Change & Forestry	200.4132	0.253	0.00168	0.06276	2.213	
Waste	0	42.804	0	0	0	0
Total	13803.17702	52.41502	3.13208	54.17124	475.96826	361.2291

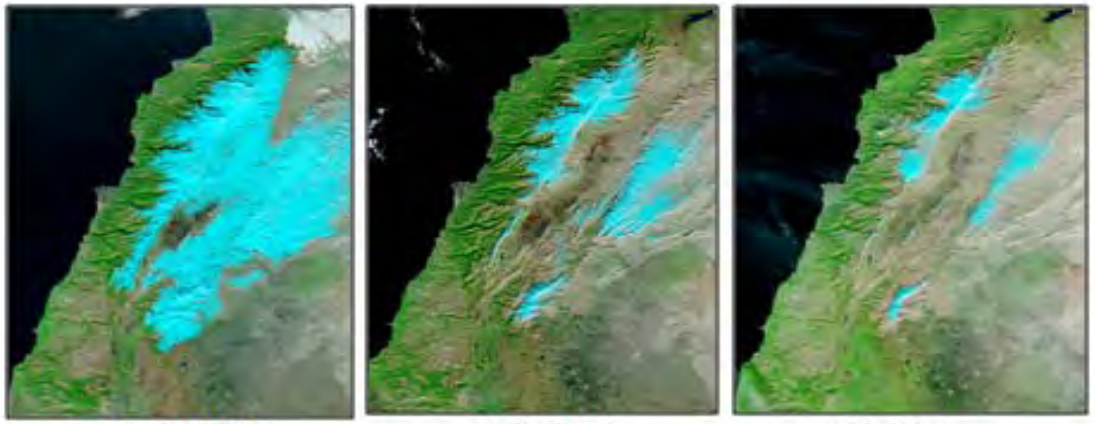
February 2011

About 93% of Beirut's population is being exposed to high levels of air pollution. The overall cost of air pollution to health could be exceeding $10 million a year.

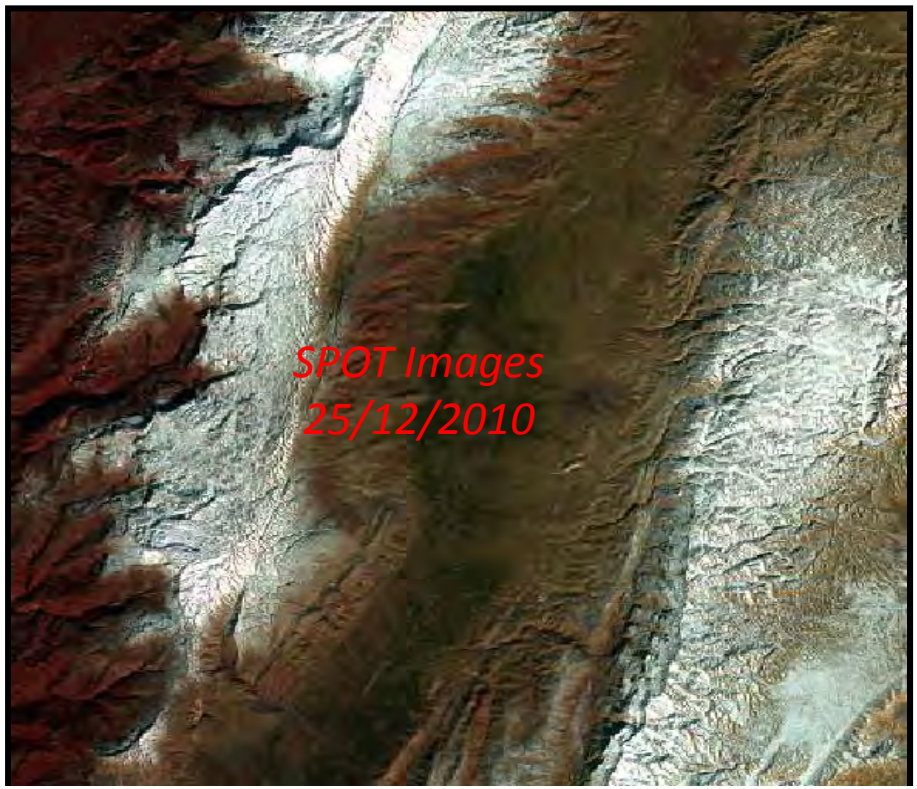
A seminar in American University of Beirut May 2011 about air pollution in Beirut.

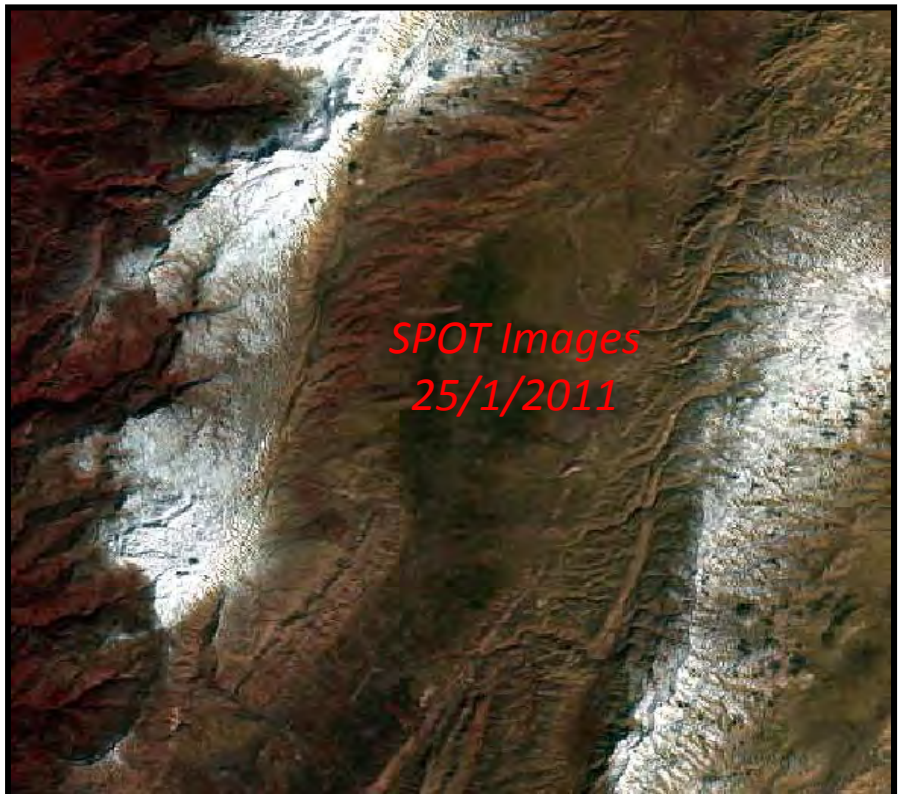
Average snow cover extent has been reduced from
2400 km2 In December to none in March 2011

MODIS Images (Bands 7-2-1)



15/12/2010 25/12/2010 25/1/2011





CNRS –CRS use of Remote Sensing in monitoring global change effects on natural resources
Snow cover

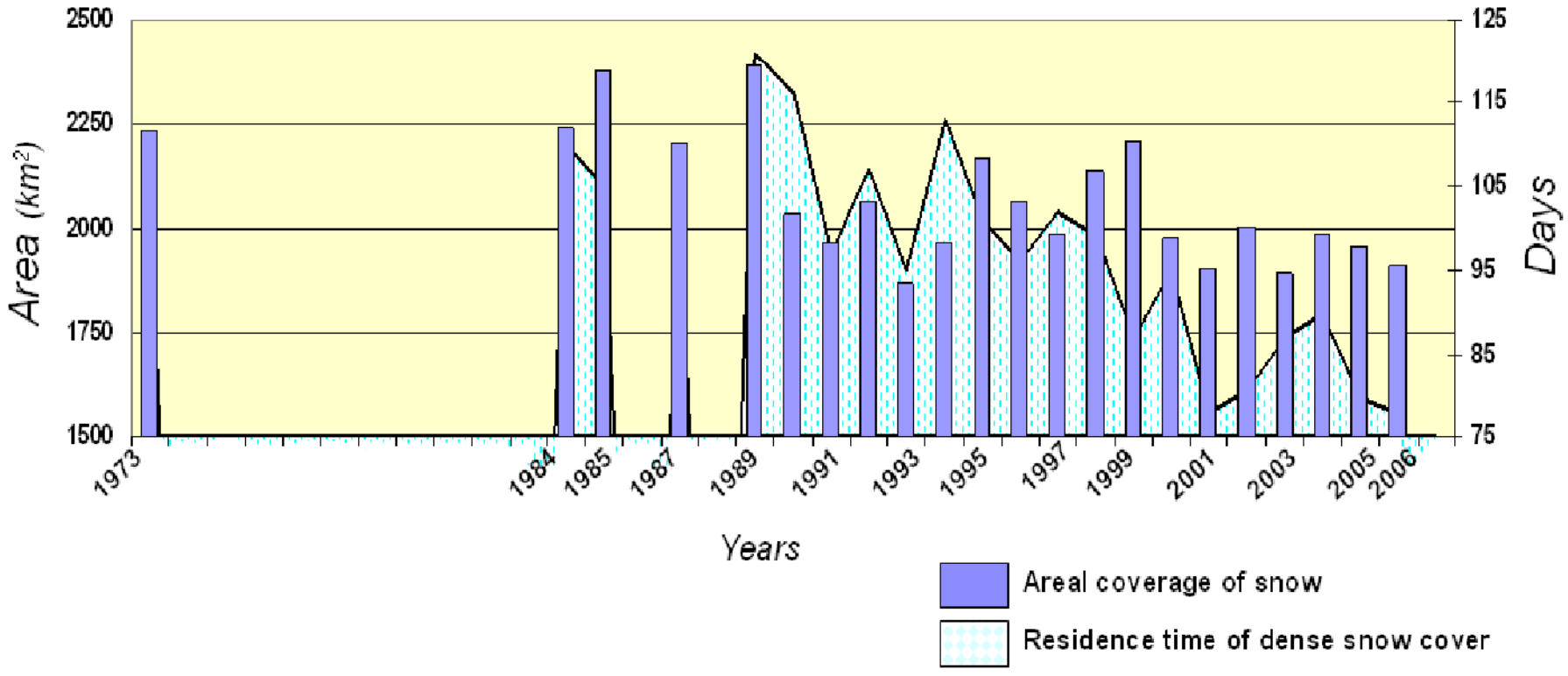
Climate change threatens Lebanon's snow and cedars

(Reuters) - Lebanon's ski resorts have survived civil war but now face an insidious threat from climate change expected to cut snow cover by 40 percent by 2040.

http://www.reuters.com/article/2010/11/14/us-climate-lebanon-idUSTRE6AD1BY20101114

No snow cover on the Lebanese mountains during March 2010 it was like August weather very hot

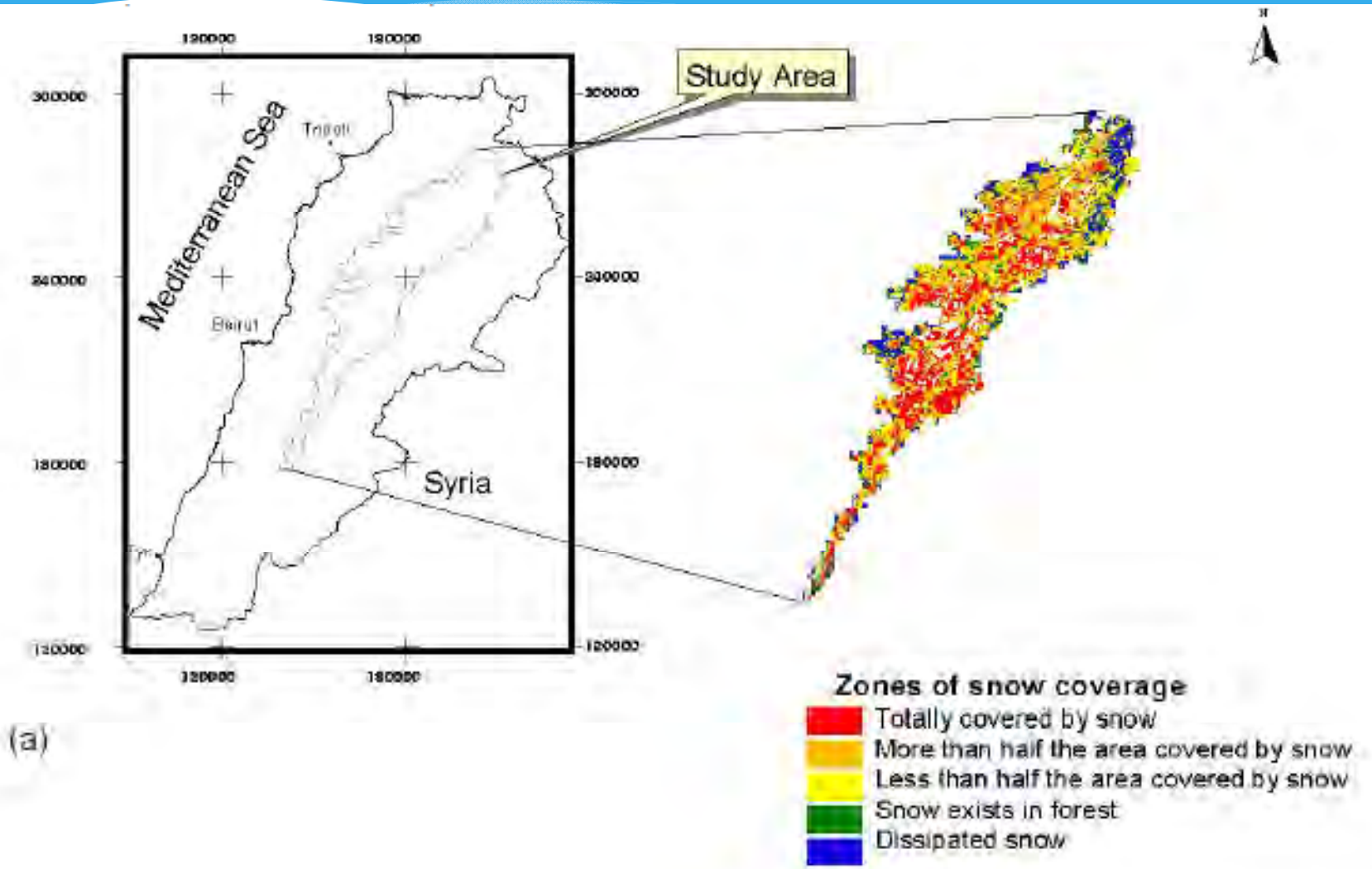
Areal Coverage & Residence time of snow cover in Lebanon



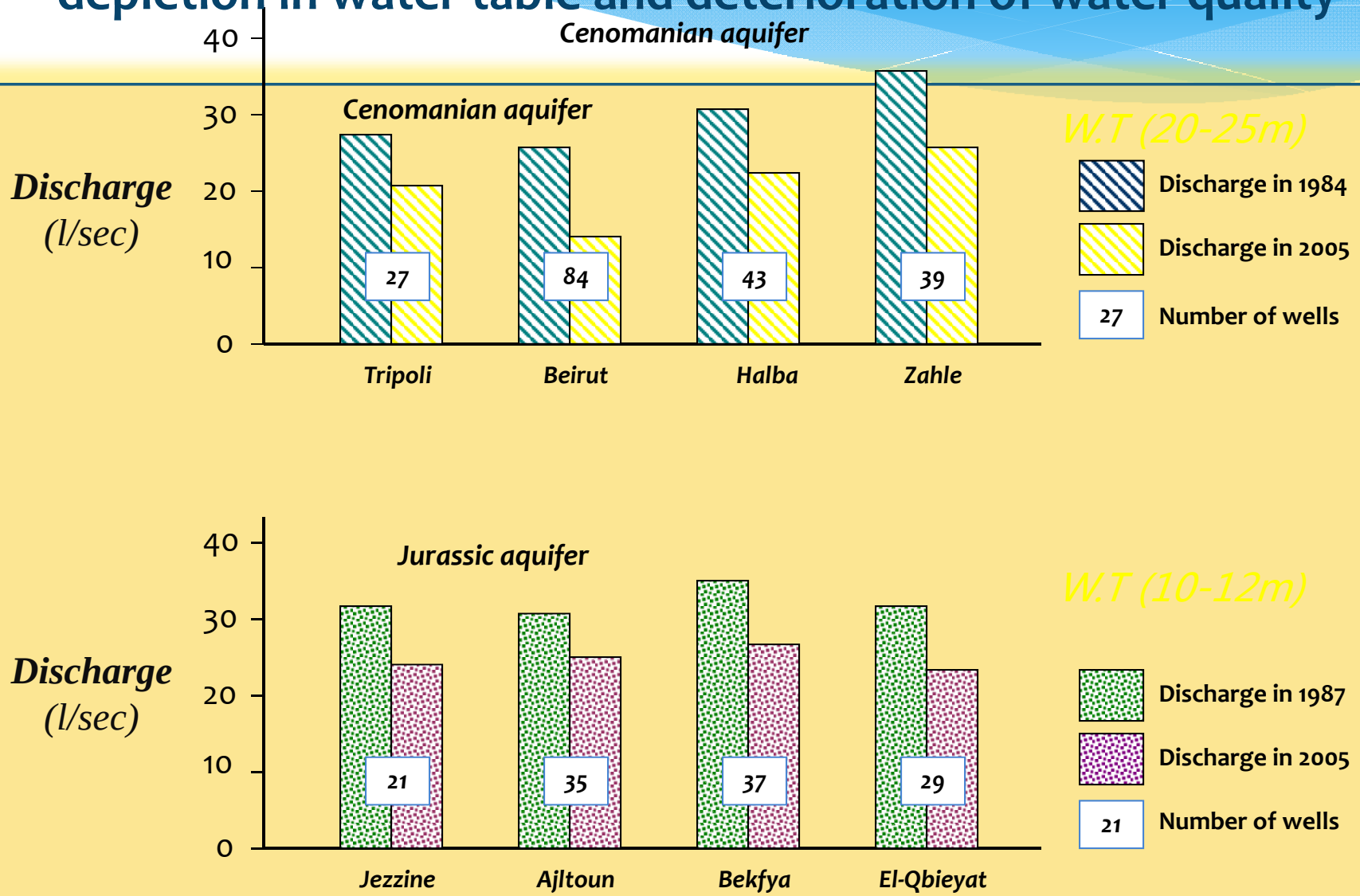
Volume of water

= Snow cover (Area) x Depth x Density

SPOT-5, Vegetation

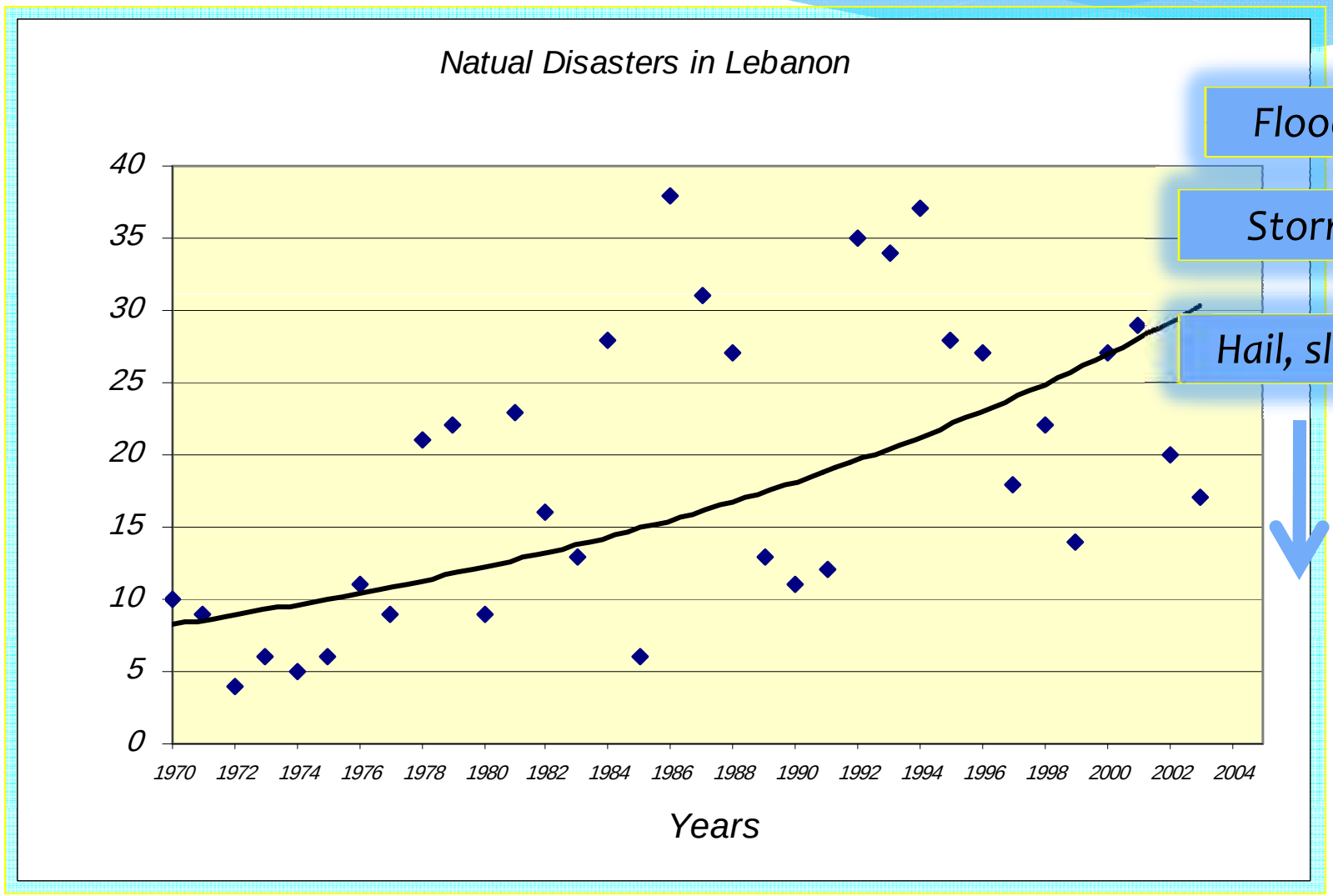

Study Area
Mediterranean Sea
Tripoli
Beirut
Syria
300000
240000
180000
120000
Zones of snow coverage
Totally covered by snow
More than half the area covered by snow
Less than half the area covered by snow
Snow exists in forest
Dissipated snow
(a)

Groundwater yield from wells was declined by 30% with a sharp depletion in water table and deterioration of water quality



➢ Indicators of Climate Change in Lebanon

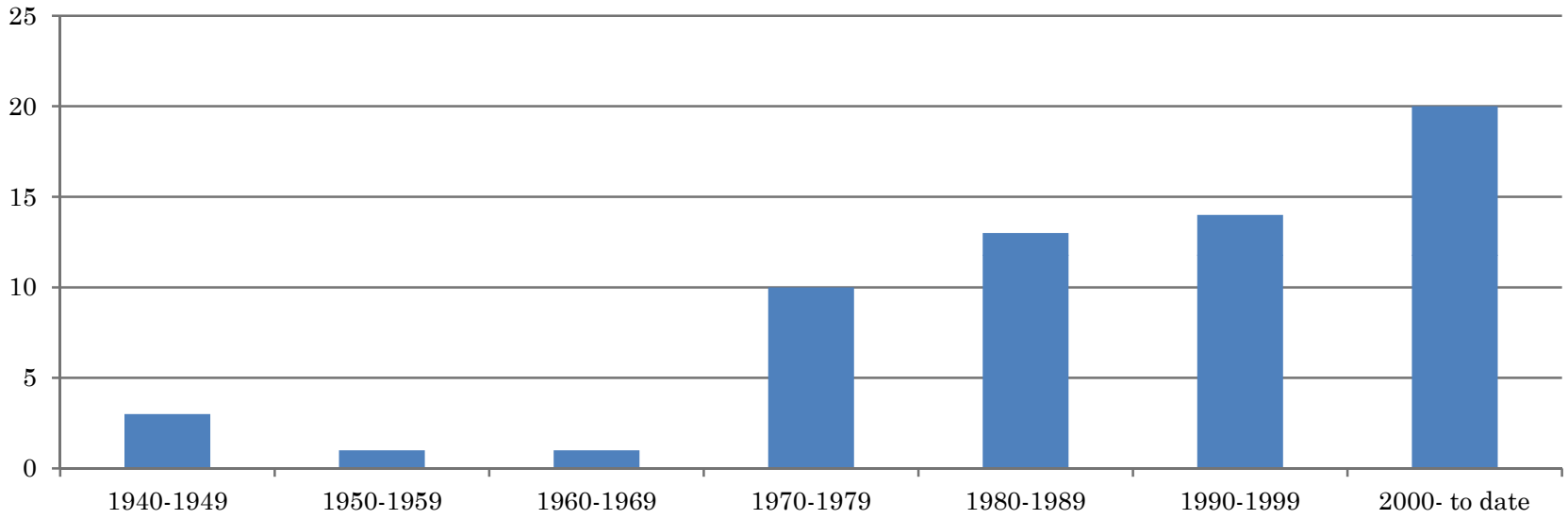
Increase in natural disasters



Hail, North Lebanon

11 dead as Mideast battered by hail, snow Bad weather has brought misery to Syrian refugees living in Lebanon and Syria (GulfNews.com http://gulfnews.com/news/region/lebanon/11-dead-as-mideast-battered-by-hail-snow-1.1130434)

Number of Major Flooding Events in the last 7 decades



many Floods events Took place in Lebanon in Winter 2013

These floods caused a high number of deaths and injuries and losses in millions of dollars

Beirut River water rose and flooded nearby roads

Main Floods Studies in Lebanon

ACSAD and GTZ studied in 2008 the flash floods in El-Qaa watershed and has led to the establishment of many water harvesting structures to reduce runoff velocity, thus increasing the time for water to infiltrate to the soil .

Another study was conducted by UNDP on flood risk management and prevention in Baalbeck- Hermel area in 2010. The study utilized remote sensing and GIS techniques along with dedicated hydrological software for proper engineering structures to reduce runoff velocity during severe rainfall events in Rass Baalbeck watershed.

Recently, the CNRS and the UNDP are conducting a project for flood hazard assessment in Lebanon to prioritize river basins and flash flood areas through calculating the intensity duration frequency curves for rivers, and to develop maps for 10, 20, 50 and 100 years recurrence periods in order to determine the probability distribution of potential future flood hazard intensity maps at a scale of 1: 20000.

Mitigation processes constructed in NE Lebanon (UNDP funded projects)

2. 2- Landslides

A general characteristic of the precipitation in Lebanon is the torrential nature and high intensity, with a noticeable shift in the rainy periods

These climatic characteristics (torrential and sporadic rainfall) enhance surface cover instability inducing superficial movements and processes

The National council for Scientific research have been conducting since 2003 projects related to landslides and mass movements.

Detailed scan of floods accompanying landslides from 1971 to-date as recorded in the Lebanese newspapers (Abdallah, 2012).

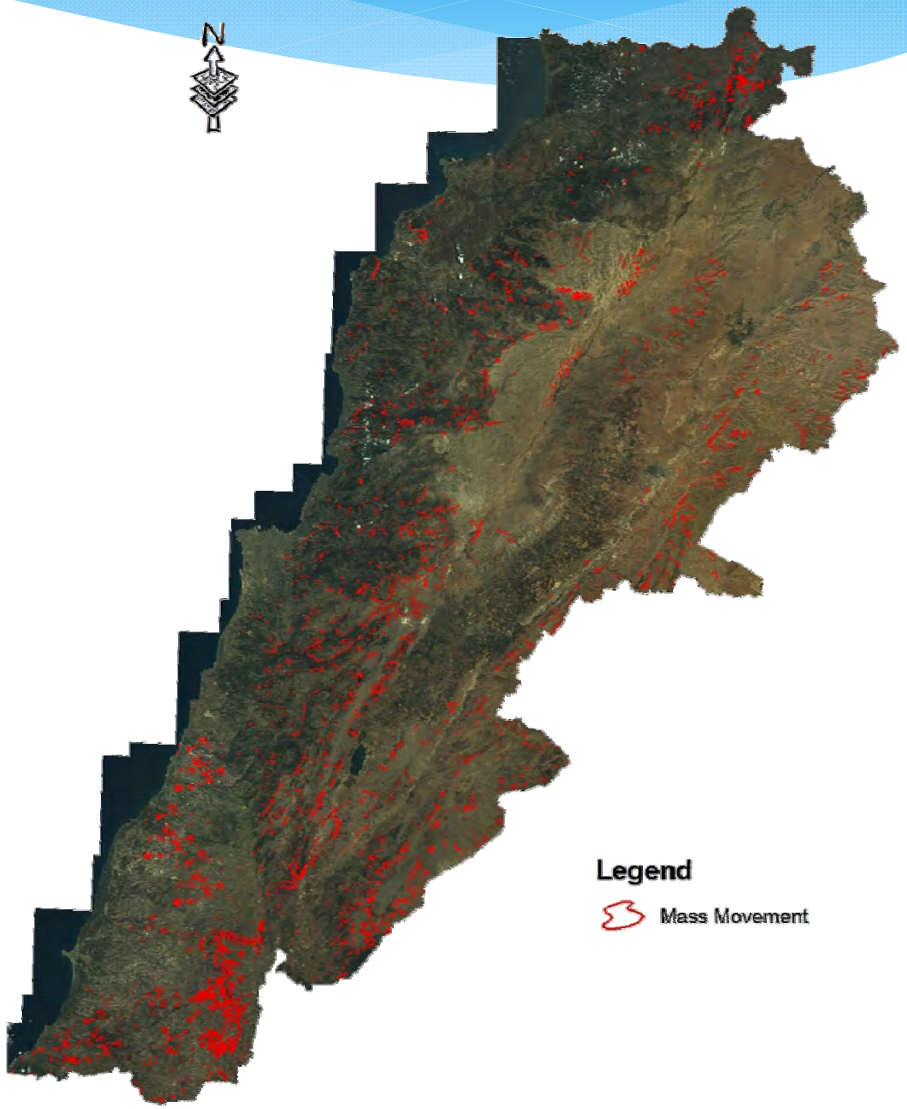
Month	1971-1981		1982-1992		1993-2003		2004-till now		Dates of occurring floods
	F*	L**	F*	L**	F*	L**	F*	L**	
November (N)	-	-	2	-	2	2	2	5	17N (1984), 21N (1986), 16N (1993), 7N (1994),25N(2008)
December (D)	1	-	3	2	3	3	14	13	1D (1971), 18D (1984), 22D (1986), 25D (1987), 5D (1994), 10D (1997), 17D (1997),18D(2009),21D(2010/flood occurred in big number of small rivers)
January (J)	4	1	2	1	2	2	-	-	2J (1972), 3J (1978), 9J (1979), 10J (1980), 19J (1986), 21J (1992), 1J (1994), 24J (1996)
February (F)	3	-	5	-	3	2	-		3F (1975), 11F (1980), 13F (1982), 14F (1983), 20F (1986), 6F (1992), 12F (1992), 8F (1995), 9F (1998)
March (M)	2	-	3	2	6	3	2	1	8M (1978), 12M (1981), 15M (1983), 23M (1987), 27M (1989), 28M (1996), 28M (1998), 2 M (2003), 5 M (2003), 15 M (2003), 22 M (2003),13M(2011), 2M(2012)

**F = number of occurring floods; **L = number of occurring landslides*


CNRS 50
1962-2012
National Council for Scientific Research
Curtsey of C. Abdallah

Detecting landslide using Remote Sensing techniques

9800 *were detected*

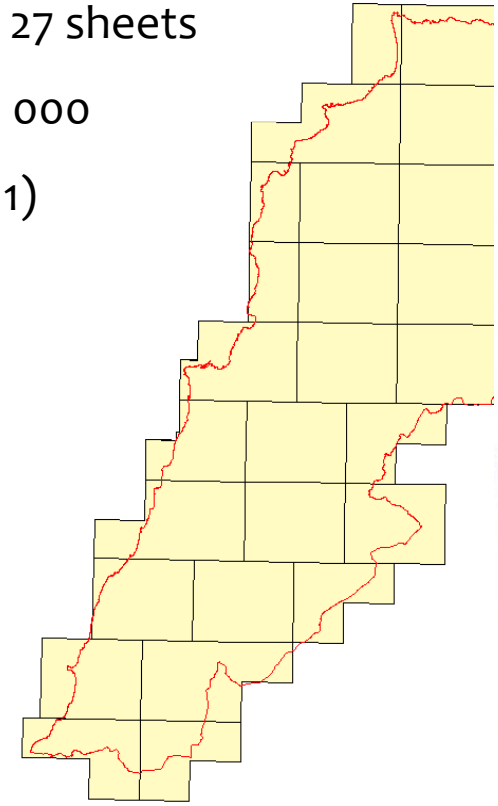


On going work

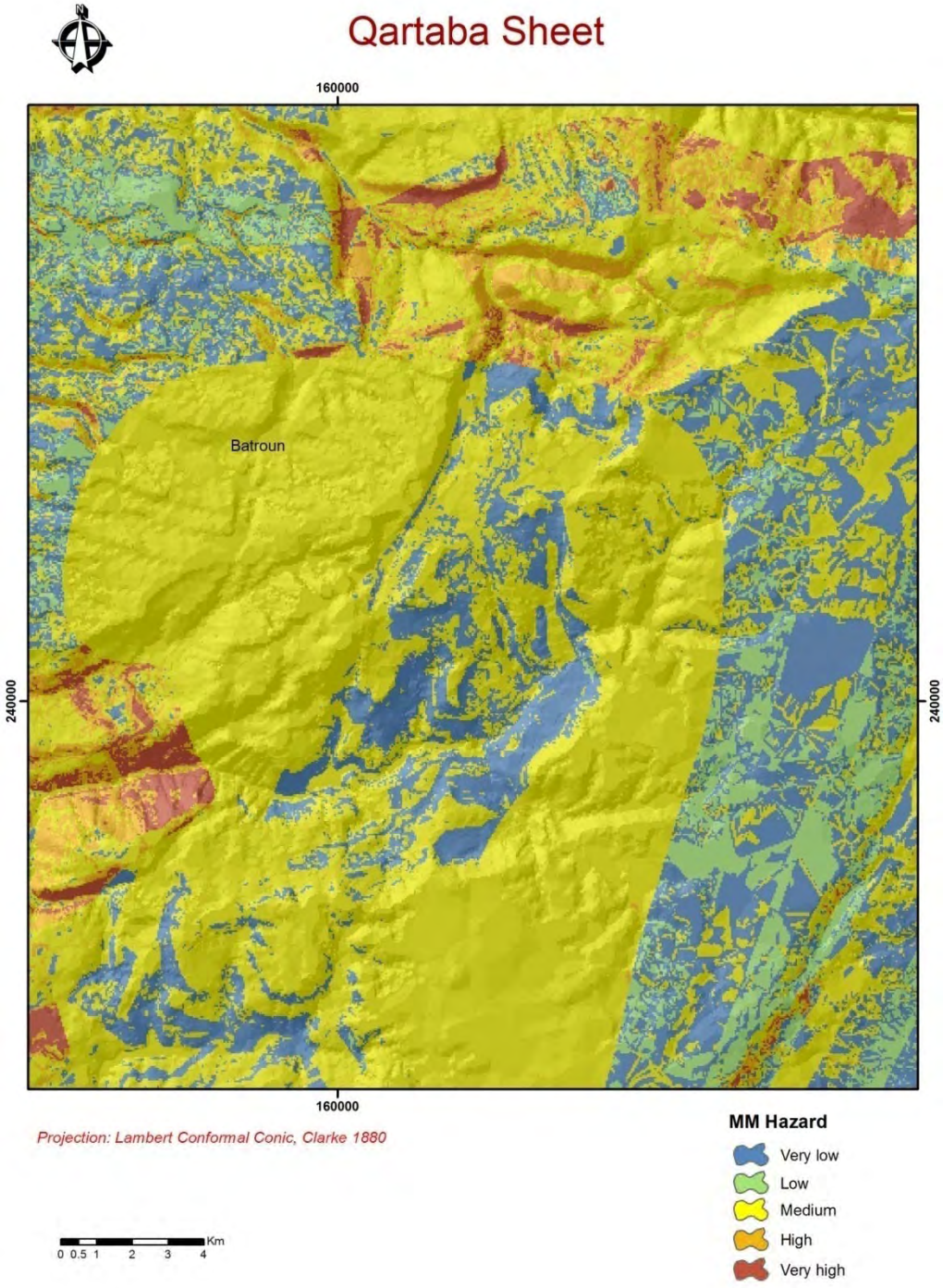
-Mapping 27 sheets

Scale 1:50 000

(2008-2011)



Risk mapping on finer scale



Forests and CO_2 sequestration research

Forest ecosystem plays a vital role in stabilizing global climate, hence studies for the use of forest biomass as sinks for carbon as a part global mitigation effort.

Forest ecosystem is one of the major source of storage of which constitutes approximately 90% of all living terrestrial biomass [1, 2]

The United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol and later Copenhagen (which Endorses the continuation of the Kyoto Protocol) has recognized forest as the most important in carbon sequestration.

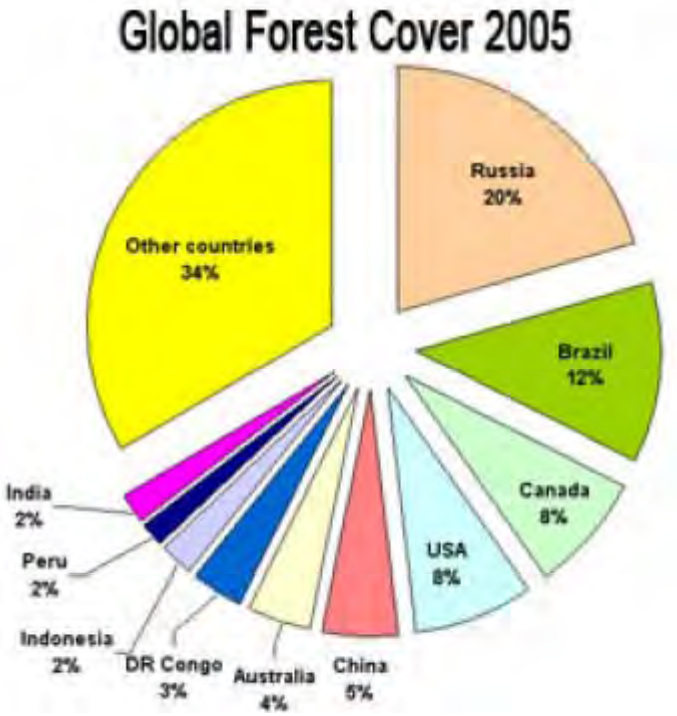
[1] Zhao, M. and Zhou, G.-S., (2005). Estimation of biomass and net primary productivity of major planted forests in China based on forest inventory data. Forest Ecology and Management, 207(3), 295-313.

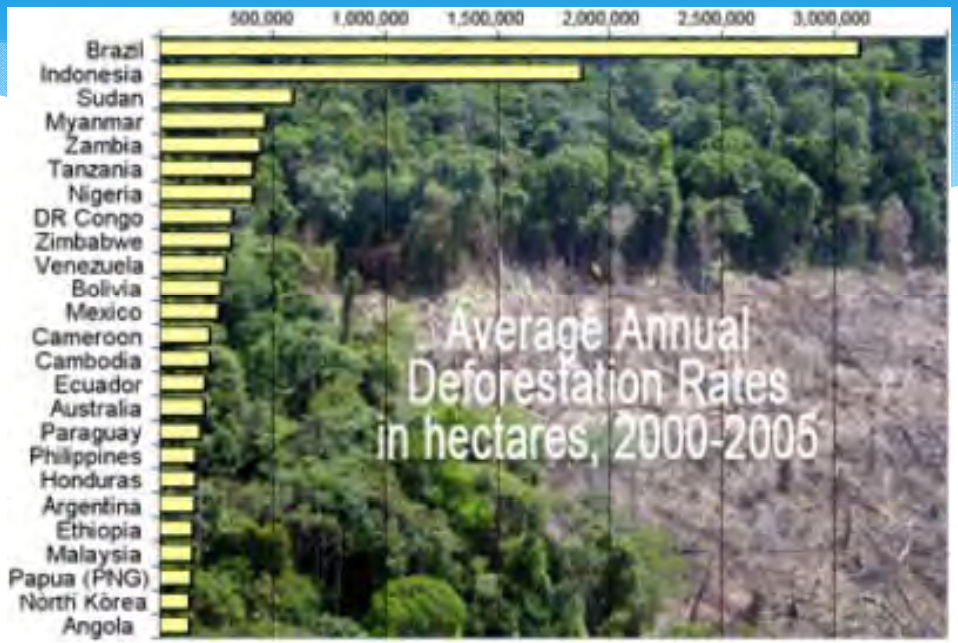
[2] Tan, K., Piao, S., Peng, C. and Fang, J., (2007). Satellite-based estimation of biomass carbon stocks for northeast China's forests between 1982 and 1999. Forest Ecology and Management, 240(1-3), 114-121.

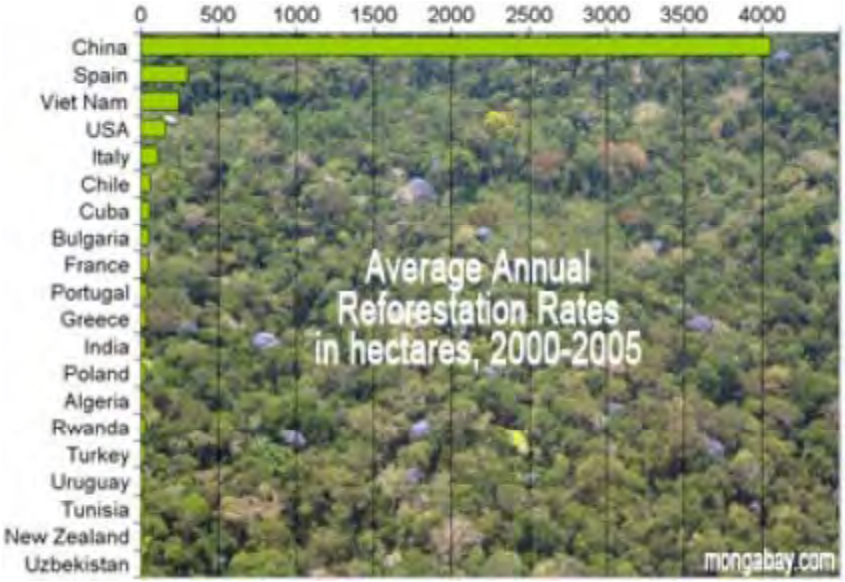
Forests and CO_2 sequestration research-Cont'd

Hyperspectral sensors have the potential to be more sensitive to differences in overall forest biomass and total carbon than traditional multispectral sensors because of the large number of bands and the fine level of discrimination between bands [1].

[1] S. L. Ustin and A. Trabucco, "Using hyperspectral data to assess forest structure," J. Forestry, vol. 98, 2000.







By Rhett A. Butler, mongabay.com. Retrieved from: http://news.mongabay.com/2007/0313-forests.html

Forests CO_2 sequestration research-Cont'd

Sensor Name	Satellite Name	Provider	Spatial Resolution	Spectral resolution	Number of bands	Revisit time	Remarks
CHRIS	PROBA	ESA	17 -34 meter	1 to 12 nm	>= 18 and <=64	7 days	400 – 1052 nm Swath wiidth = 14 km https://probausr:pfd2proba@oa-es.eo.esa.int/ra/proba_chris
Hyperion	EO-1	NASA	30 meter	10 nm	242	16 days	400-2500 nm Swath wiidth =7.2 km https://eo1.usgs.gov/dar/login
HICO	ISS	NRL and ONR	90 meter	5.7 nm	>= 87 and <= 128	3 days	353-1080 nm Swath width = 42 km http://hico.coas.oregonstate.edu/index.shtml

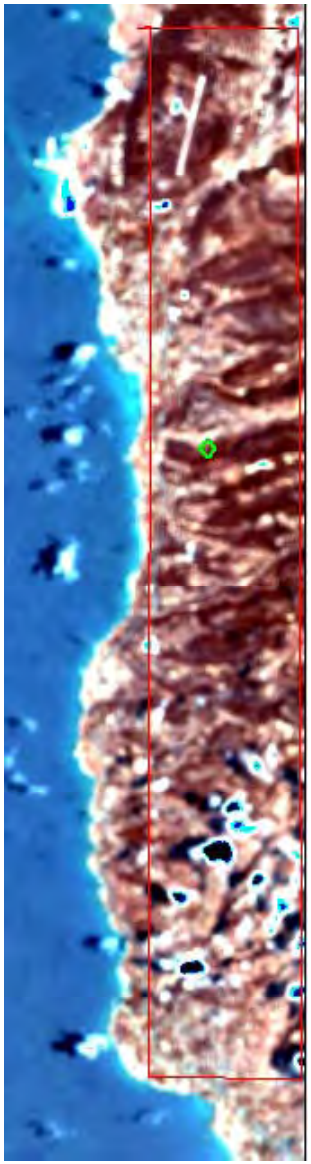
Vegetation and CO2 sequestration research-Cont'd

EO-1 Hyperion bands can be used as independent variables to predict carbon measures

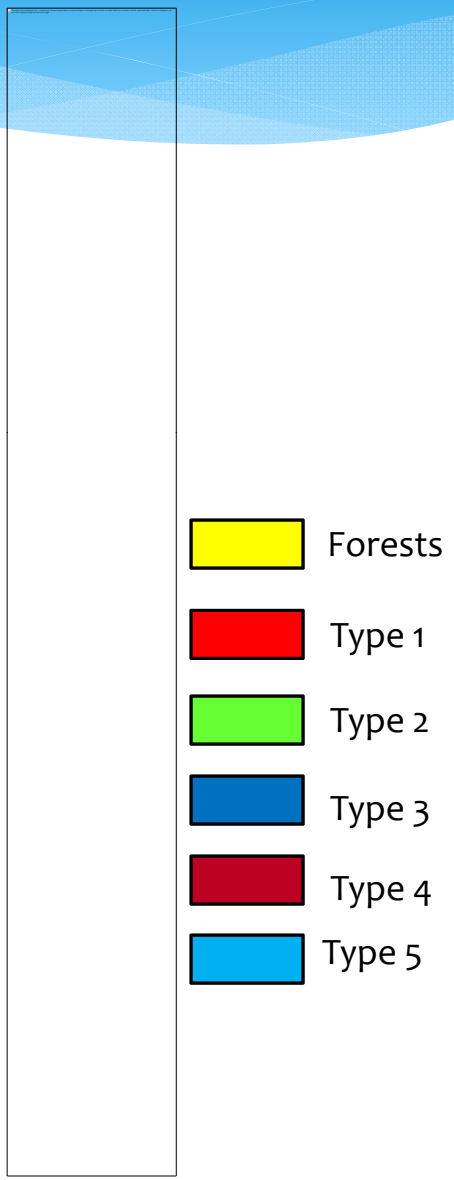
Hyperion has 242 contiguous bands spaced approximately 10 nm apart and ranging from 400-2500 nm. It images a 7.5 km swath over the length of a standard Landsat scene and has 30 m spatial resolution pixels. The revisiting time for EO-1 Hyperion is 16 days which runs in parallel and overlap with Advanced Land Imager (ALI) a multi spectral imaging sensor.

	EO-1	
Parameters	ALI	HYPERION
Spectral Range	0.4 - 2.4 μm	0.4 - 2.5 μm
Spatial Resolution	30 m	30 m
Swath Width	36 Km	7.5 Km
Spectral Resolution	Variable	10 nm
Spectral Coverage	Discrete	Continuous
Pan Band Resolution	10 m	N/A
Total Number of Bands	10	220

Hyperion area of study – Jbeil North of Beirut



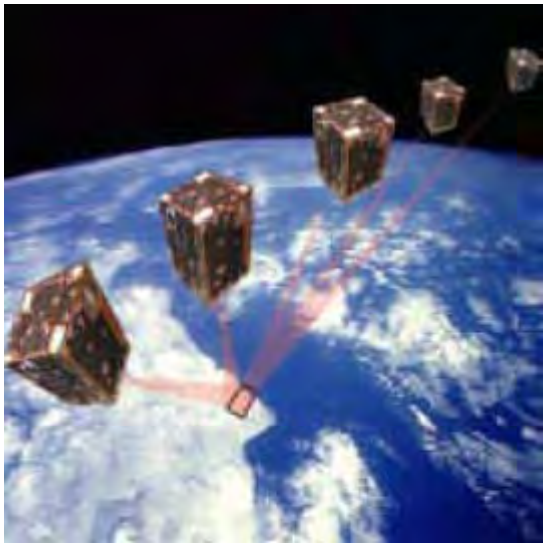
Red (711.7200)
Green (548.9200)
Blue (477.6900)



Classified Hyperion Image

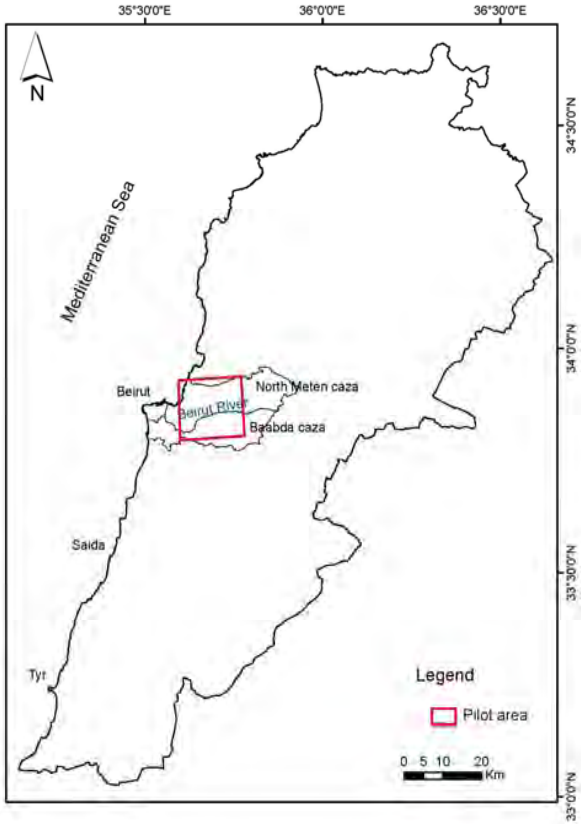
CHRIS: Compact high resolution imaging spectrometer
European Space Agency (ESA) PROBA platform

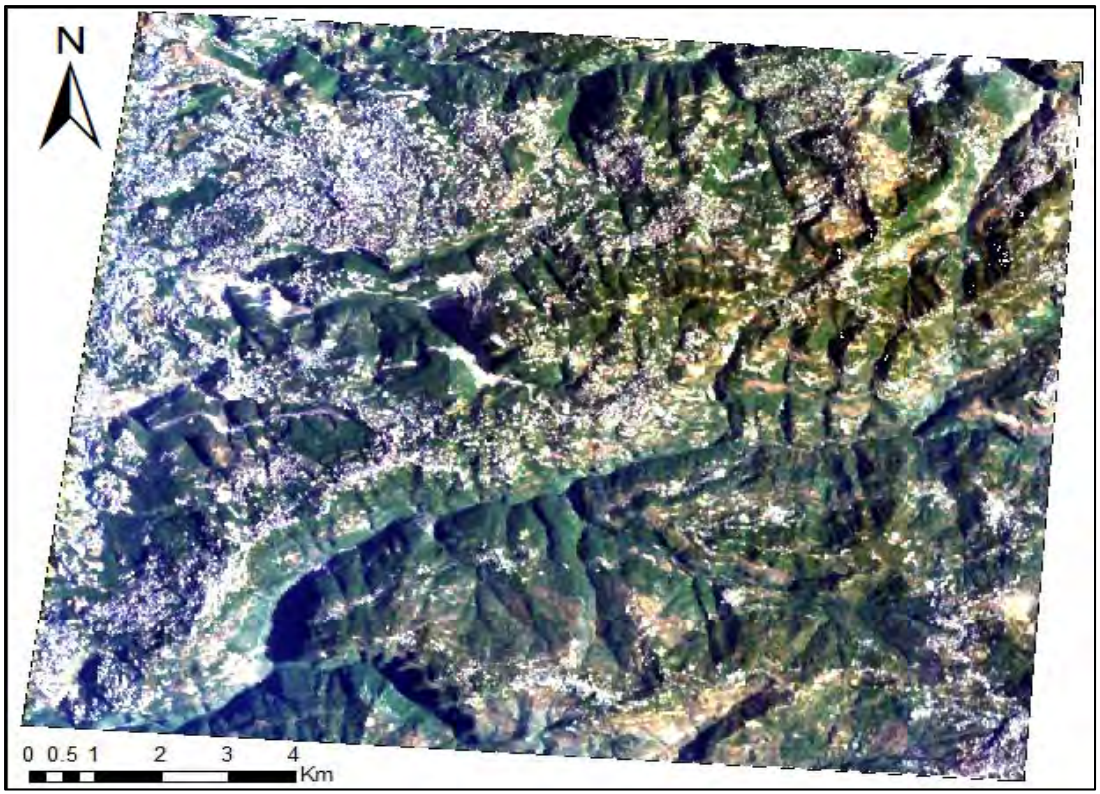
Name	Spectral resolution	Spatial resolution	Revisit time	Number of bands	Swath width
Chris Multi-Angle	Min 1.3nm to max 12nm	17 m to 34m	One time every 7 days	18 to 62 visible and NIR	14 km



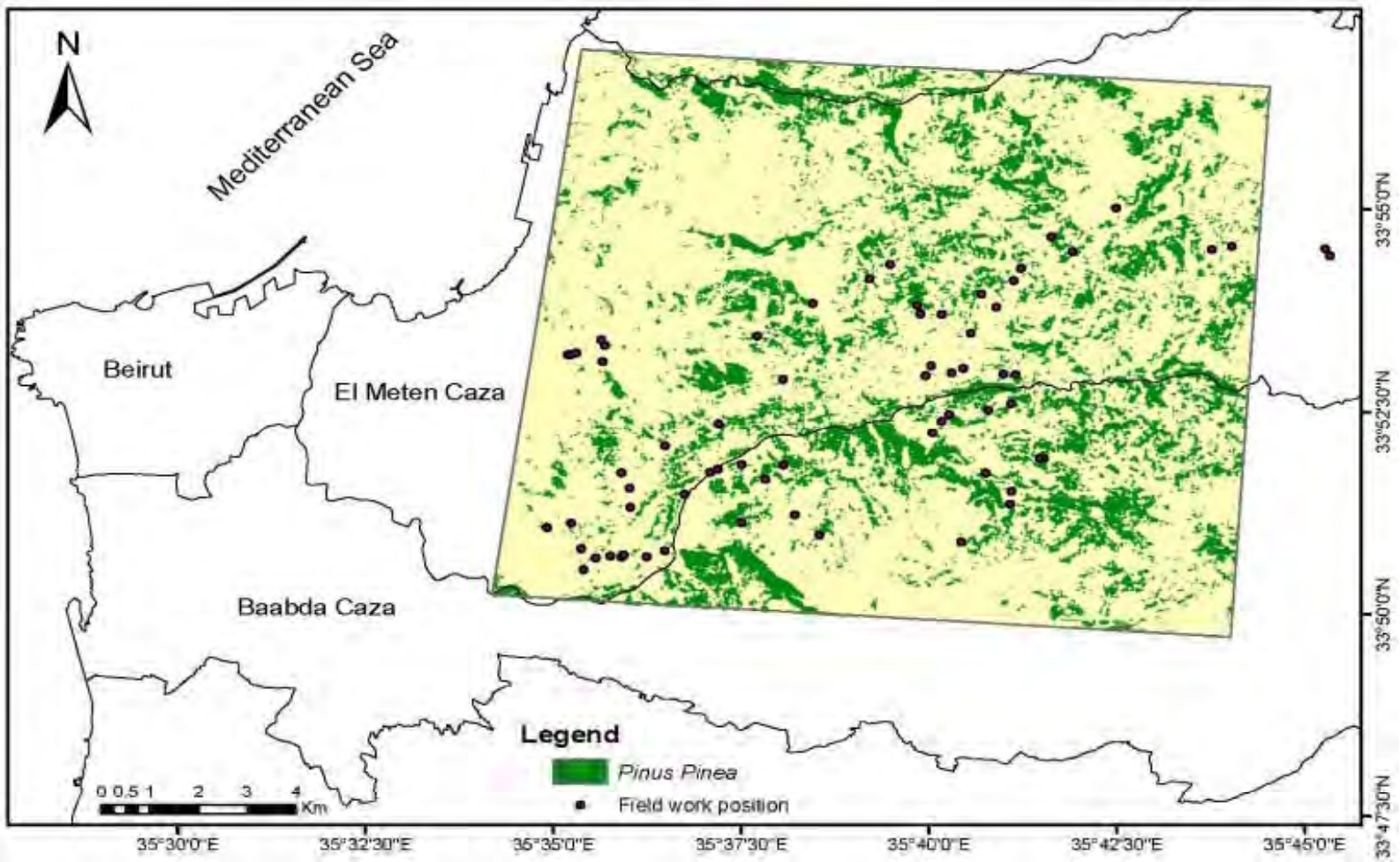
CHRIS: Compact high resolution imaging spectrometer Processing

CHRIS image was captured in August 2012 with level 3 - 5 angles such that multiple images are produced (Provided by the European Space Agency).
The hyperspectral image went through several pre-processing steps using two different software ENVI ver. 4.5 (Exelisvis, 2013) and VISAT ver. 4.10.3 which is based on BEAM software (Brookmann, 2013). These steps are the following: 1- removing stripes; 2- removing atmospheric effects 3- geometric correction and geo-reference.





CHRIS Processing –Forest cover



CO_2 sequestration research-Cont'd

* Hyperspectral data can improve the predictability of SOC compared to multispectral data under natural field conditions. They can not capture small annual variations in SOC, but could measure decadal variations with moderate error.

* Satellite-based hyperspectral data combined with map algebra can measure total SOC pools in various ecosystem or soil types to within a few per cent error.

Conclusion

* Remote Sensing in Lebanon has advanced the science of mapping and monitoring of the climate.
* Remote Sensing helped us to Produce important general and thematic maps like soil maps, coastal and national risks maps , water resources maps.
* Remote Sensing can play a crucial role in the early warning systems for catastrophic events caused by climate change such as floods and forest fires.
* Remote Sensing reduced the time and budget needed to conduct research in climate change.

Proposed Strategy for an Integrated Remote Sensing Application to Climate Change

* Up to date Remote Sensing medium resolution data for the extraction of climate and other related information should be available free of charge or with low cost.

* Creation of a Web based Meta Database which lists all information related to the accomplished or to the running projects which utilizes remote sensing for climate change research.

* Real time Early warning systems based on real time provision of satellite data especially satellites with short revisit time period.

* Exchanging experience and skills through short or long period training courses between different centers having similar climate change research interests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Thank you