

Flood Mapping with the Sentinel-1 Time-Series Data in Arid Areas

Kamila Cwik

SUMMARY

OUTLINE

MOTIVATION

OBJECTIVES

METHODOLOGY

RESULTS



OUTLINE

- Motivation
- Objectives
- Methodology
- Results
- Summary



MOTIVATION

**Flood
Mapping**

**Arid
Areas**

A background image showing a person wearing a red helmet and a red life vest, sitting in a white boat on a body of water. The image is overlaid with a large, semi-transparent white circle containing text, and two smaller blue circles on the right side.

MOTIVATION

Worldwide weather related disaster statistics (1995-2015) (UNISDR, 2016):

- 43% of all weather-related catastrophes are floods

**Flood
Mapping**

**Arid
Areas**

MOTIVATION

Worldwide weather related disaster statistics (1995-2015) (UNISDR, 2016):

- 43% of all weather-related catastrophes are floods

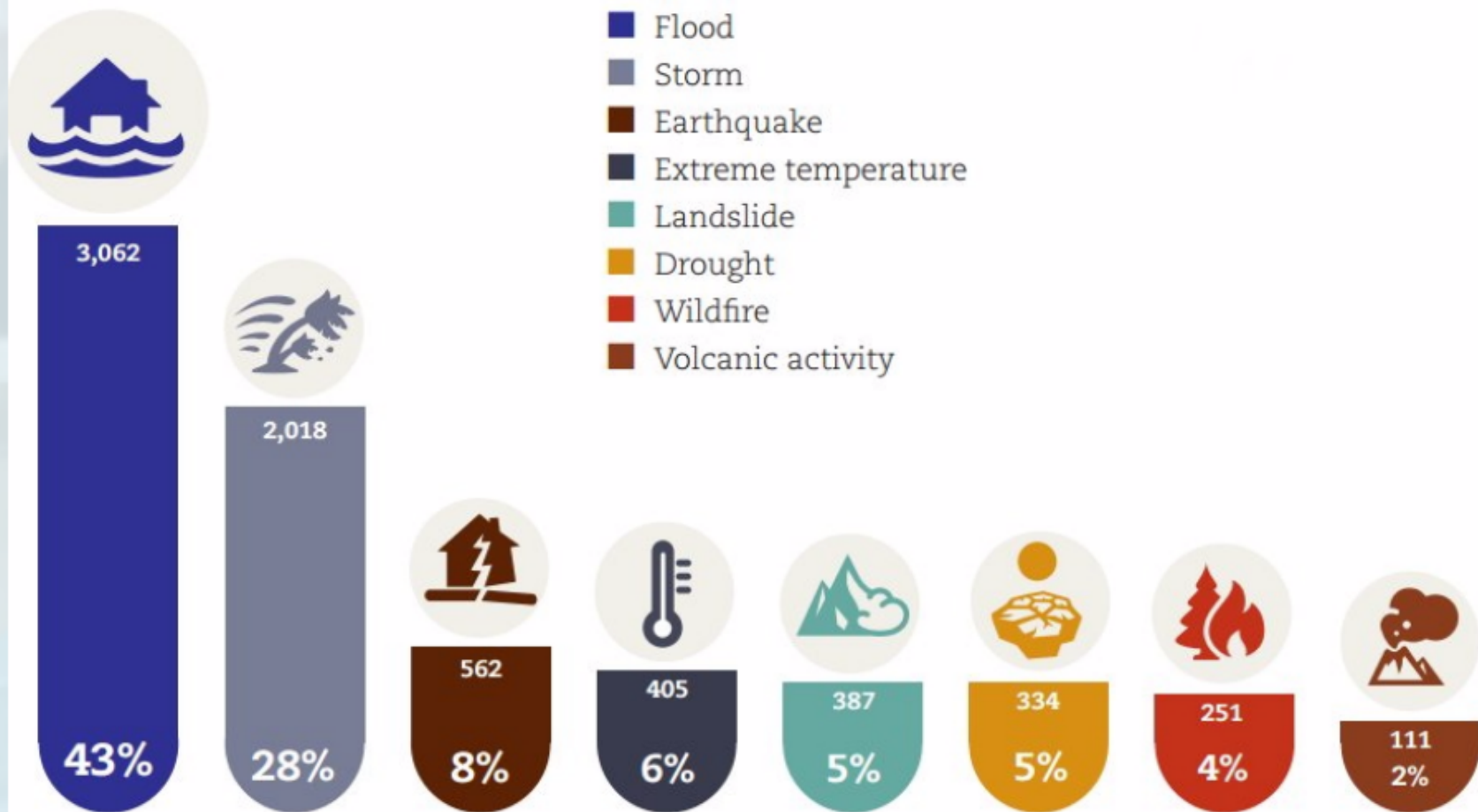


**Flood
Mapping**

**Arid
Areas**

Percentage of occurrences of natural disasters by disaster type (1995-2015)

- Flood
- Storm
- Earthquake
- Extreme temperature
- Landslide
- Drought
- Wildfire
- Volcanic activity



MOTIVATION

Worldwide weather related disaster statistics (1995-2015) (UNISDR, 2016):

- 43% of all weather-related catastrophes are floods



Flood Mapping

Arid Areas

MOTIVATION

Worldwide weather related disaster statistics (1995-2015) (UNISDR, 2016):

- 43% of all weather-related catastrophes are floods
- \$662 billion of economic damage



Flood Mapping

Arid Areas

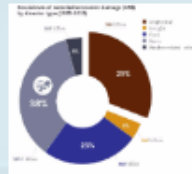
MOTIVATION

Worldwide weather related disaster statistics (1995-2015) (UNISDR, 2016):

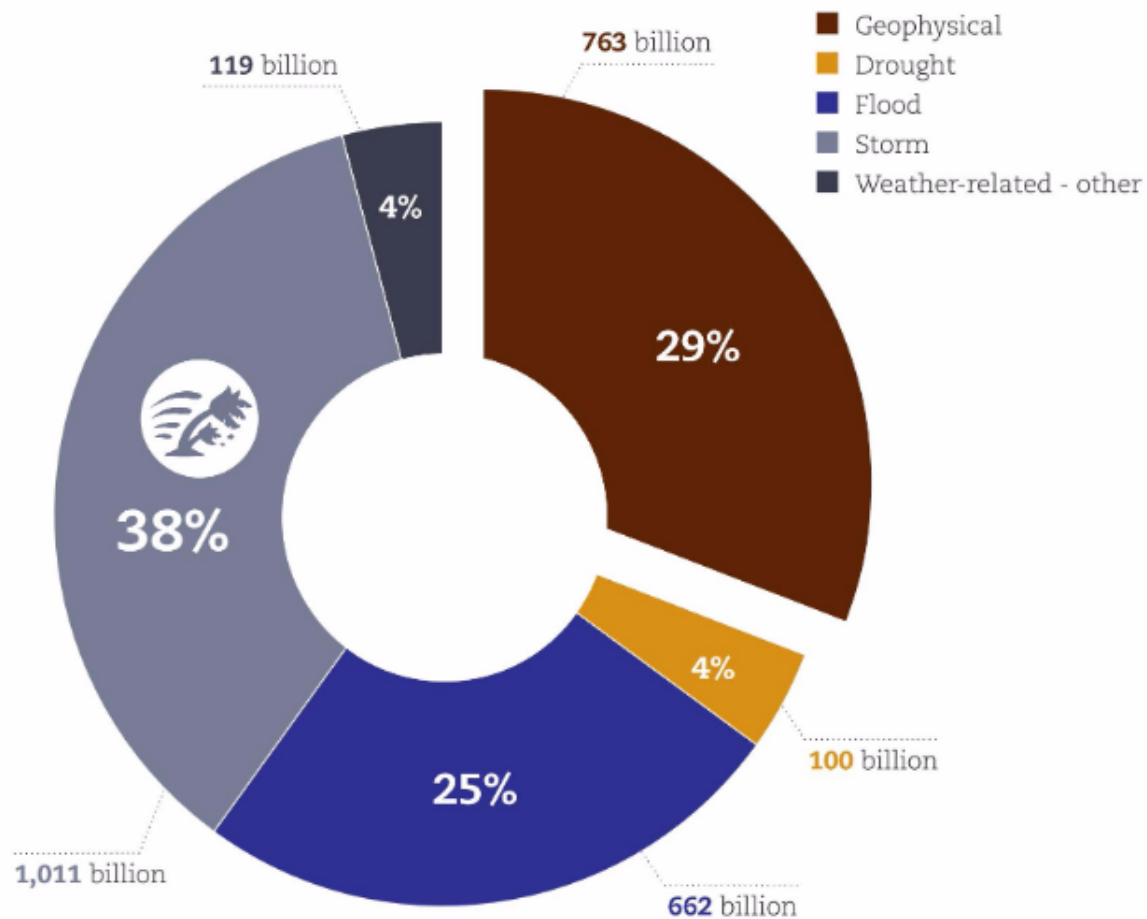
- 43% of all weather-related catastrophes are floods
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Flood Mapping

Arid Areas



Breakdown of recorded economic damage (US\$)
by disaster type (1995-2015)



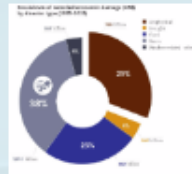
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Flood Mapping

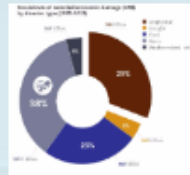
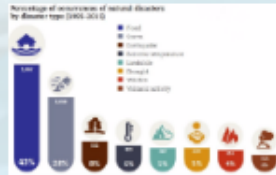
Arid Areas



MOTIVATION

Worldwide weather related disaster statistics (1995-2015) (UNISDR, 2016):

- 43% of all weather-related catastrophes are floods
- \$662 billion of economic damage
- 2.3 billion people affected by floods



Flood Mapping

Arid Areas

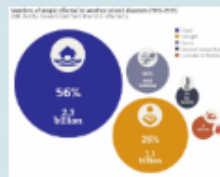
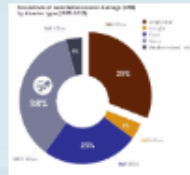
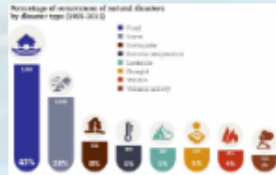
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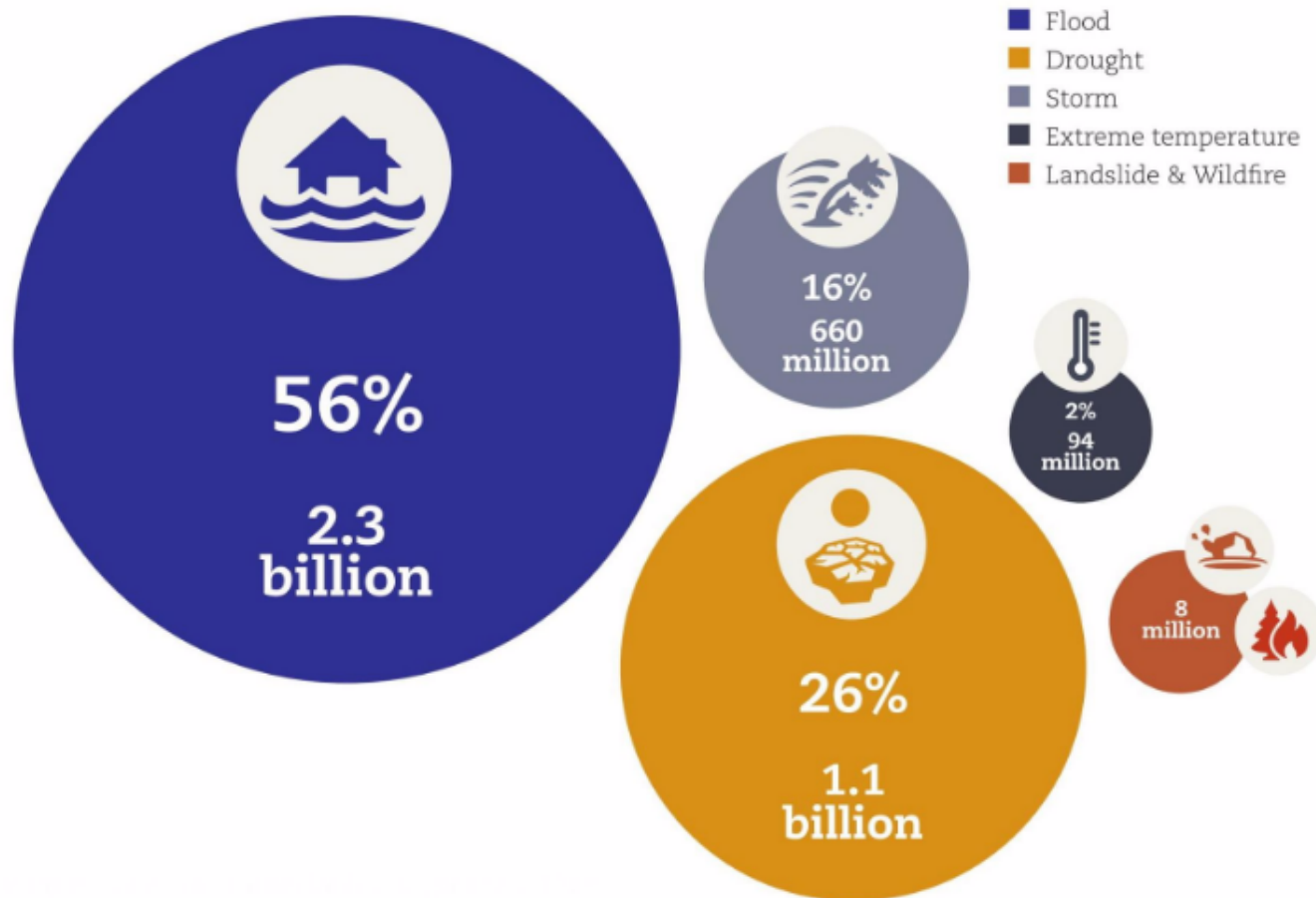
Flood Mapping

Arid Areas



Numbers of people affected by weather-related disasters (1995-2015)

(NB: deaths are excluded from the total affected.)



Flood Mapping

- First use of remote sensing for flood mapping in 1970s

Flood Mapping

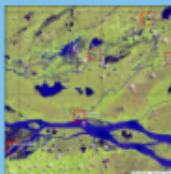
- First use of remote sensing for flood mapping in 1970s
- Crutial element of flood risk management

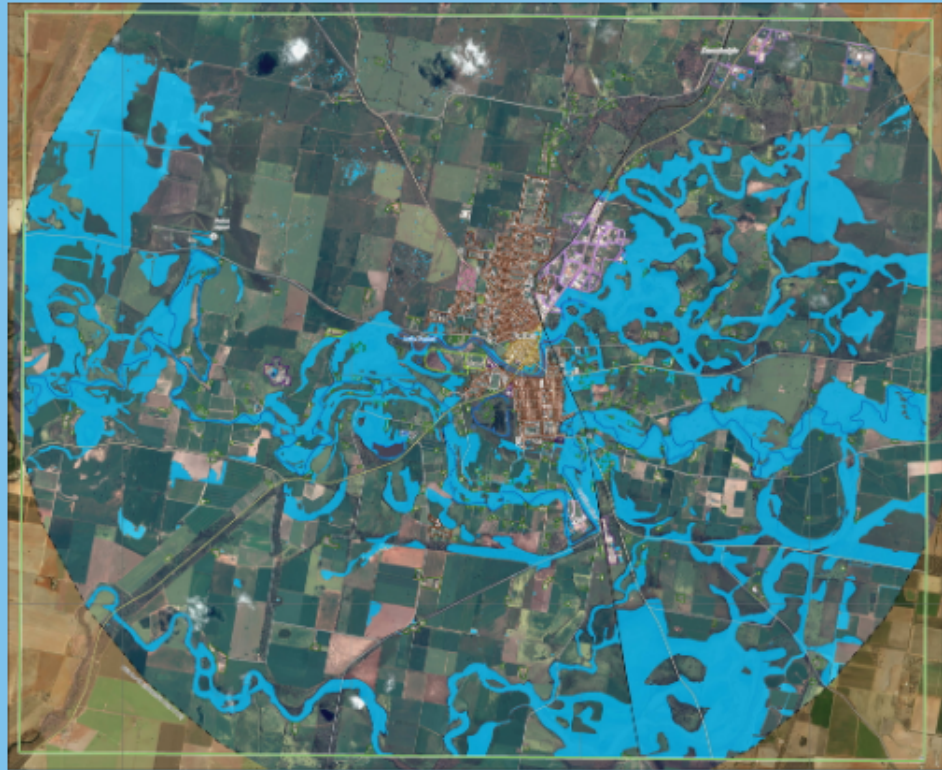
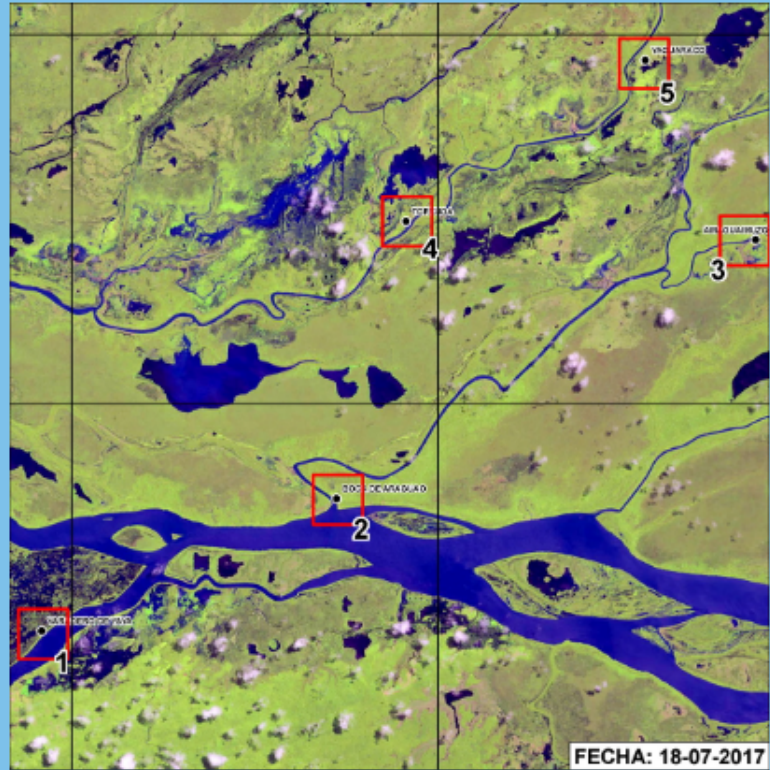
Flood Mapping

- First use of remote sensing for flood mapping in 1970s
- Crucial element of flood risk management
- Important source of information for supporting disaster management authorities, decision makers, and humanitarian relief organizations

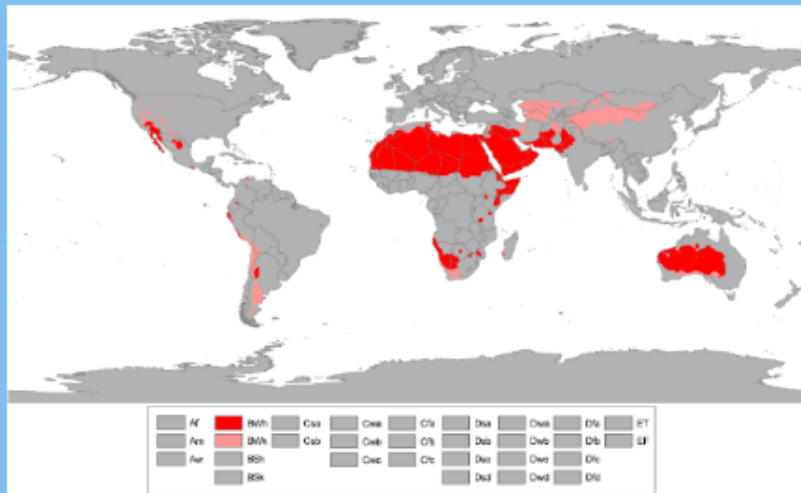
Flood Mapping

- First use of remote sensing for flood mapping in 1970s
- Crucial element of flood risk management
- Important source of information for supporting disaster management authorities, decision makers, and humanitarian relief organizations





Arid Areas





OBJECTIVES

- Investigation of time-series-based method for improvement of flood mapping

**Research
Question 1**

**Research
Question 2**

**Research
Question 3**

OBJECTIVES

- Investigation of time-series-based method for improvement of flood mapping
- Testing influence of time-series duration

**Research
Question 1**

**Research
Question 2**

**Research
Question 3**

OBJECTIVES

- Investigation of time-series-based method for improvement of flood mapping
- Testing influence of time-series duration
- Assessment of statistical parameters of time-series data

**Research
Question 1**

**Research
Question 2**

**Research
Question 3**

Research Question 1

Does the use of the Sentinel-1 time-series data improve flood mapping in arid areas in comparison to existing approach from Sentinel-1 Flood Service?

Research Question 2

What is the influence of
time-series parameters on
classification accuracy?

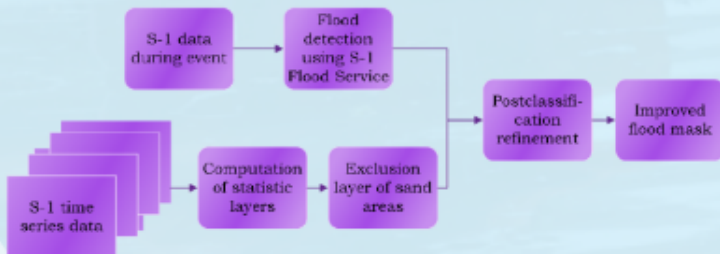
Research Question 3

What are the uncertainties and limitations of this approach?

METHODOLOGY

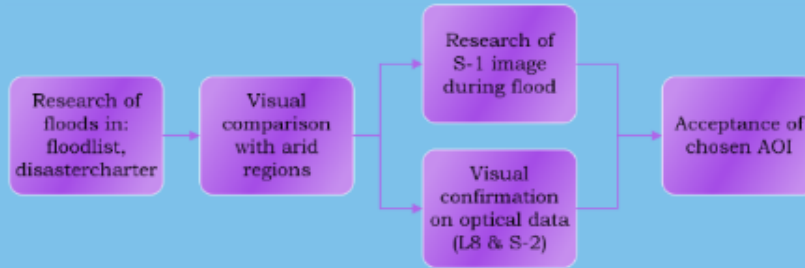


First Stage



Second Stage

First Stage



Research of
floods in:
floodlist,
disastercharter

Visual
comparison
with arid
regions

during flood

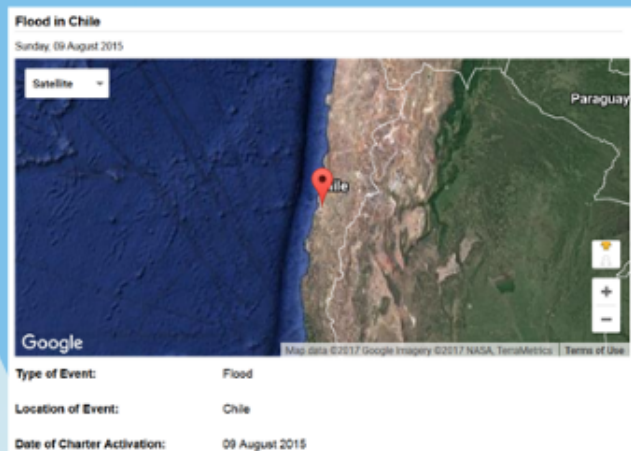
Visual
confirmati
on optical d
(L8 & S-2

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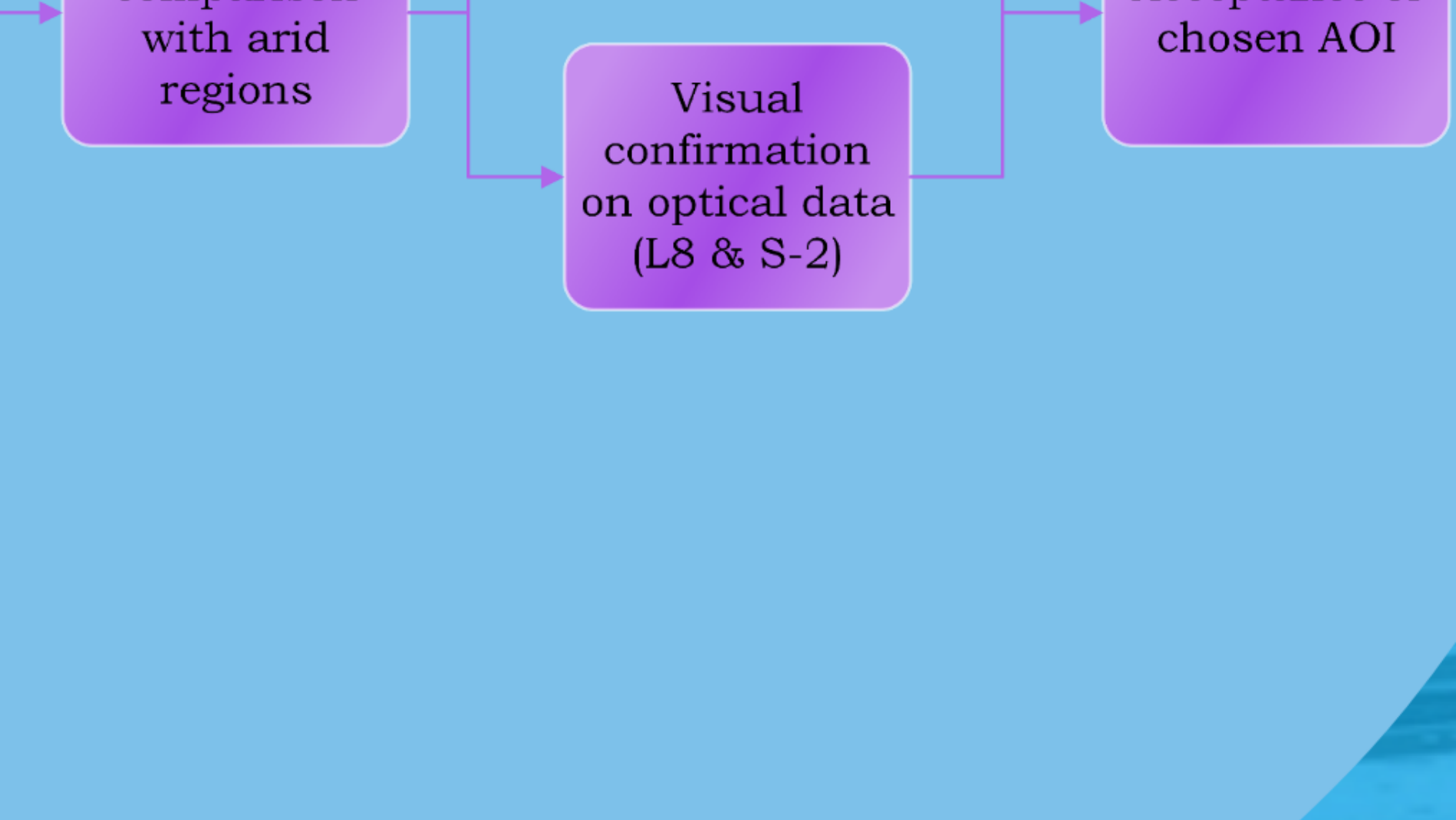


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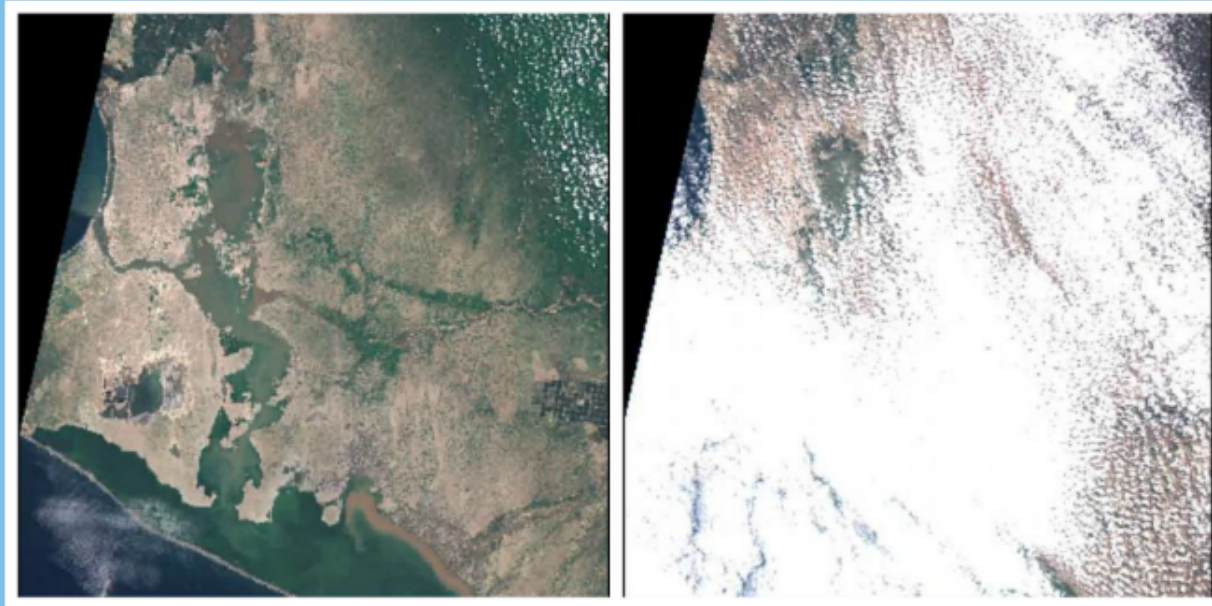
Visual
confirmation
on optical data
(L8 & S-2)

chosen AOI

with arid
regions

Visual
confirmation
on optical data
(L8 & S-2)

chosen AOI



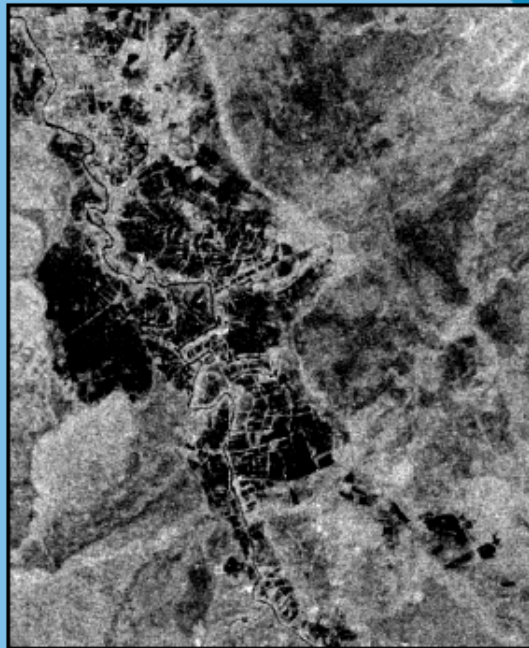
```
graph LR; A[Research of S-1 image during flood] --> C[Acceptance of chosen AOI]; B[Visual confirmation] --> C;
```

Research of
S-1 image
during flood

Visual
confirmation

Acceptance of
chosen AOI

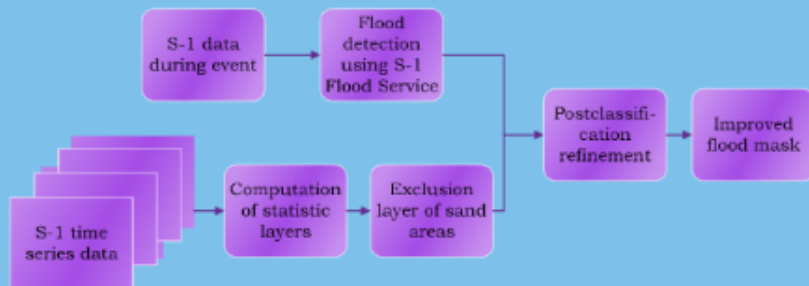
Research of
S-1 image
during flood



Acceptance of
chosen AOI

Visual
confirmation

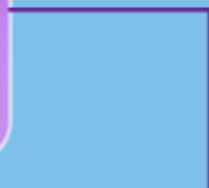
Second Stage

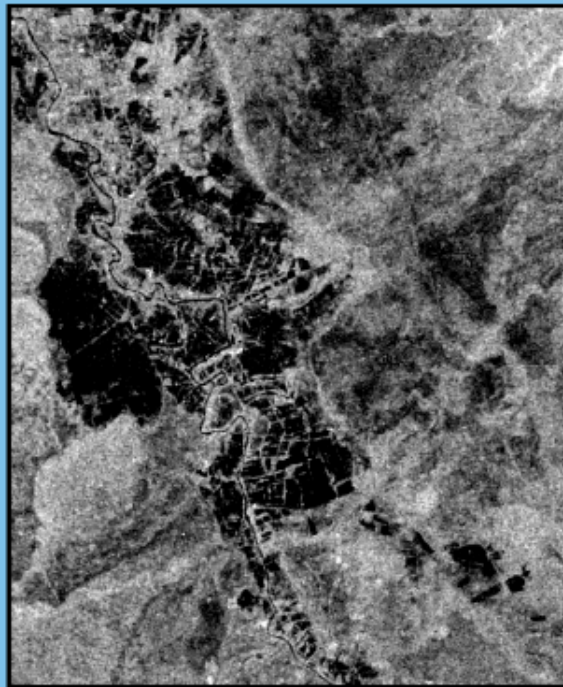


S-1 data
during event



Flood
detection
using S-1
Flood Service



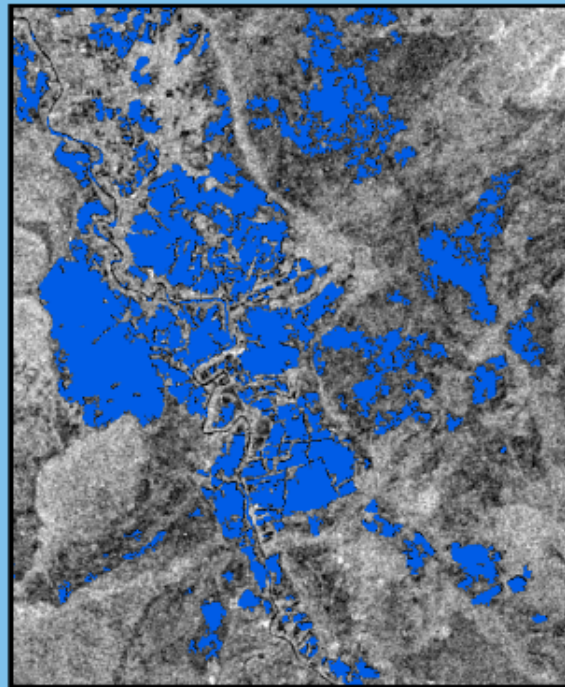
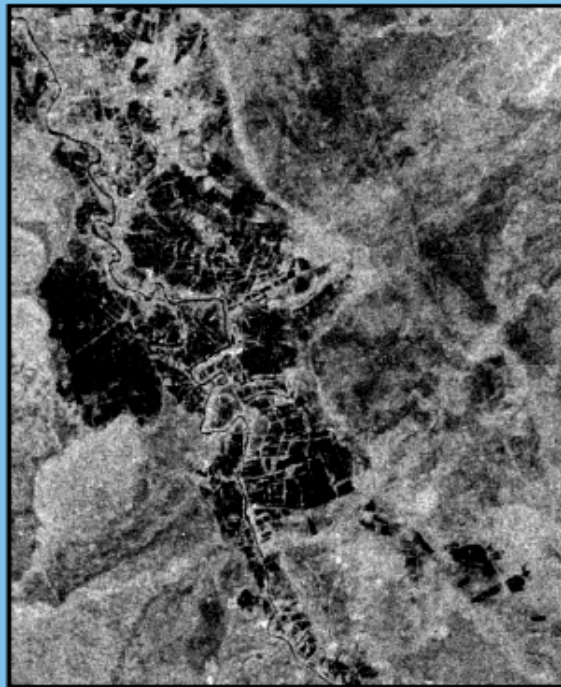


S-1 data
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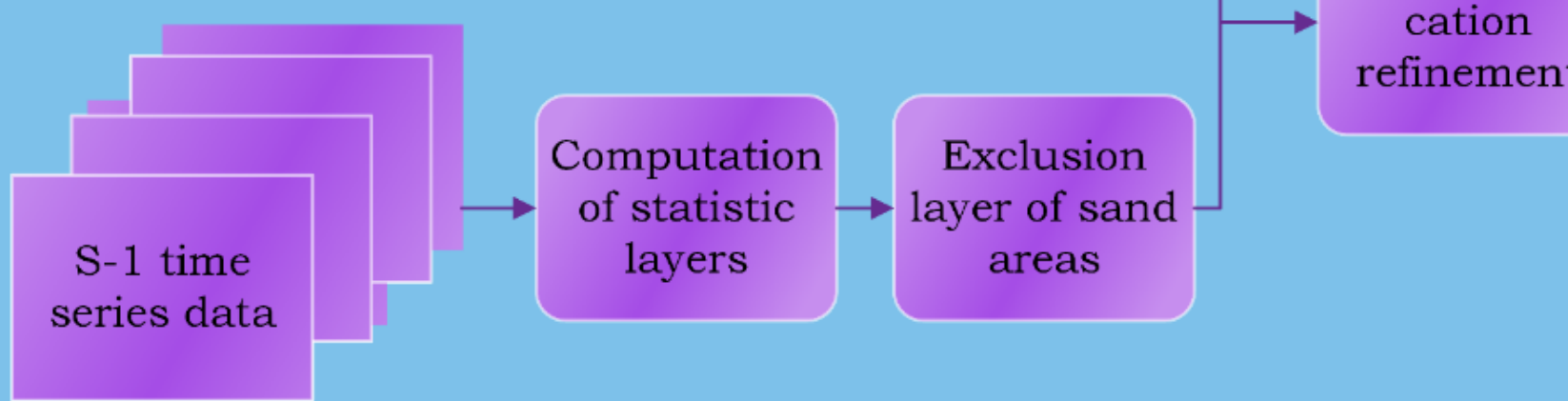
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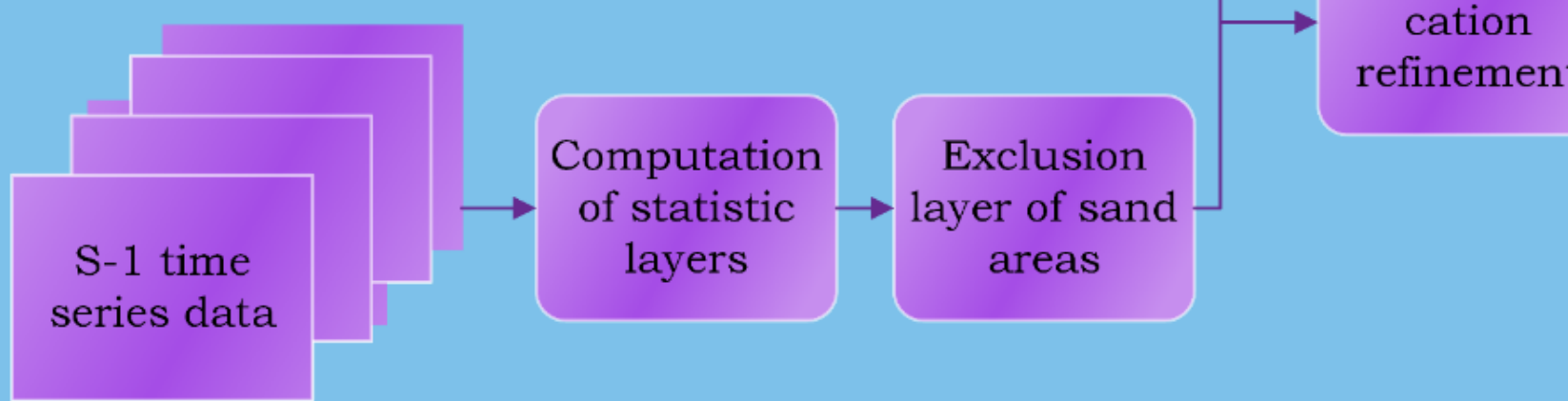




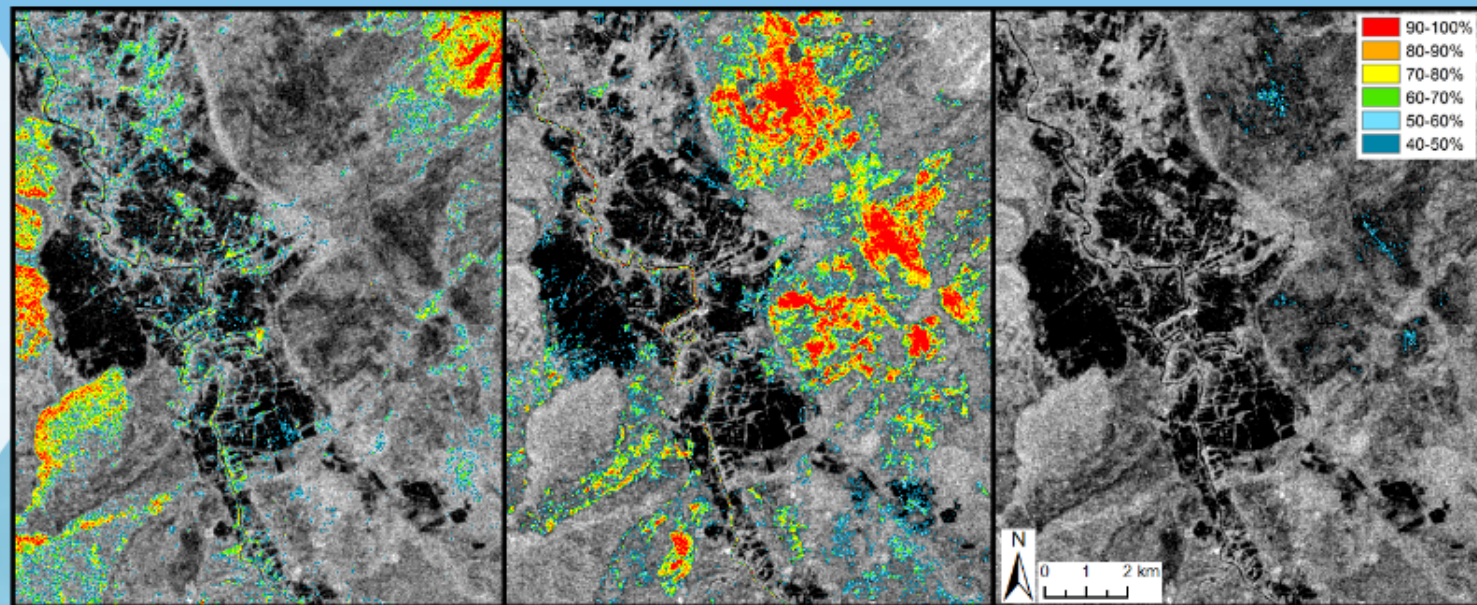
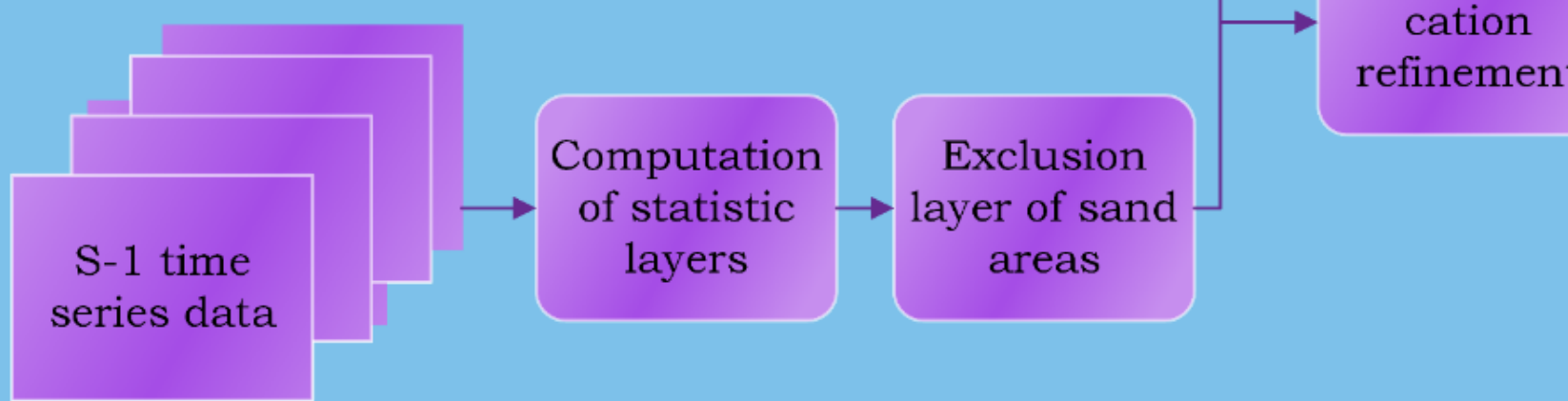
S-1 data
during event

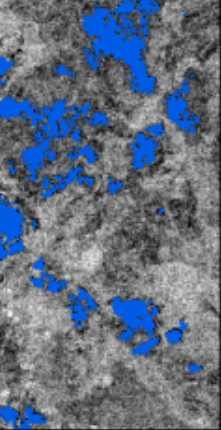
Flood
detection
using S-1
Flood Service





- Download all Sentinel-1 images
- Geometric correction & radiometric calibration
- Calculation of statistical parameters
- Merging of statistics into maps



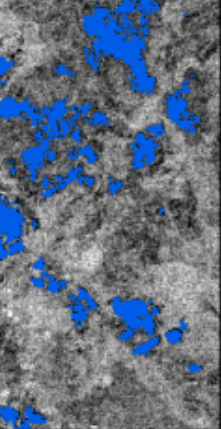


and
ion
S-1
ervice

Exclusion

Postclassifi-
cation
refinement

Improved
flood mask



Classification
S-1
Service

Exclusion

Result (x - 100%)		Reference Data		Row total
		Flood	Non Flood	
Classification Data	Flood	f/f	nf/f	UA1 = f/f + nf/f
	Non Flood	f/nf	nf/nf	UA2 = f/nf + nf/nf
Column total		PA1 = f/f + f/nf	PA2 = nf/f + nf/nf	SUM = PA1 + PA2

Postclassifi-
cation
refinement

Improved
flood mask

RESULTS

Somalia
May, 2016



Iraq
November, 2015



Somalia

Iraq

Somalia

May, 2016



Iraq

November, 2015



Somalia

- Tests with time-series periods:
 - 2014-2017
 - 2015
 - 2016
- Tests with MODIS

2014-2017

2015

2016

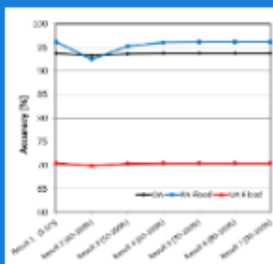
MODIS

Summary

2014-2017

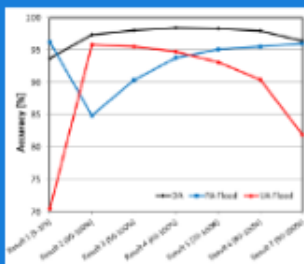
200 images

-10 dB



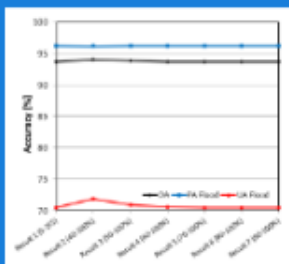
Overall Accuracy - sum of correctly classified pixels from each class divided by number of all pixels

-15 dB



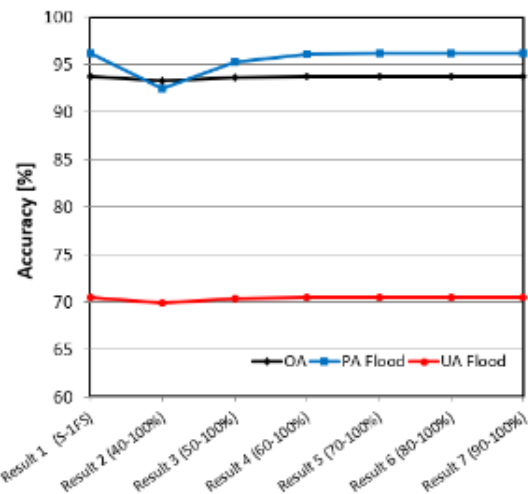
Producer's Accuracy - ratio of number of pixels which are correctly classified as flood to the total number of pixels which truly are flood in reference data

-20 dB



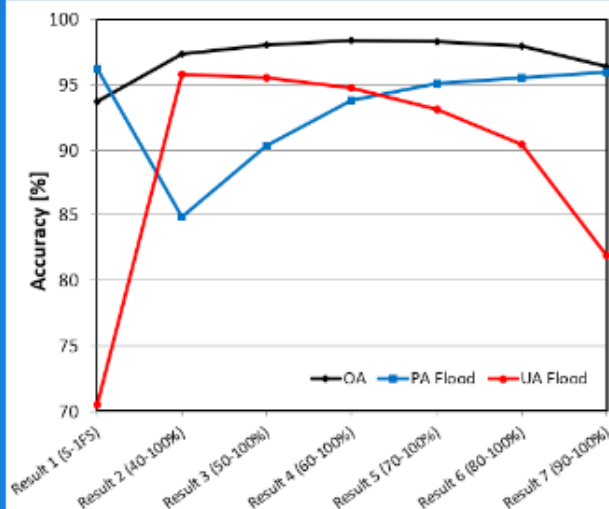
User's Accuracy - ratio of number of pixels which are correctly classified as flood to the total number of pixels classified as flood

-10 dB



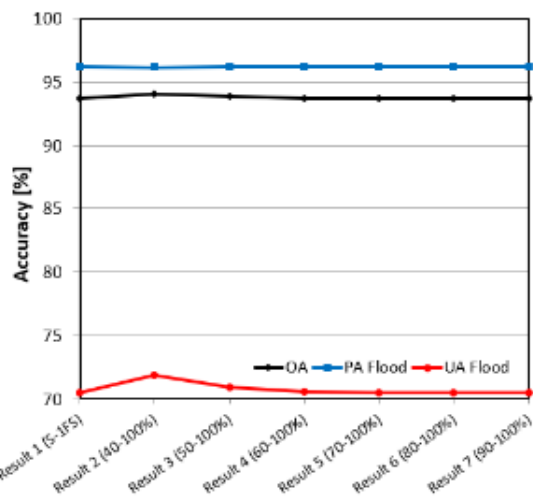
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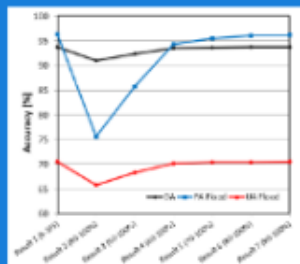


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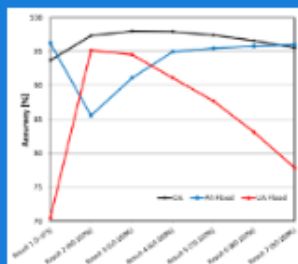
2015

55 images

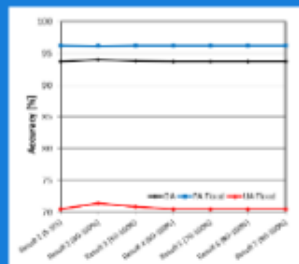
-10 dB



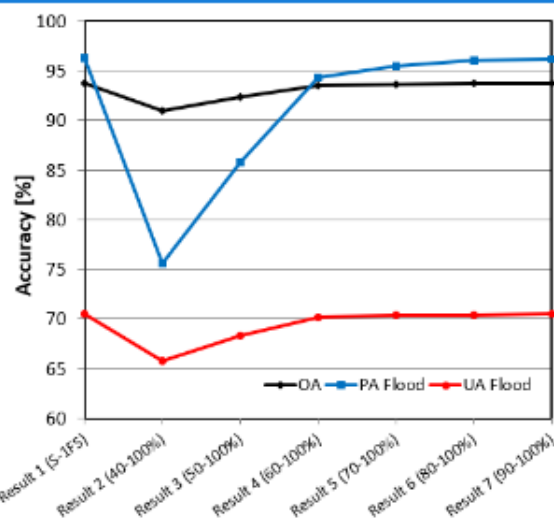
-15 dB



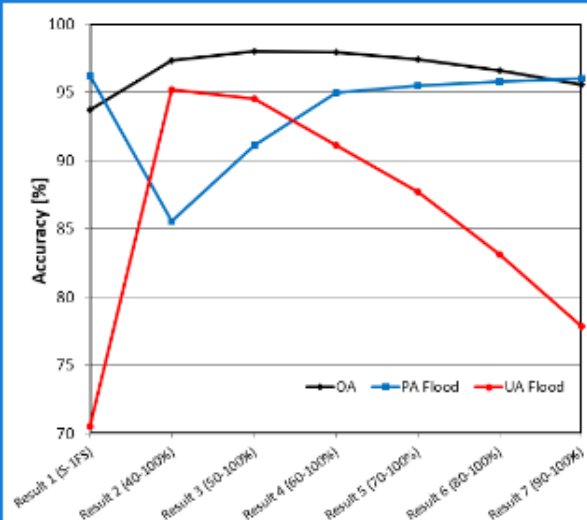
-20 dB



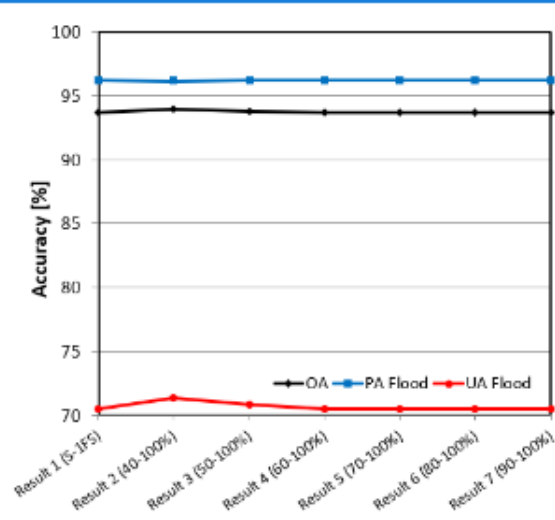
-10 dB



-15 dB



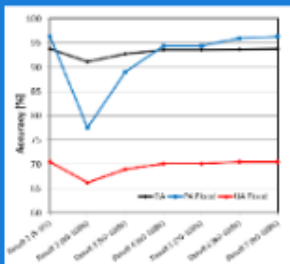
-20 dB



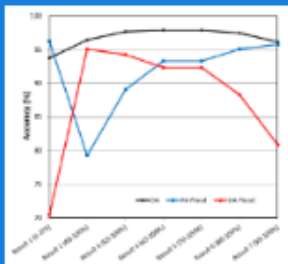
2016

64 images

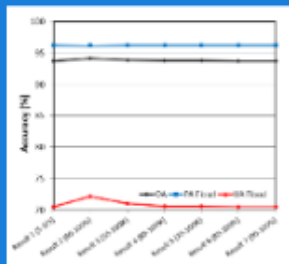
-10 dB



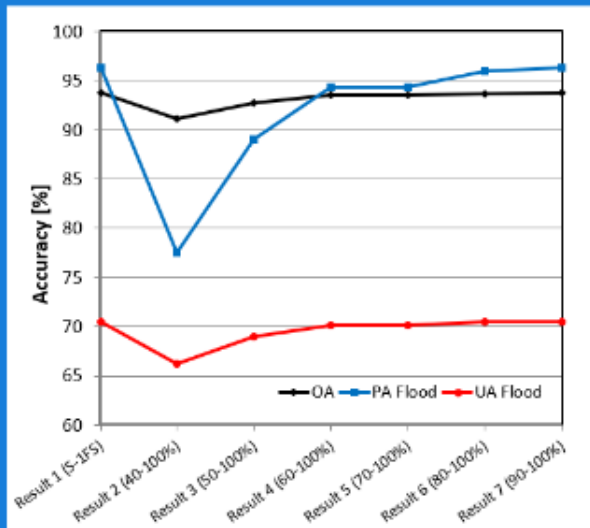
-15 dB



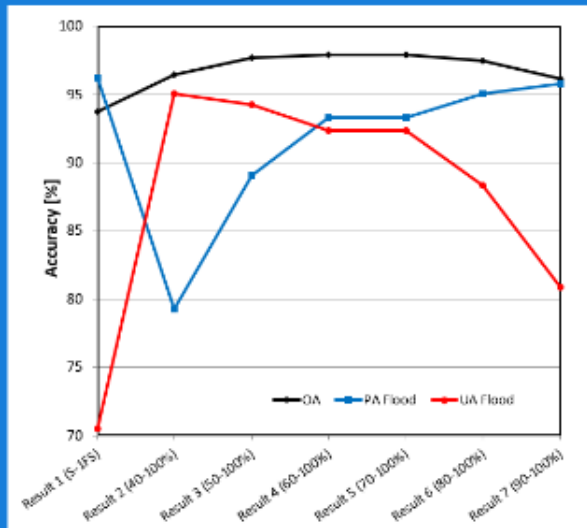
-20 dB



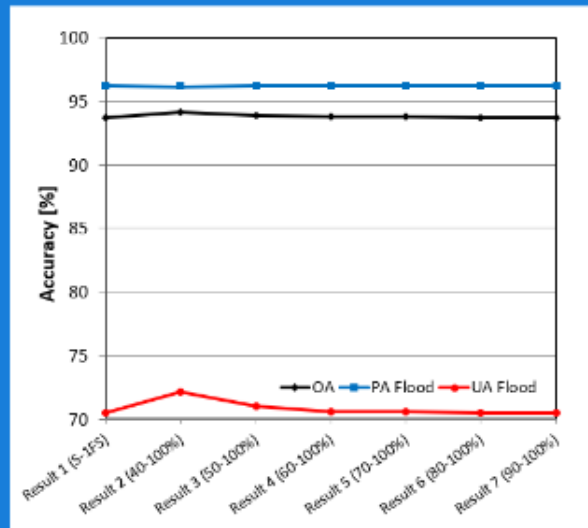
-10 dB



-15 dB

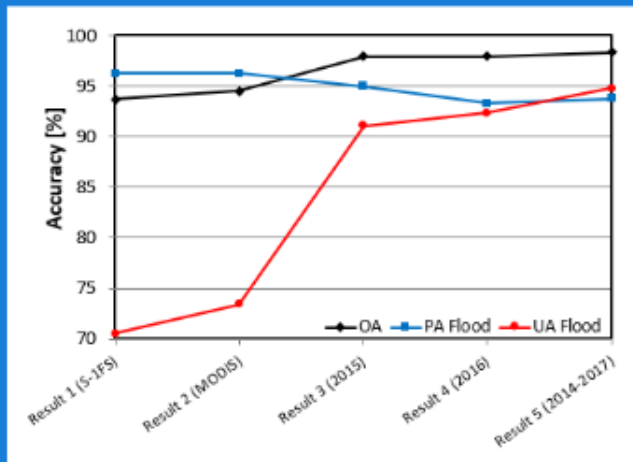


-20 dB



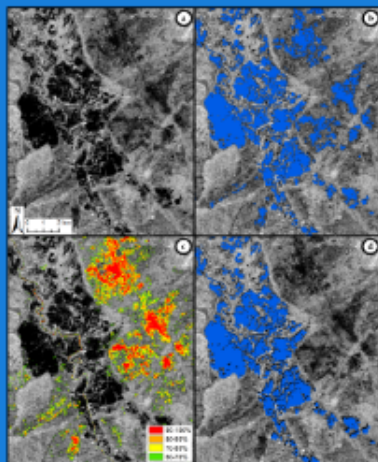
MODIS

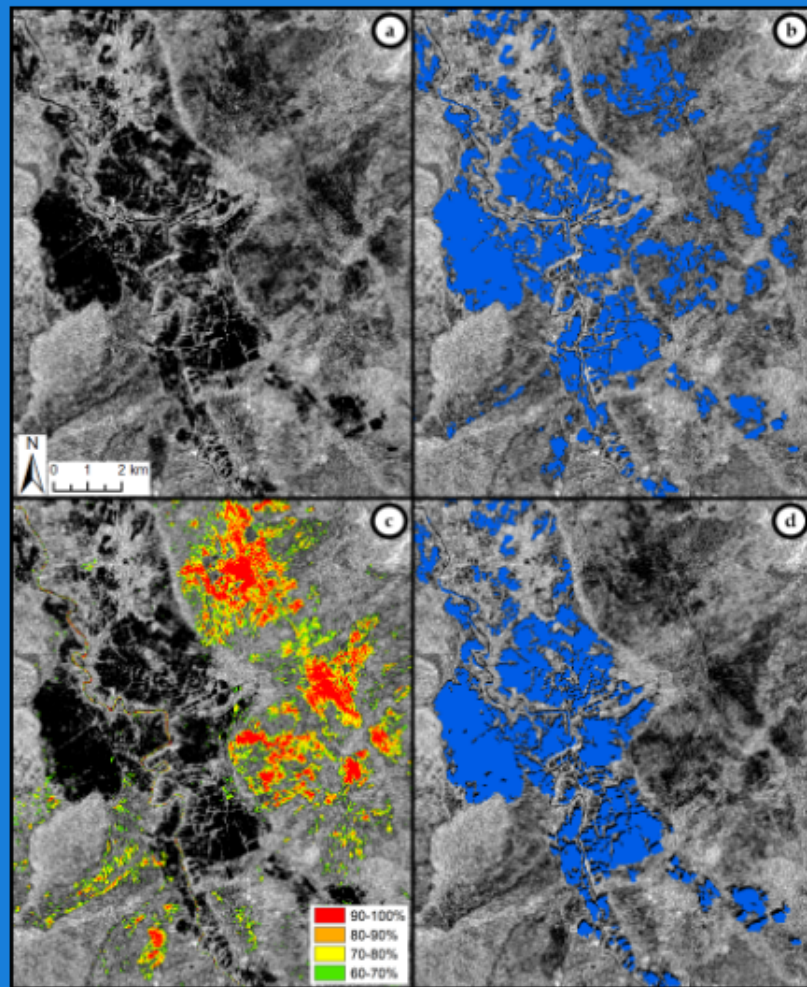
- Three-years time series obtains the highest accuracy
- Time Series with higher accuracy than MODIS

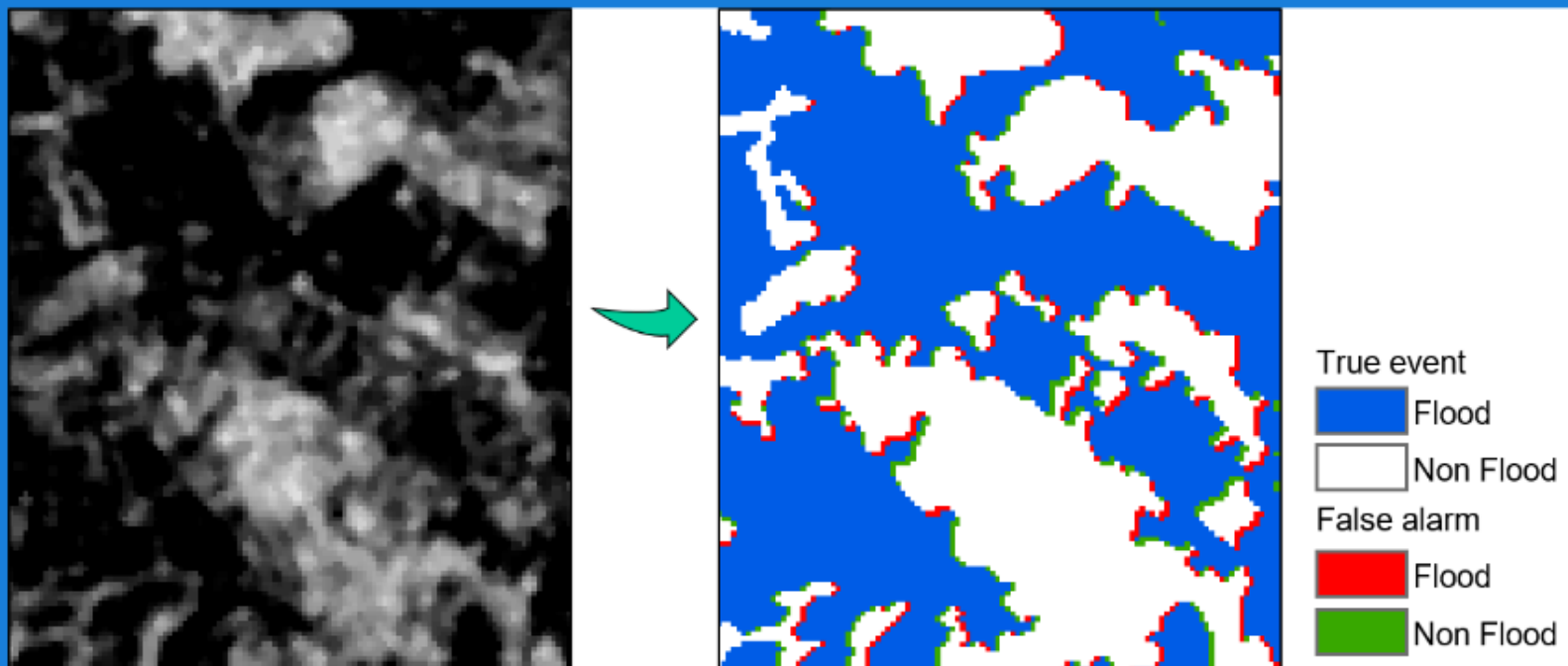


Summary

- -15 dB generate the highest accuracy
- The best results with frequency range 60-100%



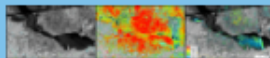
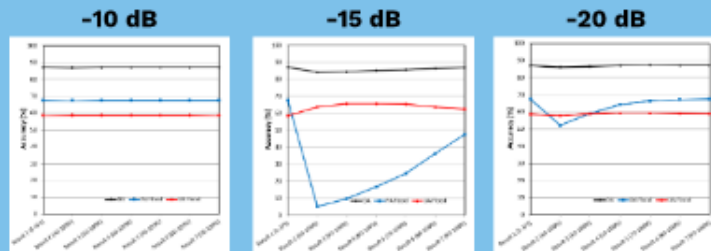




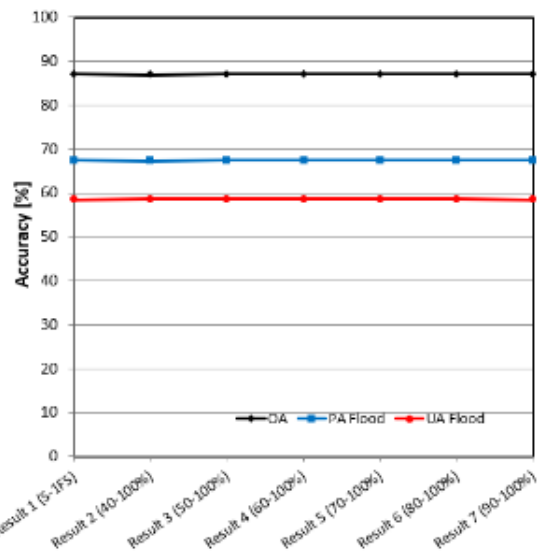
Iraq

- 2016
- 79 images
- Performed to test limitation of approach

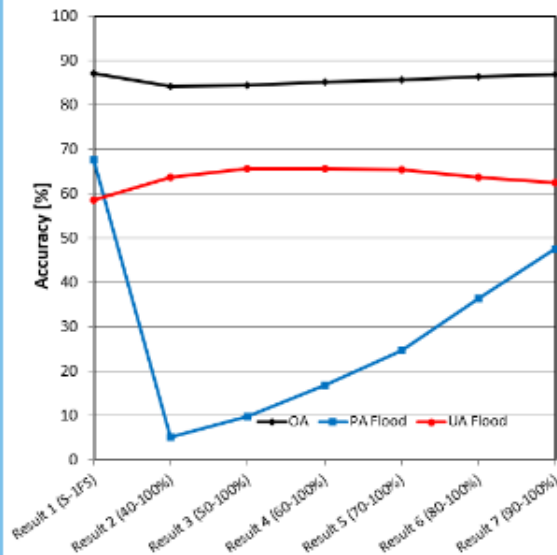
Summary



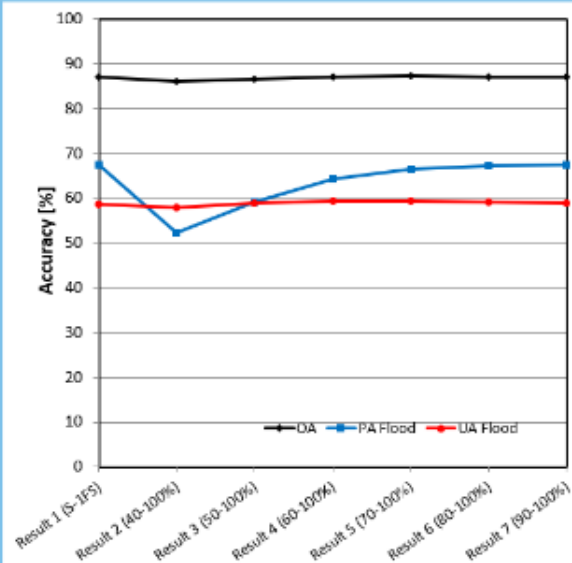
-10 dB

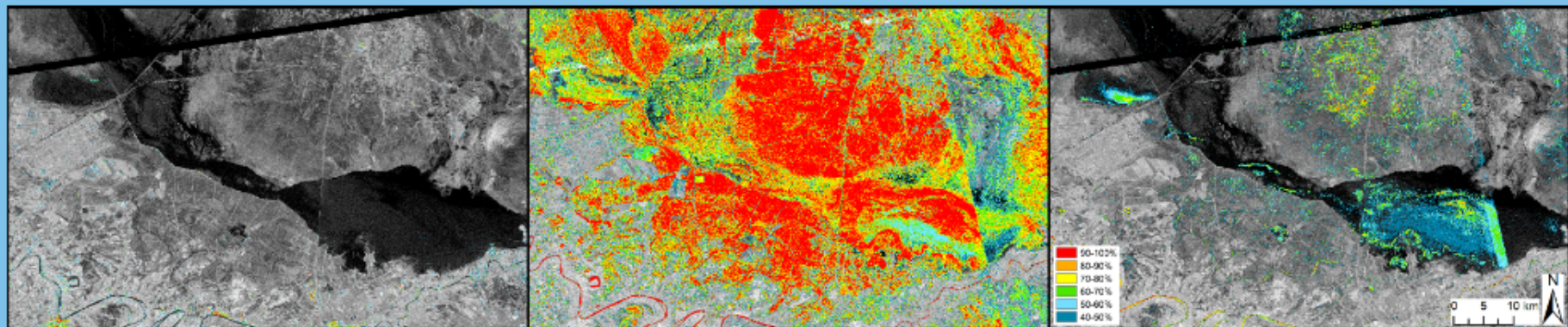


-15 dB



-20 dB





Summary

- -20 dB improves less than 1%
- Floods on sandy regions not detectable



Summary

- -20 dB improves less than 1%
- Floods on sandy regions not detectable



SUMMARY

- Successful creation of exclusion layers

**Future
Research**

Sources

SUMMARY

- Successful creation of exclusion layers
- Improvement of flood mapping using time-series data

**Future
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Sources

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- Successful creation of exclusion layers
- Improvement of flood mapping using time-series data
- Better accuracy with three-years than a one-year period

**Future
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- Successful creation of exclusion layers
- Improvement of flood mapping using time-series data
- Better accuracy with three-years than a one-year period
- Better results than with MODIS

**Future
Research**

Sources

SUMMARY

- Successful creation of exclusion layers
- Improvement of flood mapping using time-series data
- Better accuracy with three-years than a one-year period
- Better results than with MODIS
- Iraq case confirms limitations of the method

**Future
Research**

Sources

Future Research

- Additional experiments with the method

Future Research

- Additional experiments with the method
- World-wide exclusion layers for near-real-time flood mapping

Future Research

- Additional experiments with the method
- World-wide exclusion layers for near-real-time flood mapping
- Further tests on different AOI

Sources

Motivation:

- UNISDR, CRED (2016). Poverty & death: Disaster Mortality 1996-2015. Retrieved [17.08.2017] from <http://www.preventionweb.net/publications/list/#hits=20&sortby=default&view=pw&filter=unisdrcontenttype%3A%5E%22Documents+%26+Publications%22%24%0D%0Ahazards%3A%5E%22Flood%22%24>

Flood Mapping:

- <https://disasterscharter.org/web/guest/-/flood-in-venezuela-bolivarian-republic-of-call-619->
- <https://disasterscharter.org/web/guest/-/flood-in-austral-2>

Arid Areas:

- Peel, M. C., Finlayson, B. L., and McMahon, T. A. (2011). Updated world map of the Köppen-Geiger climate classification. Desert climate (BWh, BWk). Retrieved [11.06.2017] from https://en.wikipedia.org/wiki/Desert_climate.

First Stage:

- <https://disasterscharter.org/web/guest/-/flood-in-chi-5>
- <http://unesdoc.unesco.org/images/0021/002163/216333s.pdf>
- <https://earthexplorer.usgs.gov/>
- <https://scihub.copernicus.eu/>

Results:

- Google Earth

Iraq:

- Google Earth
- <https://scihub.copernicus.eu/>

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