UNITED NATIONS
Office for Outer Space Affairs

پژوهشگاه فضایی ایران
Iranian Space Research Center

Flood Monitoring and Damage Assessment in Agriculture by Space Remote Sensing

Case Study: 2019 Floods in Iran

Presented by: Omid Shekoofa

✉: **o.shekoofa@isrc.ac.ir**

Iranian Space Research Center (ISRC)

Contents

- ISRC and its Background on Precision Agriculture
- Natural Disasters in Iran
- Overview on March 2019 Flood
- Flood Monitoring/Management
- Flood Damage Assessment in Agriculture
- Conclusion

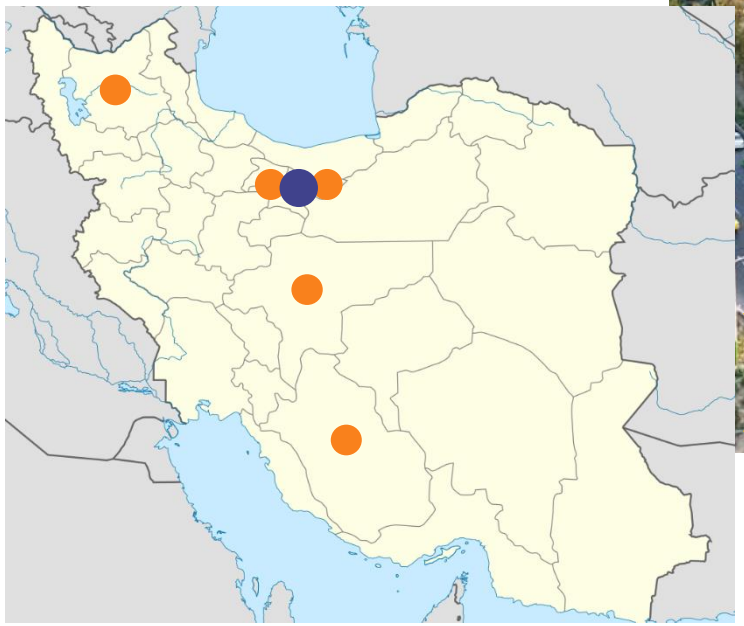

2–4 September
Graz, Austria
UNITED NATIONS / AUSTRIA
SYMPOSIUM
2019
SPACE: a Tool for
Accessibility, Diplomacy
and Cooperation
co-sponsored by
Austrian Ministry for Transport, Innovation and Technology • City of Graz • State of Styria • Austrian Research Promotion Agency (FFG)
Austrospace • European Space Agency • Graz University of Technology • German Aerospace Center DLR • NPOC Space Law
supported by
SUSTAINABLE DEVELOPMENT GOALS


2–4 September
Graz, Austria
SYMPOSIUM
SPACE: a Tool for
Accessibility, Diplomacy
and Cooperation

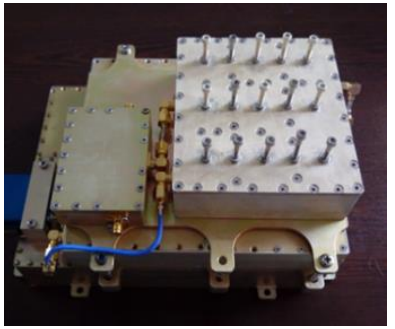

SYMPOSIUM
MONDAY, SEPTEMBER 2nd, 2019
SPACE: a Tool for
Accessibility, Diplomacy
and Cooperation

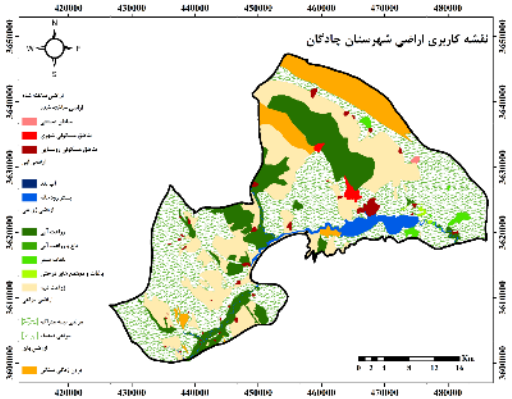
Iranian Space Research Center (ISRC)

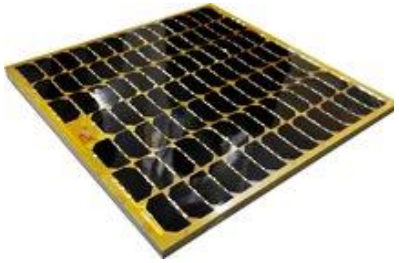
- Developing space systems and technologies for domestic needs in civil and peaceful applications

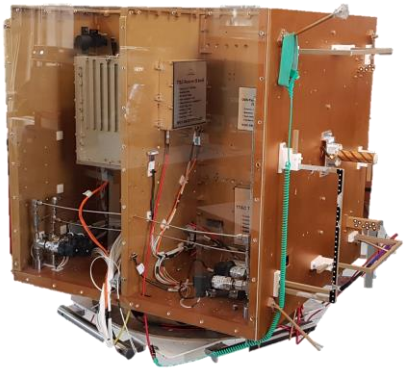


Space Technology & Application Development





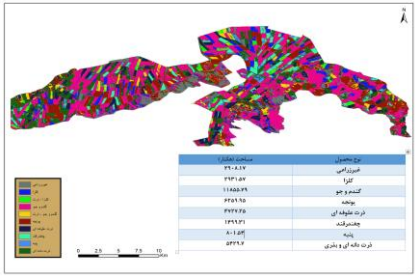


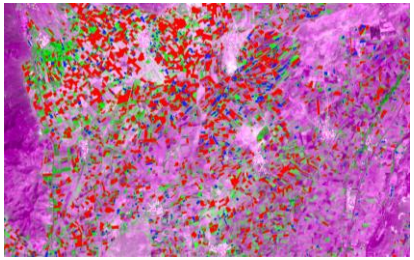


Precision Agricultural and Land Monitoring

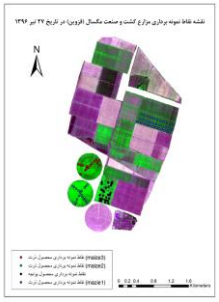
Remote Sensing Department

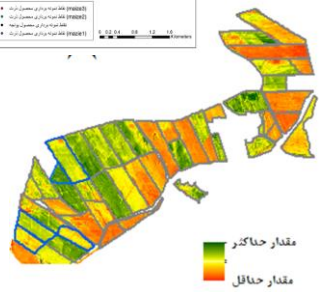
- **Crop Mapping**



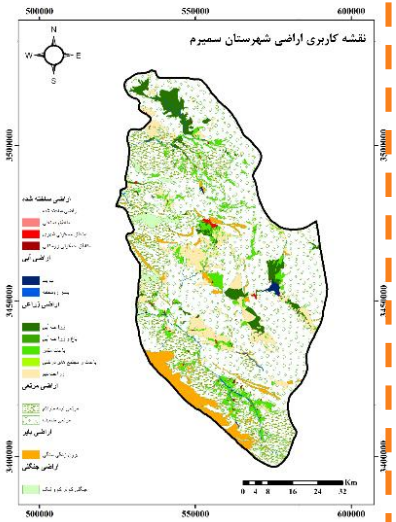


- **Quantitative Monitoring of Crop Parameters**

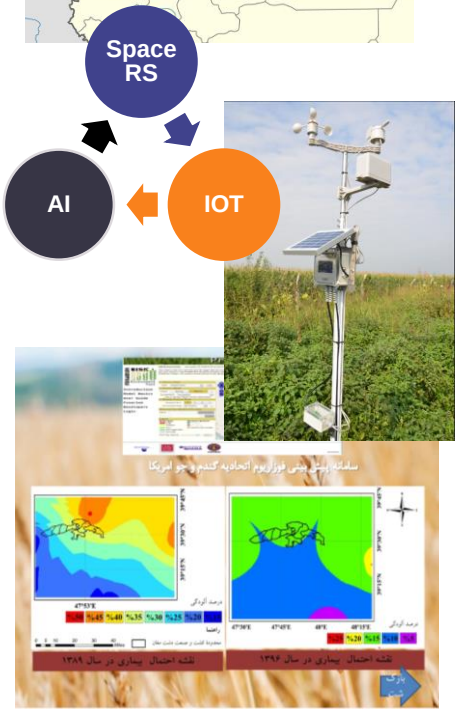




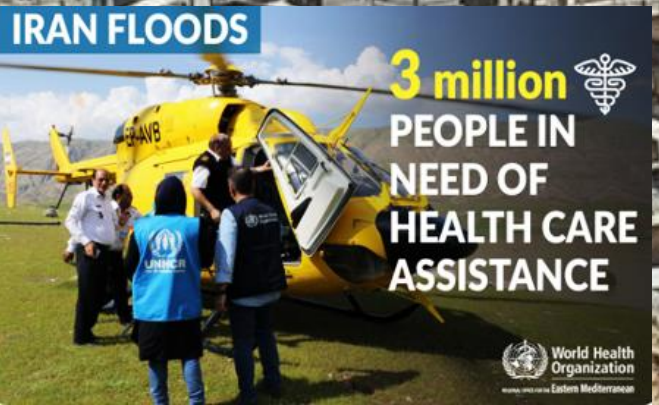
- **Land Use Planning**



- **Wheat Fusarium Prediction**



Risk Index of Natural Disasters in Iran



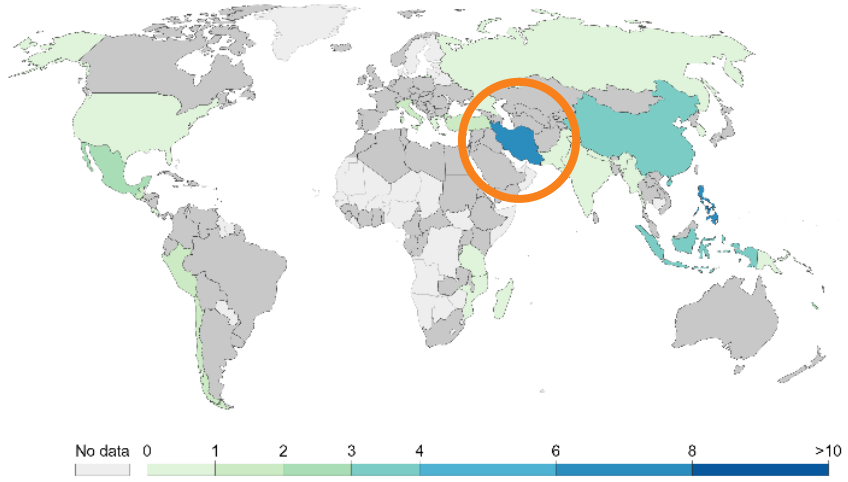
Iran and Natural Disasters

European Joint Research Center (JRC)

Risk	Rank
All natural disasters	11 (Global)
Earthquake	1 (Global)
Drought	32 (Global)
Flood	1 (Middle east)

http://www.un-spider.org

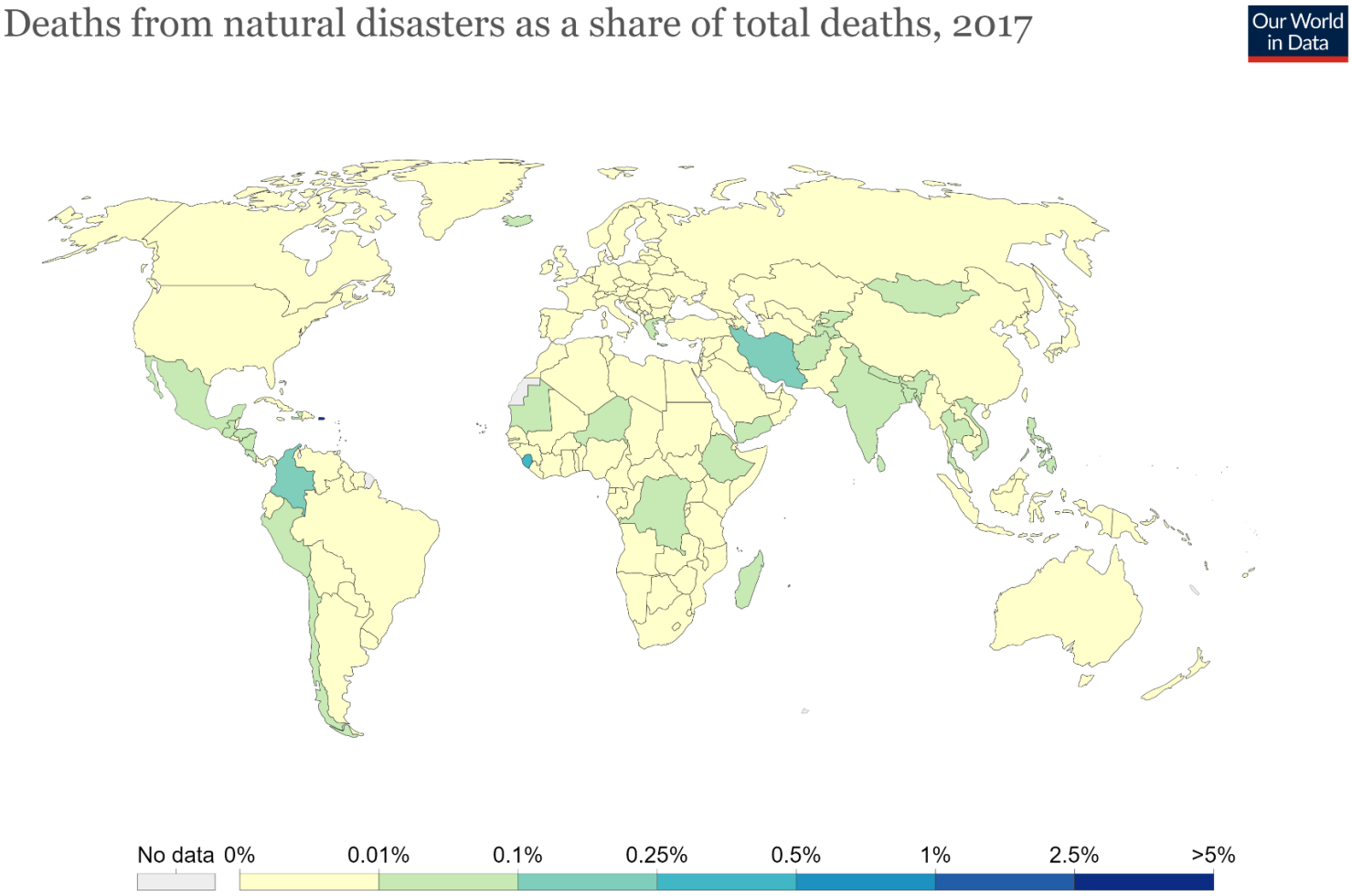
Number of known significant earthquakes, 2017



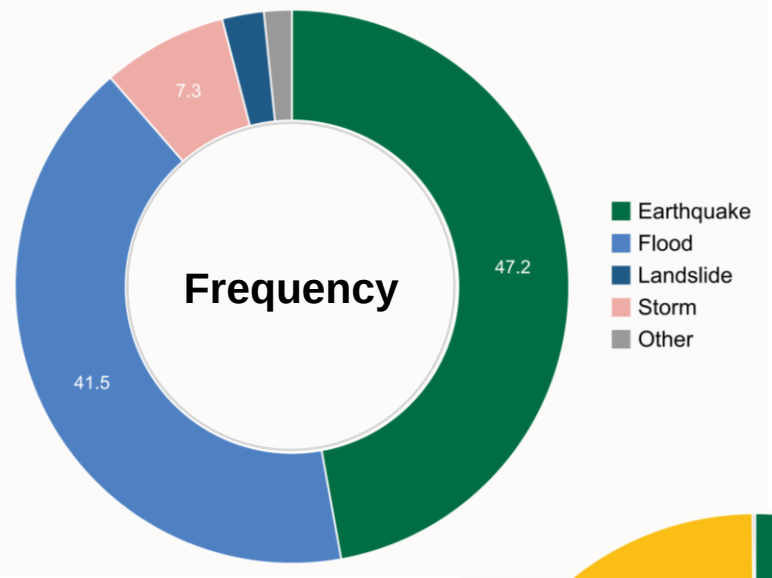
Source: National Geophysical Data Center (NGDC) of the NOAA

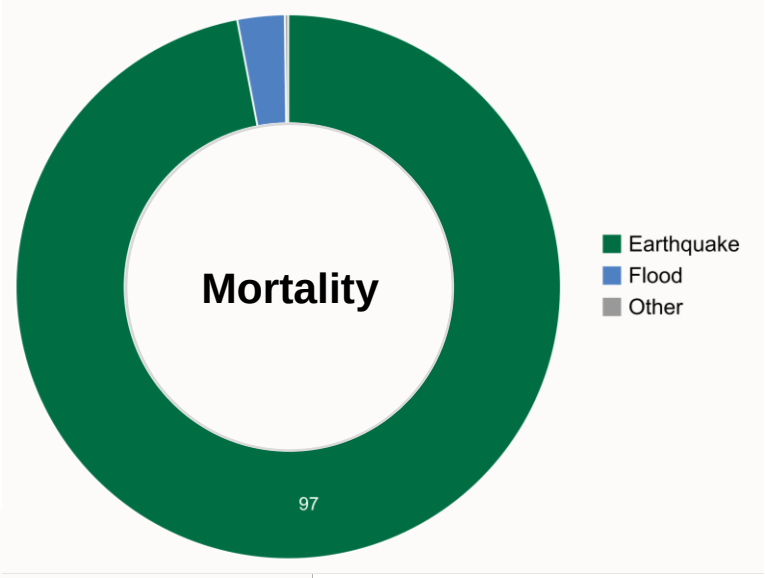
https://doi.org/10.1016/j.gloenvcha.2015.01.002

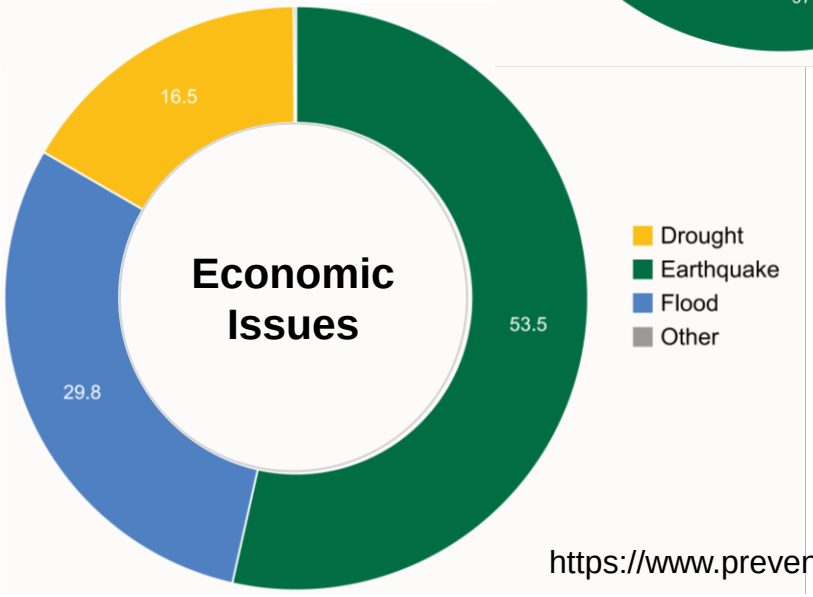
Natural Disasters Impacts Index



Natural Disasters Impacts Index (2015)





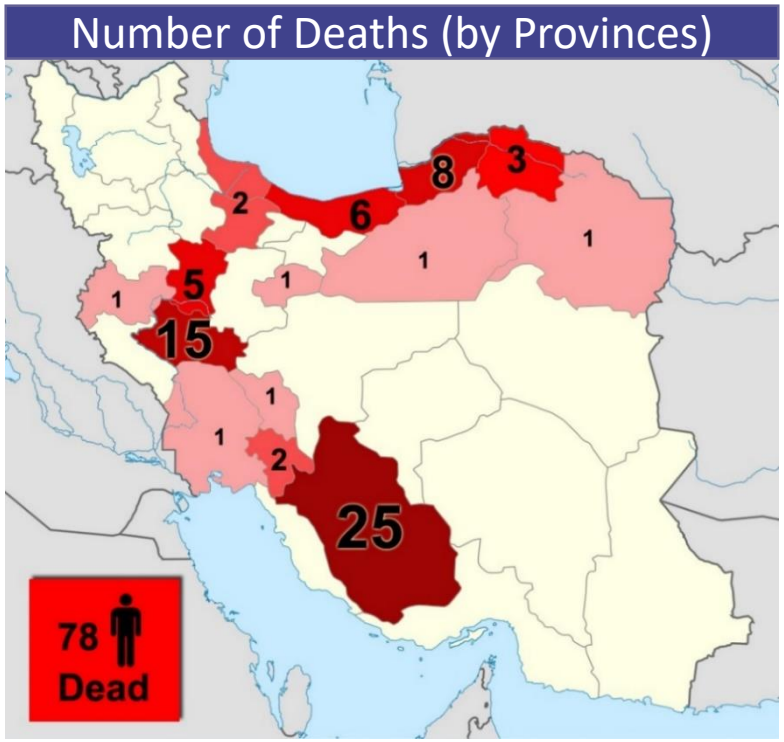


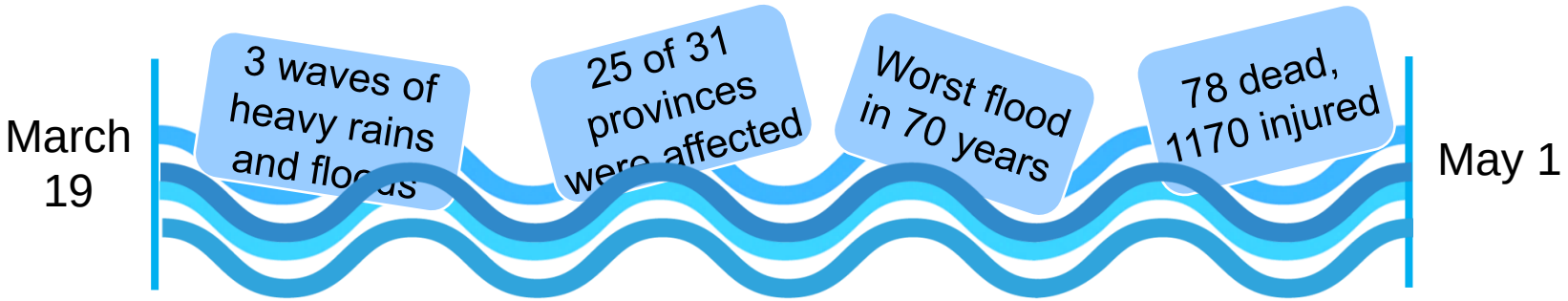
https://www.preventionweb.net/countries/irn/data/

What Happened During March to May 2019 in Iran?

Golestan province, Iran, March 22, 2019. Tasnim News Agency

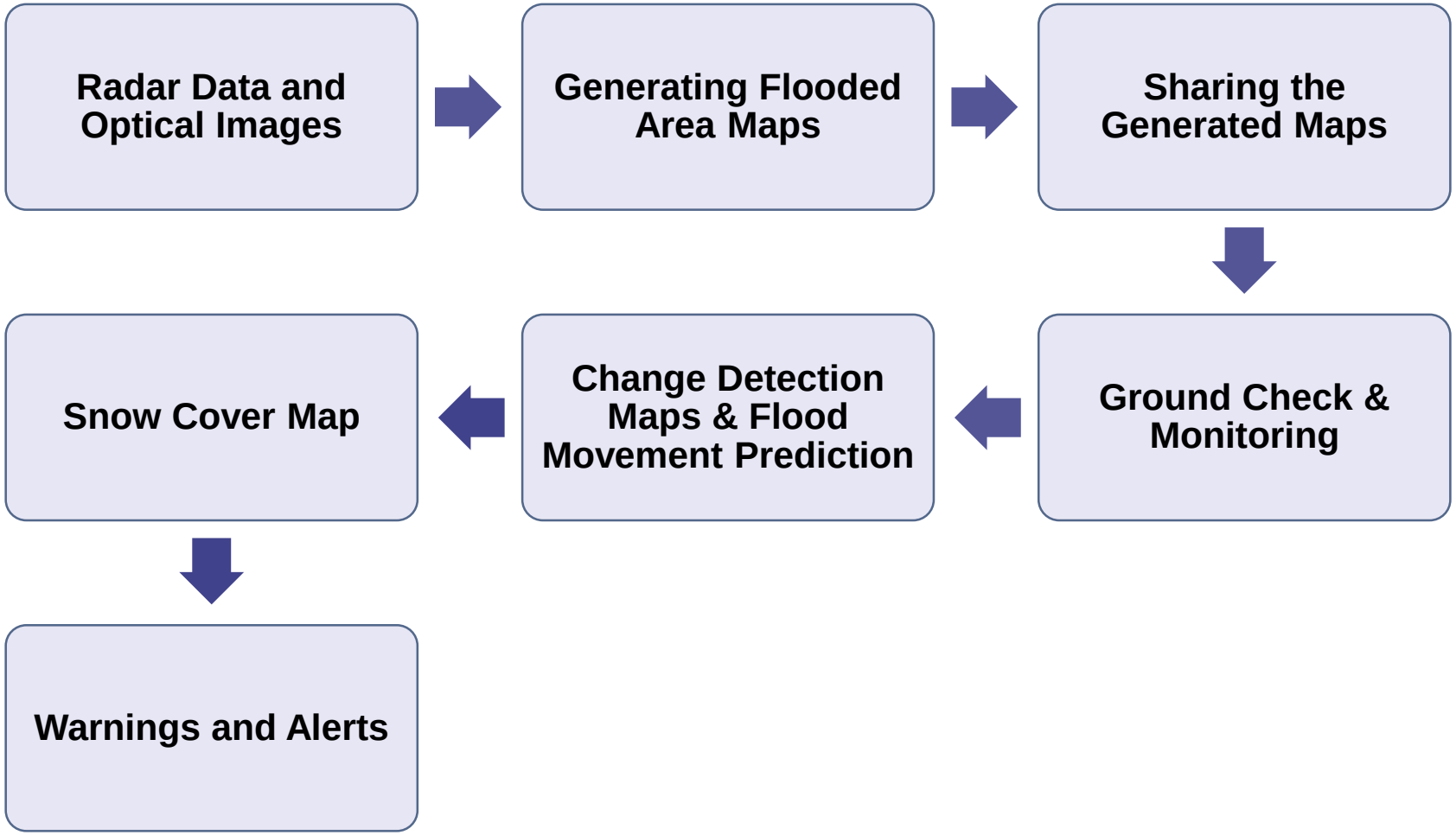
Iran Flood 2019 Overview





Flood Monitoring/Management by Space Remote Sensing

The Summary of What We Have Done!



Timetable of Flood Maps

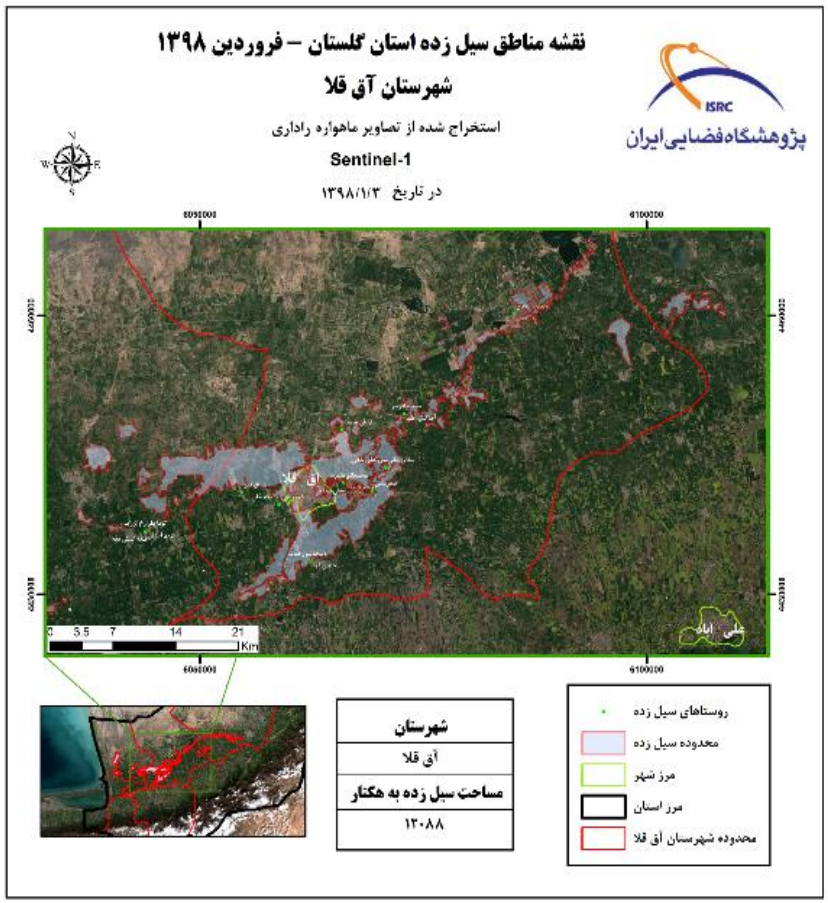
- Daily timetable of the available satellites pass over the flood areas was prepared.
- In Golestan province and due to the clouds, radar data and images were processed and used for the first time.

Place	Map Description	Spatial Resolution [m]	Image Type		Date
			Optical	Radar	
Golestan Province	Flood Area	20 m	-	Sentinel-1	2019-3-23
Golestan Province	Changes in Flood Area	20	-	Sentinel-1	2019-3-24
Gomishan County	Flood Area	20	-	Sentinel-1	2019-3-29
Aq-Qala County	Flood Area				
Qara-Su County	Flood Area				
Golestan Province	Changes in Water Basins				
Golestan Province	Changes in Flood Area	300	Sentinel-3	-	2019-4-1
Golestan Province	Changes in Snow Cover				

Generating Flood Area Maps

Flood Areas in Gomishan on March 25

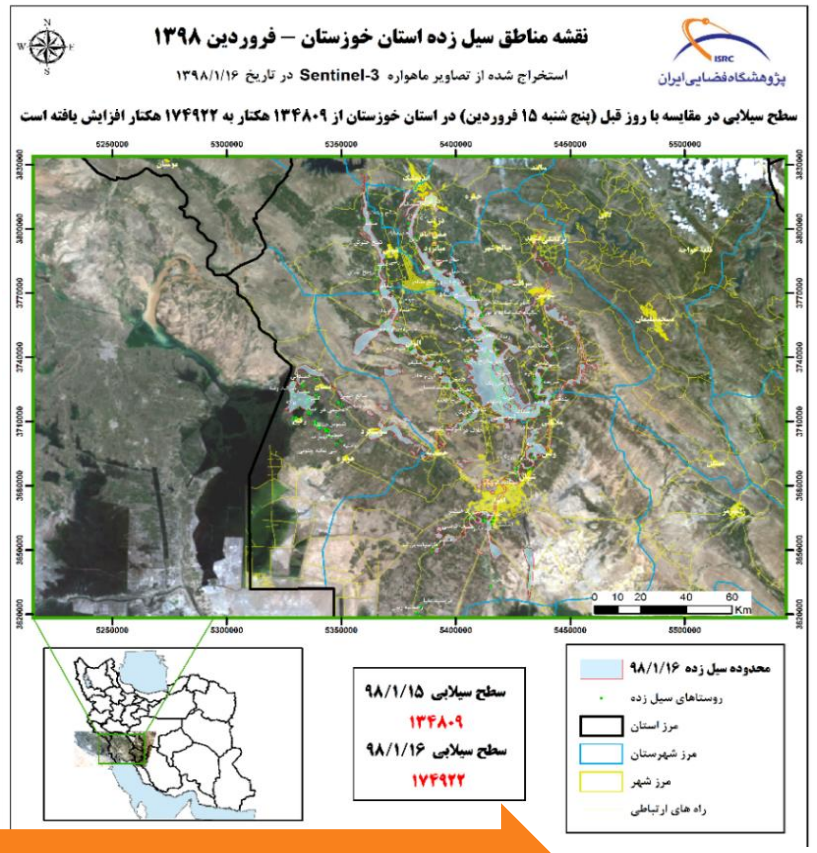
Flood Areas in Aq-qalla on March 25



Flood Area Changes in Khuzestan

Flood Areas in Khozestan on April 5

Flood Areas in Khozestan on April 6



29% increase in the flood area in one Day

Flood Area Changes in Khuzestan-2

Flood Areas Change in Shush

March 27 March 22

Flood Areas Change in Shadegan

March 27 March 22

Flood Areas Change in Shushtar

March 27 March 22

Flood Areas Change in Ahvaz

March 27 March 22

Flood Areas Change in Shushatr-nu

March 27 March 22

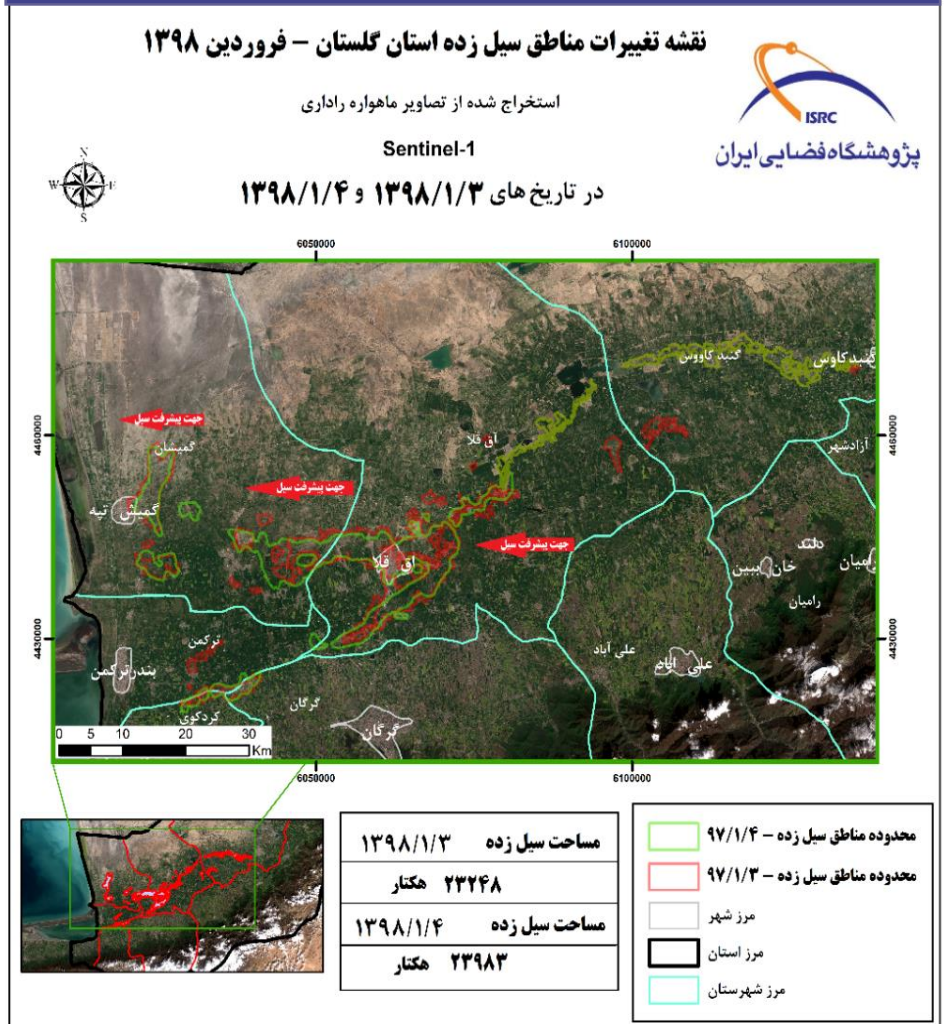
Flood Areas Change in Dezful

March 27 March 22

Flood Path Prediction in Golestan

- The flood flow and pathway were predicted in different areas.
- The cities, towns and villages in the flood path were determined.
- On-time alerts helped the flood management authorities to prevent larger damages.

Flood Areas Change in Golestan Province (March 23-24)



Identifying Damaged Roads

Damaged Roads in Gomishan County (March 23)

نقشه مناطق سیل زده استان گلستان – فروردین ۱۳۹۸

شهرستان گمیشان

استخراج شده از تصاویر ماهواره راداری

Sentinel-1

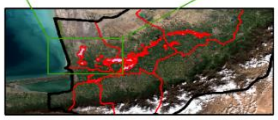
در تاریخ ۱۳۹۸/۱/۳

پژوهشگاه فضایی ایران

جدول مشخصات راه‌های آسیب دیده شهرستان گمیشان به تفکیک مناطق روستایی

شهرستان	طول راه‌های آسیب دیده (کیلومتر)	درصد از کل راه‌های آسیب دیده	راه های آسیب دیده به تفکیک مناطق روستایی				
			ID	X (Center)	Y (Center)	طول جاده آسیب دیده (کیلومتر)	توضیحات
گمیشان	۳۴.۵	۲۷	۱	۵۴.۱۰۴۴۹۵	۳۷.۰۷۷۹۴۹	۹.۵	جاده سیمین شهر گمیشان
			۲	۵۴.۱۳۴۹۸۴	۳۶.۹۹۷۶۳۸	۶	جاده سیمین شهرخواجه نفس
			۳	۵۴.۲۹۴۴۷۱	۳۶.۹۸۰۷۰۶	۸.۹	جاده فرینجیک سیمین شهر
			۴	۵۴.۳۶۲۲۹۴	۳۷.۰۲۲۳۰۱	۱۰.۱	جاده گمیش تپه آق قلا

به طور مثال برای هر یک از جاده های ذکر شده فوق، مختصات جغرافیایی مرکز آن جهت شناسایی جاده مشخص شده است. (Decimal Degree)



شهرستان
گمیشان
مساحت سیل زده به هکتار
۴۳۰۰

روستاهای سیل زده
راه های ارتباطی
محدوده سیل زده
مرز شهر
مرز استان
محدوده شهرستان گمیشان

Damaged Roads in Aq-qalla County (March 23)

نقشه مناطق سیل زده استان گلستان – فروردین ۱۳۹۸

شهرستان آق قلا

استخراج شده از تصاویر ماهواره راداری

Sentinel-1

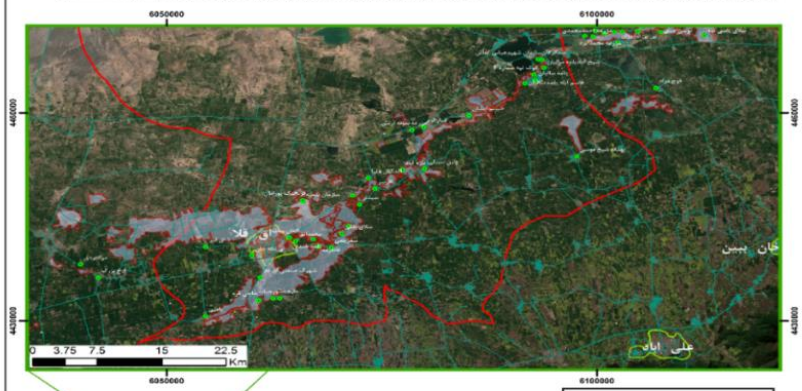
در تاریخ ۱۳۹۸/۱/۳

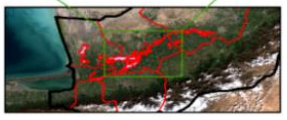
پژوهشگاه فضایی ایران

جدول مشخصات راه‌های آسیب دیده شهرستان آق قلا به تفکیک مناطق روستایی

شهرستان	طول راه‌های آسیب دیده (کیلومتر)	درصد از کل راه‌های آسیب دیده	راه های آسیب دیده به تفکیک مناطق روستایی				
			ID	X (Center)	Y (Center)	طول جاده آسیب دیده (کیلومتر)	توضیحات
آق قلا	۶۹	۵۴	۱	۵۴.۴۳۸۸۶۵	۳۶.۹۶۹۴۸۵	۴.۶	جاده شهرک صنعتی – آق قلا
			۲	۵۴.۵۰۹۳۷۹	۳۷.۰۴۴۶۲۸	۵.۴	جاده فرنجیک پورامان – آق قلا
			۳	۵۴.۴۸۰۲۲۲	۳۷.۰۵۵۱۲۴	۰.۶	جاده سازمان سمیه
			۴	۵۴.۳۷۹۹۲۹	۳۷.۰۲۴۳۷۸	۳۱.۸	جاده آق قبر – آق قلا
			۵	۵۴.۶۰۵۸۷۵	۳۷.۱۱۶۸۰۷	۱۱	جاده چین سیمابی – تازه آباد – انبارالوم
			۶	۵۴.۵۴۱۱۵۴	۳۷.۰۳۵۵۳	۱۵.۶	جاده قانقرمه – سفربلقی – میرزاعلی بلقی

به طور مثال برای هر یک از جاده های ذکر شده فوق، مختصات جغرافیایی مرکز آن جهت شناسایی جاده مشخص شده است. (Decimal Degree)



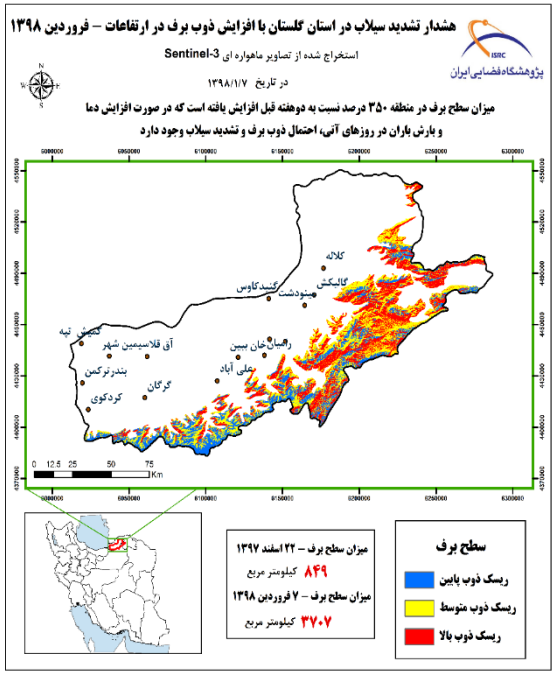


شهرستان
آق قلا
مساحت سیل زده به هکتار
۱۲۰۸۸

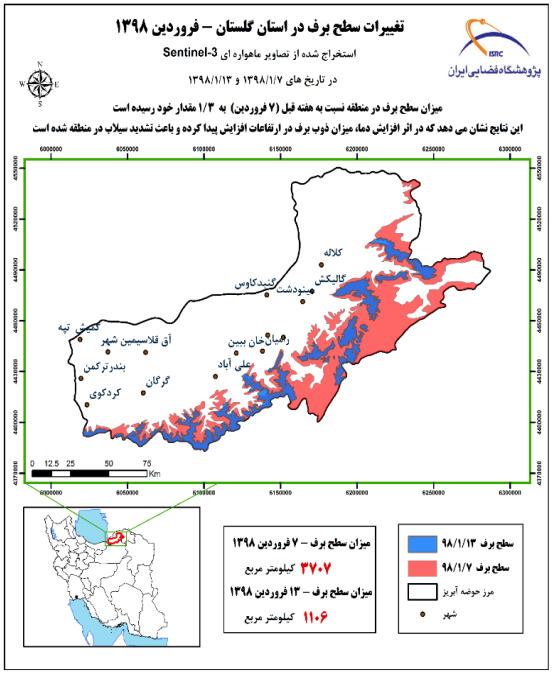
روستاهای سیل زده
راه های ارتباطی
محدوده سیل زده
مرز شهر
مرز استان
محدوده شهرستان آق قلا

Snow Cover and its Melting

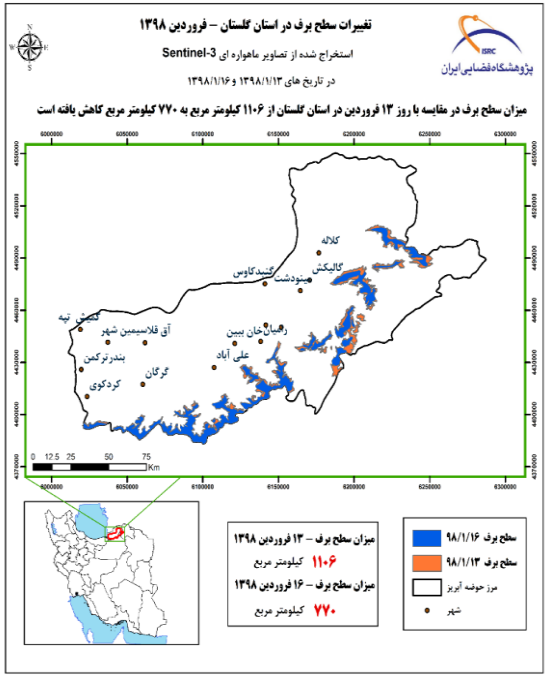
Snow Cover in Golestan (March 27)



Snow Cover in Golestan (April 3)



Snow Cover in Golestan (April 6)

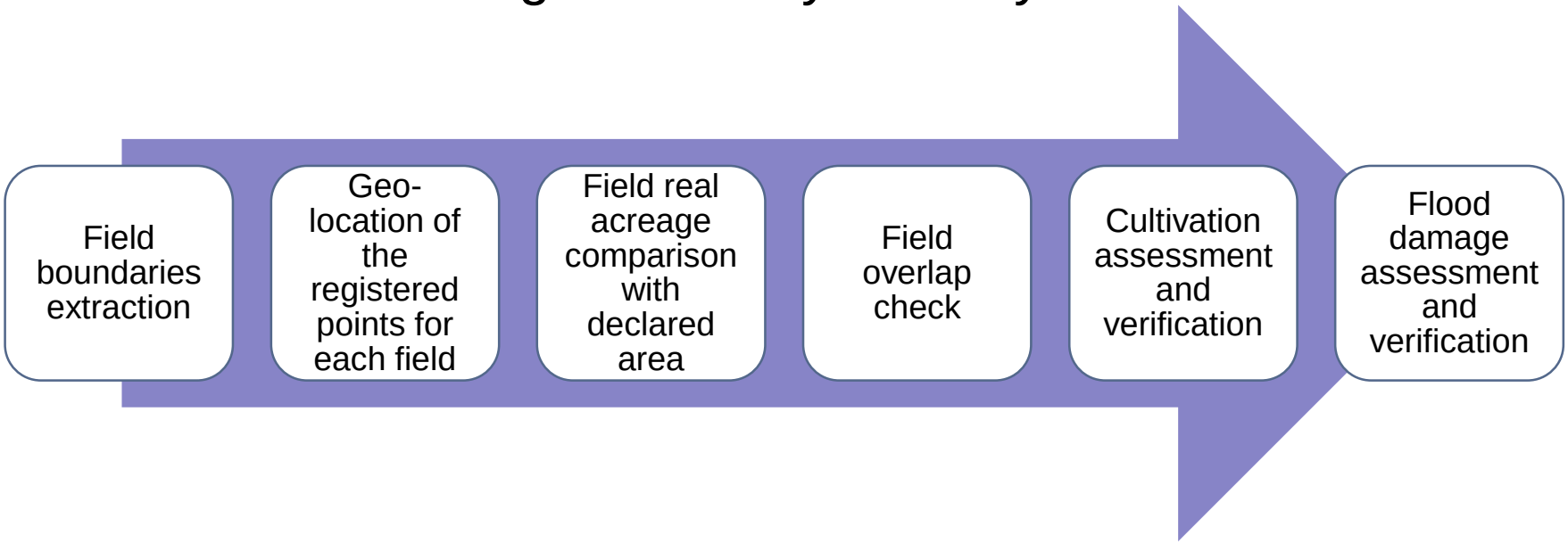


- Observing the snow cover in mountainous areas of Golestan showed 350% of increase from March 13 to March 27.
- The average temperature was forecasted to rise about 10 °C in a few days.
- The huge amount of melted snow lead to increase the level of flood in west Golestan rapidly.

Flood Damage Assessment in Agriculture

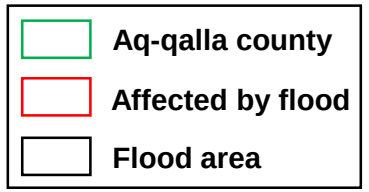
Flood Damage Assessment by ISRC

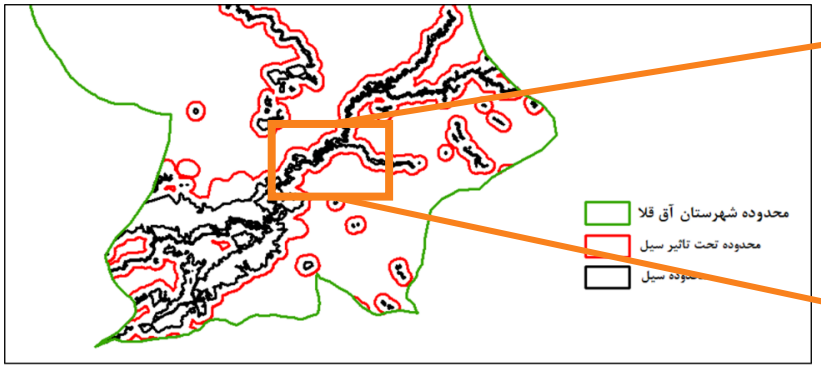
- The primary damage assessments carried out and announced by different organizations were different and mostly not in accordance with the expectations.
- Because of ISRC backgrounds in precision agriculture projects, it was officially assigned to flood damage assessment in agriculture by ministry of internal affaires.

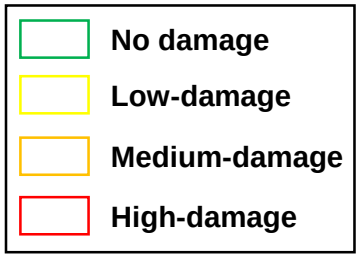


Preparing Field Cadastral Maps

- Acquisition of archived satellite images with 80 cm spatial resolution
- Field boundary extraction for pre- and post-flood
- Determining the flood stricken area
- Defining a margin for the affected area

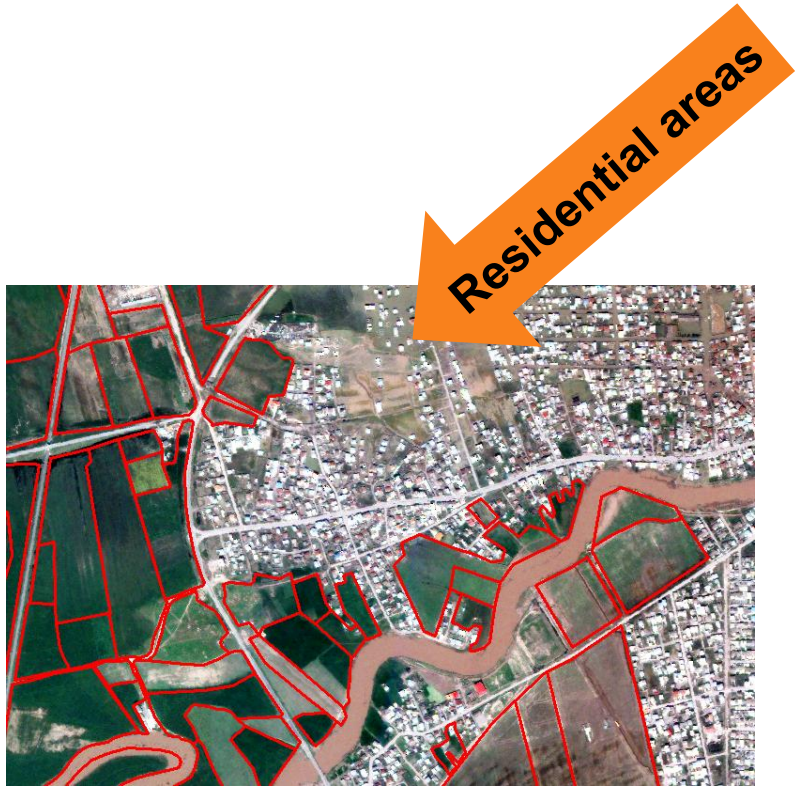




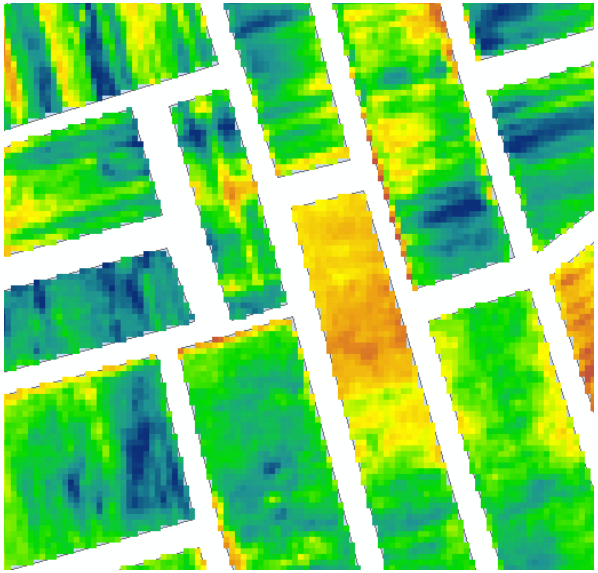


Agricultural & Non-Agricultural Areas

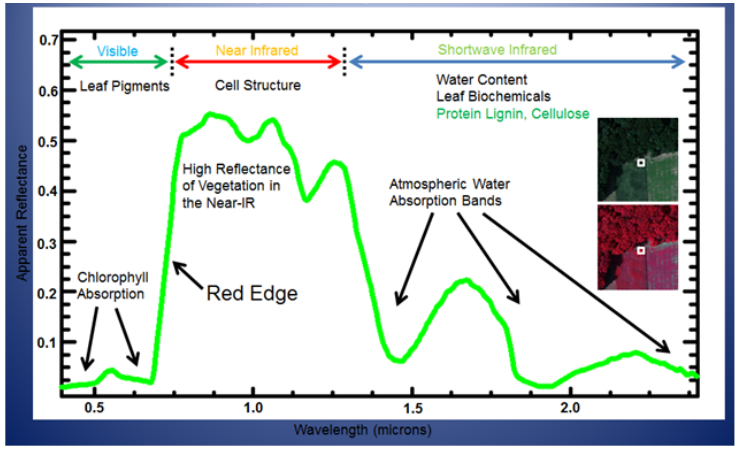
- Removing non-agricultural areas from damage maps, including:
  - Ranges
  - Residential areas
  - Sport places, etc.

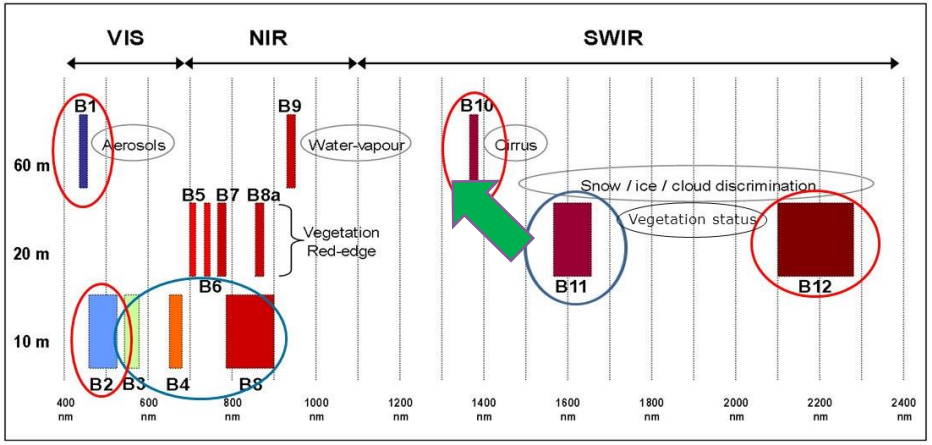


Development of Crop and Field Indexes

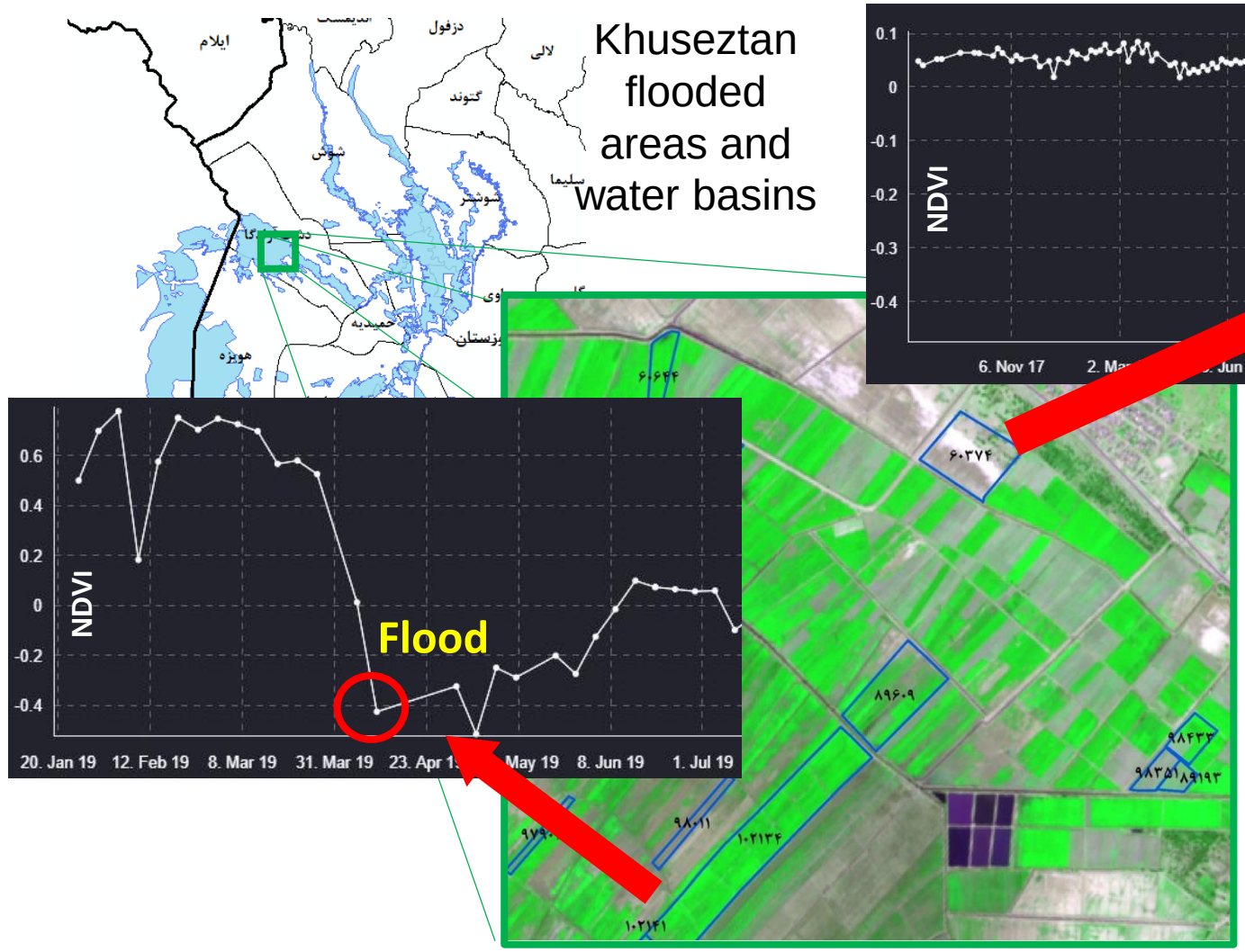


- Identification of flood-damaged and stressed fields by using different optical bands (Visible, Red-Edge, NIR and SWIR)



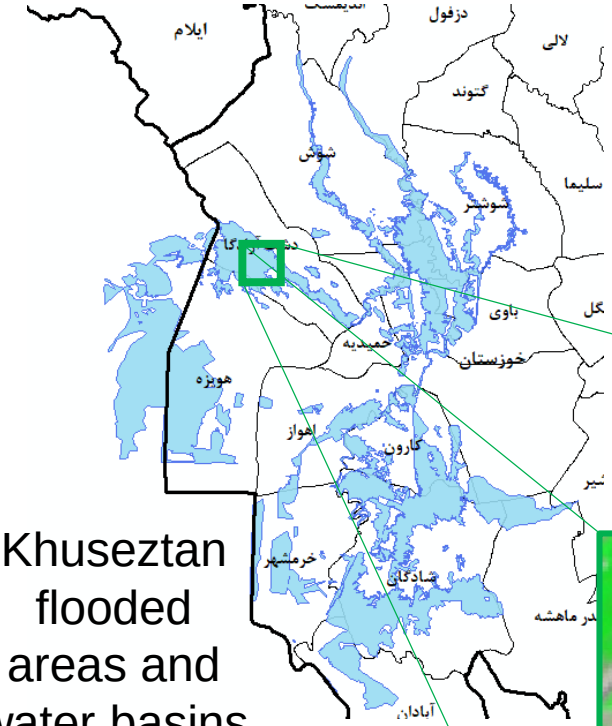


Cultivated and Non-Cultivated Fields



Satellite image of a part of Dasht-e Azadegan

Not Affected Fields

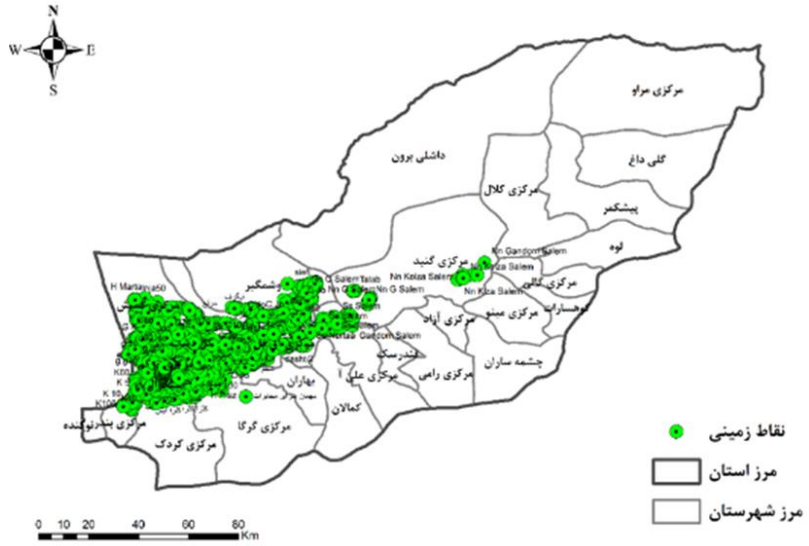


Khuseztan flooded areas and water basins

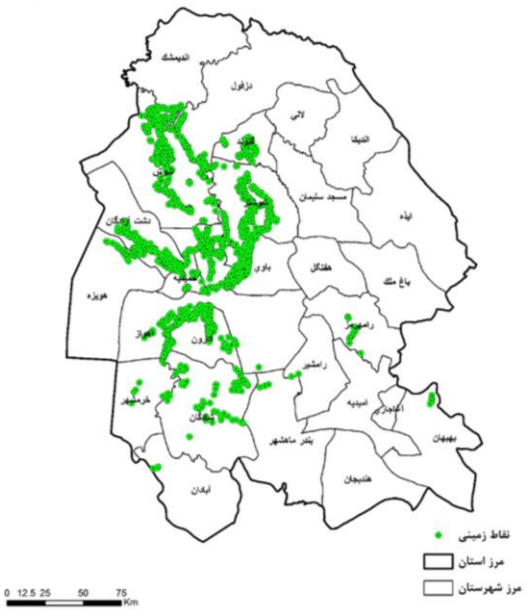
Satellite image of a part of Dasht-e Azadegan

Ground (Field) Checking

Checking more than 4000 points in Golestan Province



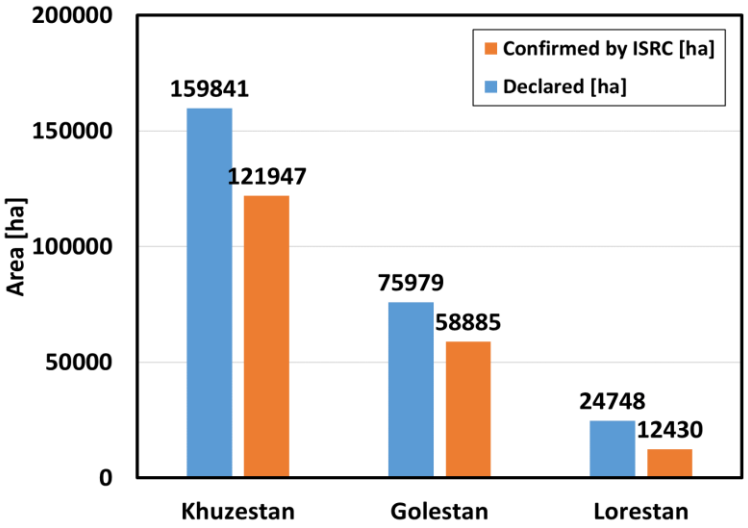
Checking more than 4300 points in Khuzestan Province



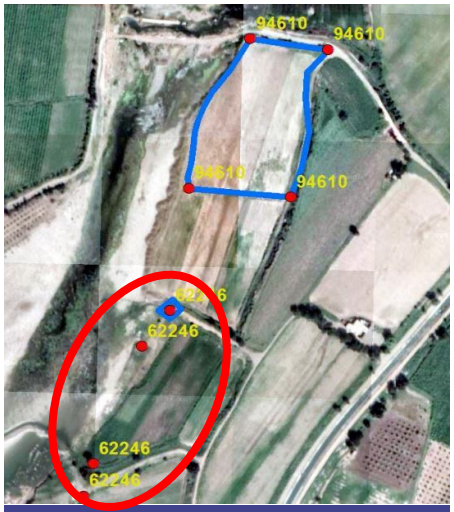
Example: Damage Assessment in Aq-qala

Crop Type / Damage percentage	Barley and Wheat		Canola		Other Crops		Not Cultivated	Sum	
	Area [ha]	[%]	Area [ha]	[%]	Area [ha]	[%]	Area [ha]	Area [ha]	[%]
High (>70%)	13624	57	364	42	1440	80	-	15429	57
Medium (40-70 %)	1289	5	46	5	21	1	-	1356	5
Low (< 40%)	1813	7	117	14	261	15	-	2192	8
No Damage	7316	31	334	38	69	4		8239	30
Sum	24042	100	862	100	1792	100	519	27215	100

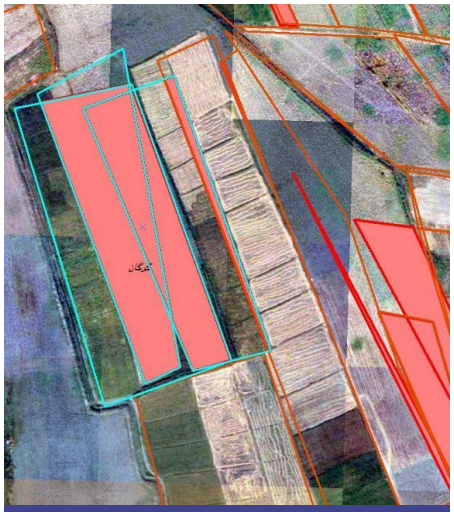
Big Difference in Damage Assessment



- Comparing the results of conventional method (**claimed by farmers** and **integrated by local authorities**) and space-based remote sensing method **(by ISRC)** showed a total difference of **67300 ha** in the damage areas in 3 provinces.

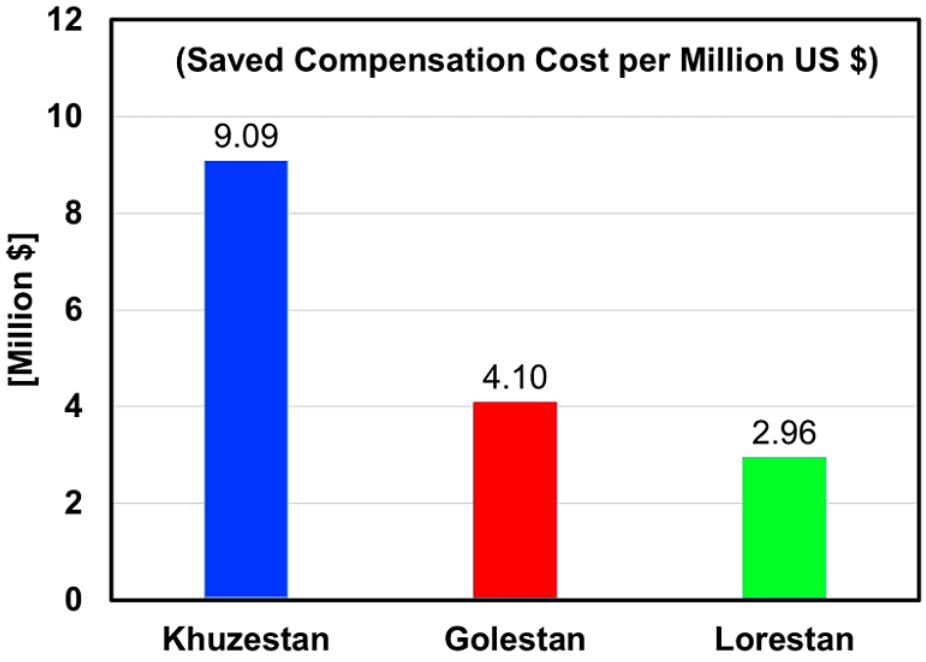


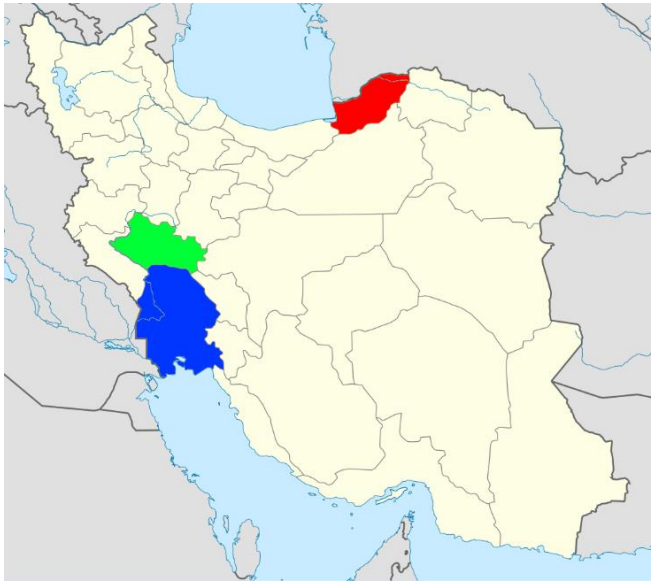
Badly Geolocated Points


Overlapped Polygons


Non-cultivated Areas

Damage Compensation Cost





- Considering (240 $/ha) of financial support for compensation of damage to cultivated fields, the value of the difference between conventional and RS method was about **16.1 million US$** .
- Therefore, the government became able to accurately pay the damage compensation cost to the farmers whose farms were really affected and damaged by the flood.

Conclusion

- ISRC used space-based remote sensing to efficiently monitor the flood and help the disaster management during and after the flood for the first time in Iran. Flood damage assessment in agriculture was carried out in all affected provinces by ISRC.
- In the three most-affected provinces, the conventional method of damage assessment showed 32% of overestimation in comparison to RS method.
- Space-based RS technology helped the government to better manage the financial resources for damage compensation in agriculture, with the value of more than 16 million US$.
- ISRC expresses its deep gratitude and appreciation to European Commission, ESA, UN-SPIDER and APSCO for sharing the images and data with other countries in emergency situations.
- We hope all the Member States, especially the space faring countries, to keep and enhance the cooperation on natural disaster management via sharing their data and experiences.

Thanks for Your Kind Attention!

Any Questions?