Near Real-Time and Historic MODIS Flood Detection and Impact Assessment Systems for Southeast Asia

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Disasters Working Group
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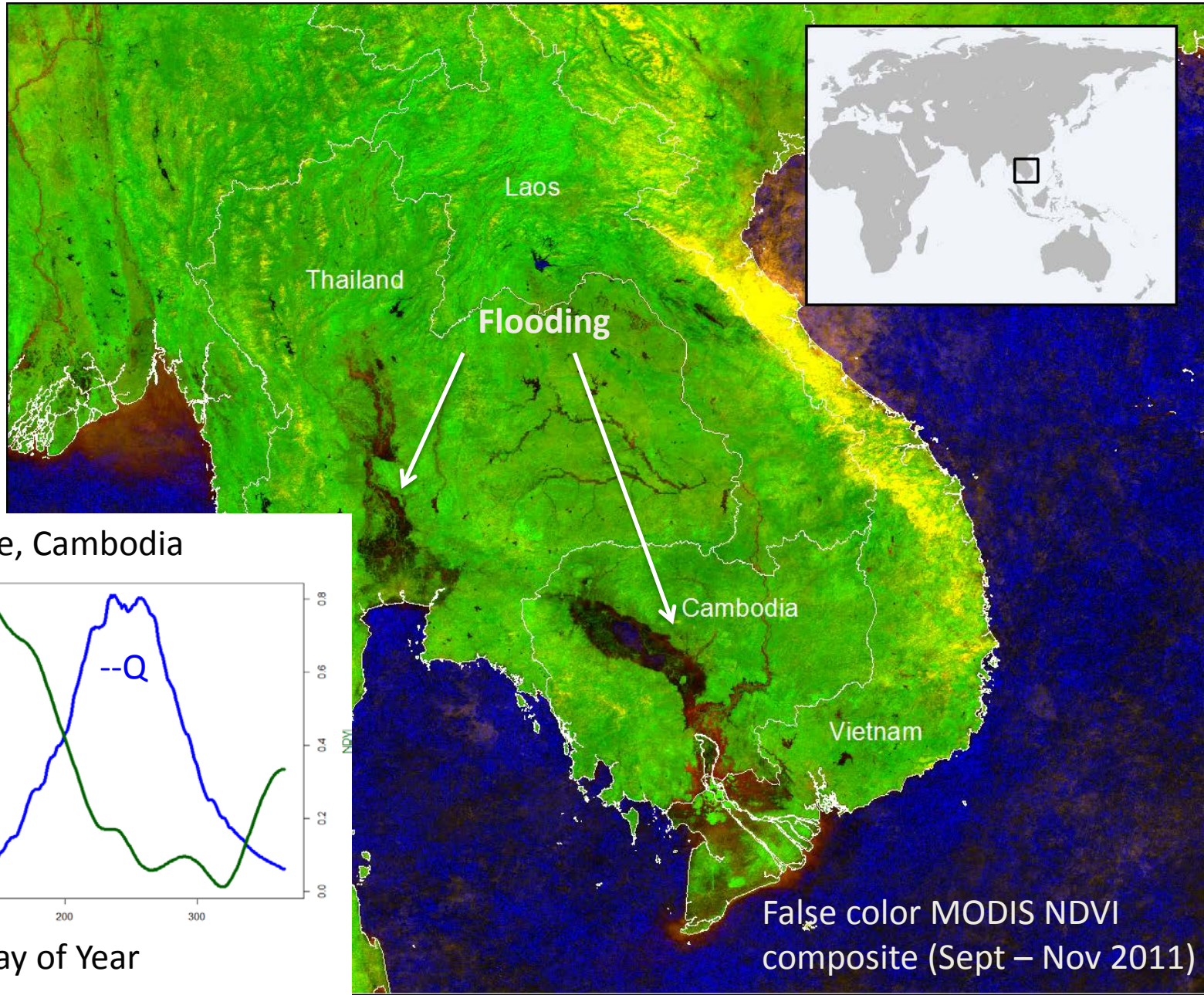
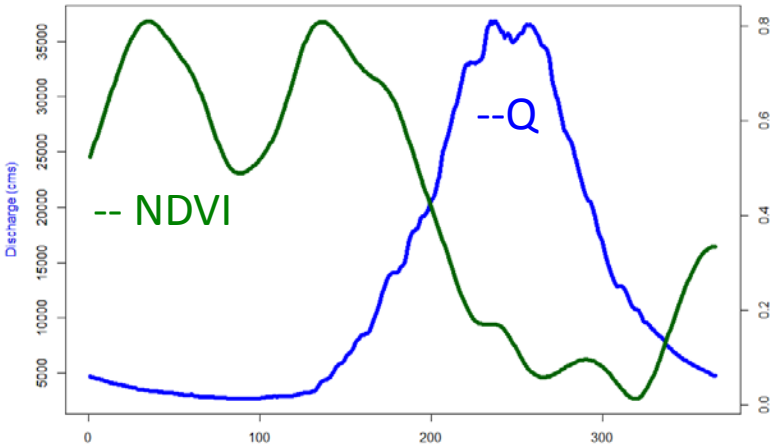
NASA GSFC

Identifying 2011 Floods



Kratie, Cambodia

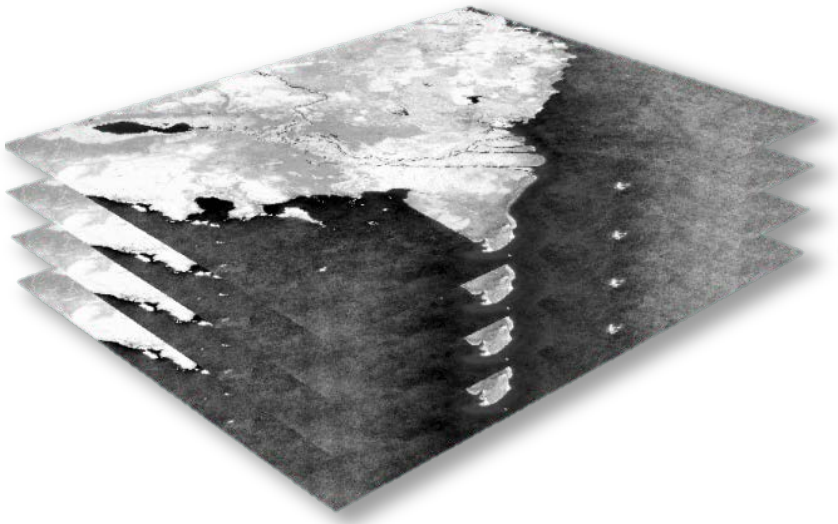


Day of Year

Near Real-Time Flood Detection

Annual Average January **NDVI** Composite (2003 – 2011)

Courtesy Joe Spruce (MSFC)



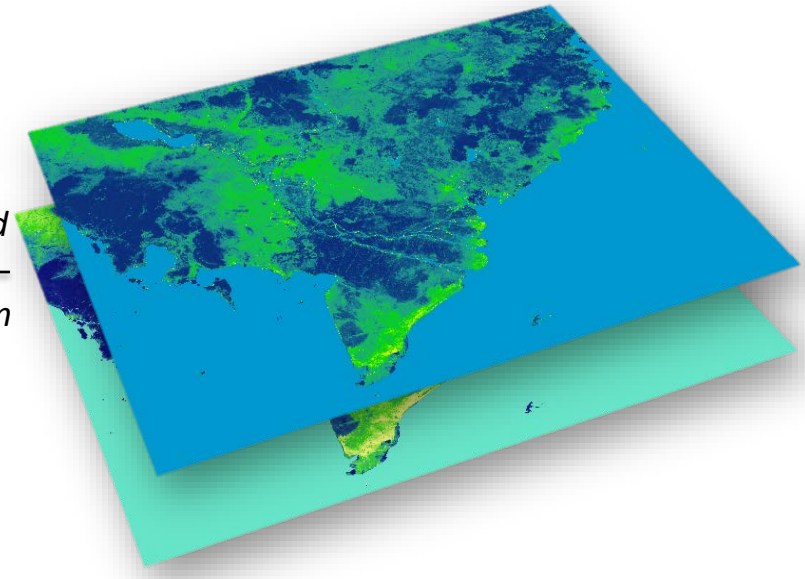
"Baseline" MODIS NDVI

Near Real-Time **NDVI**

LANCE-MODIS MOD/MYD09GQ

Cloud/Shadow Identification: MOD/MYD09GQ 1km bit fields

Automated comparison

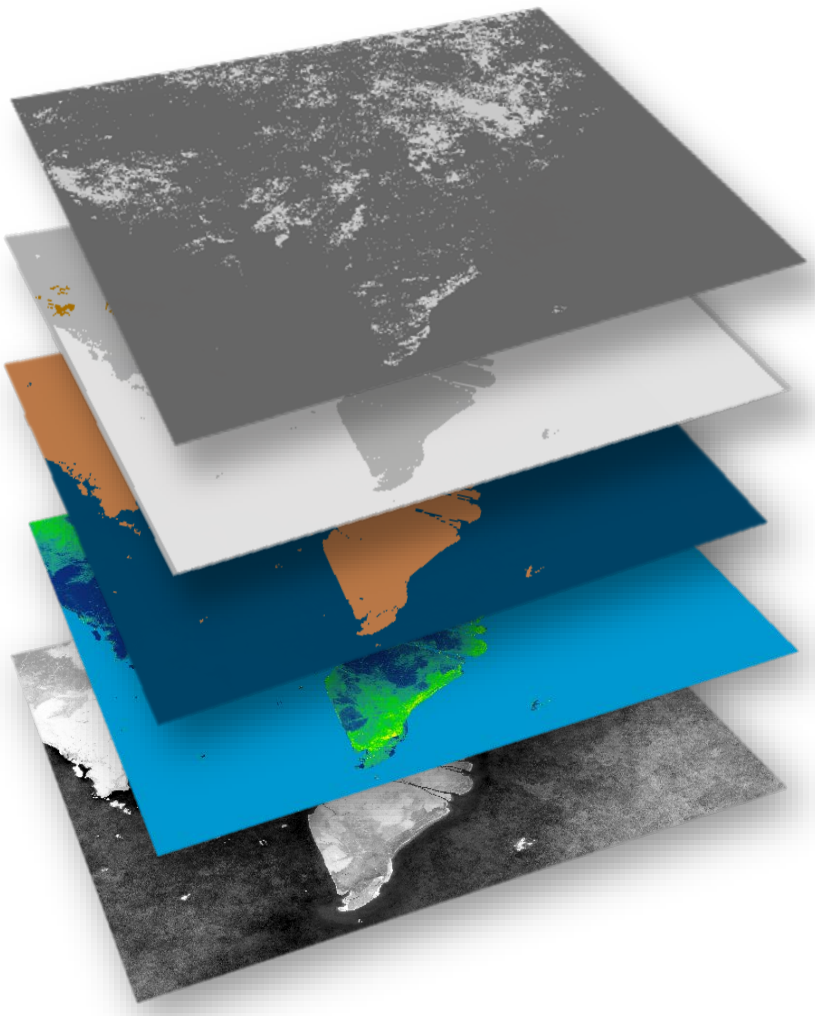


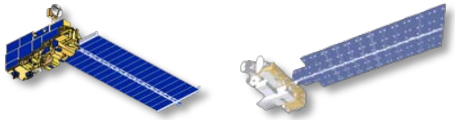
Daily, 4-day, 8-day Composites

$$\Delta NDVI = \left(\frac{\mathrm{NDVI}_{\mathrm{Flood}} - \mathrm{NDVI}_{\mathrm{Dry}}}{\mathrm{NDVI}_{\mathrm{Dry}}} \right) \times 100$$

< - 75% == Flood

Flood Detection Product Methodology





Cloud Mask (MOD/MYD09GA Bit)

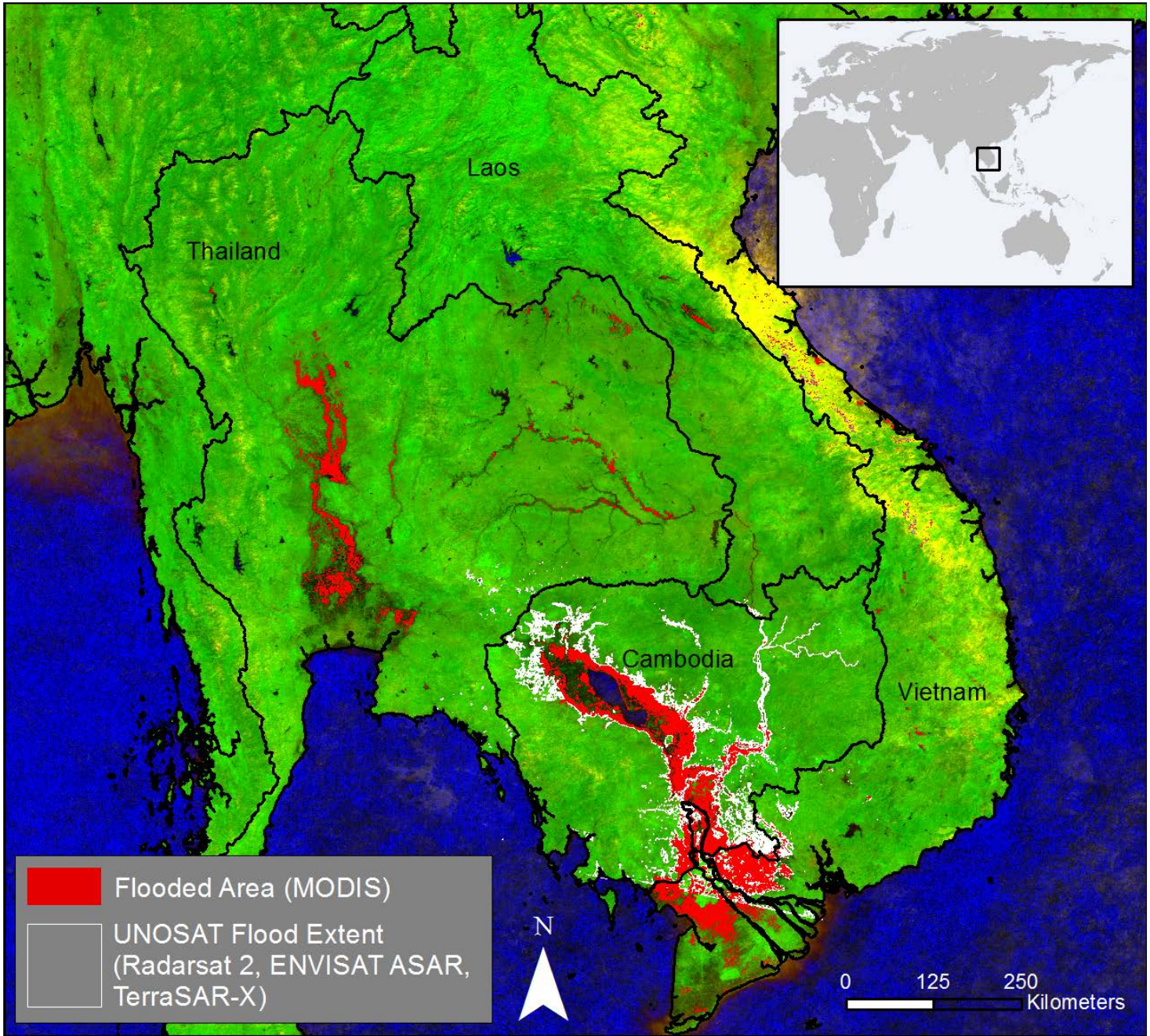
SRTM DEM

Permanent Water Mask (MOD44W)

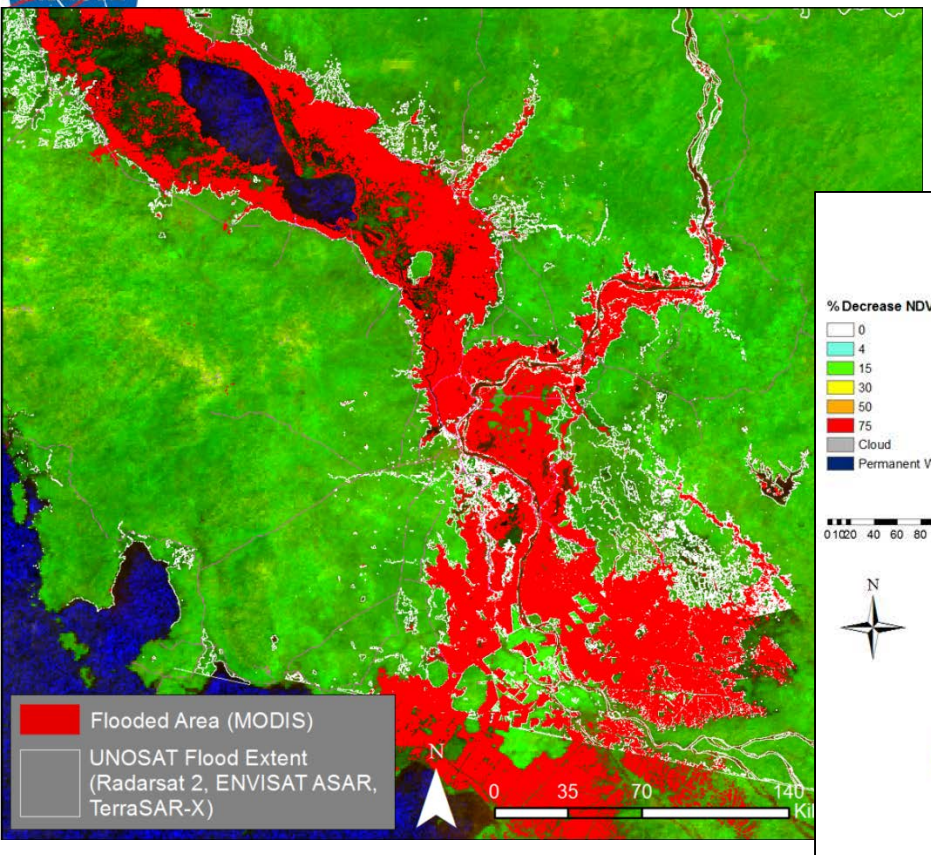
Near Real Time NDVI (MOD/MYD09 GQ)

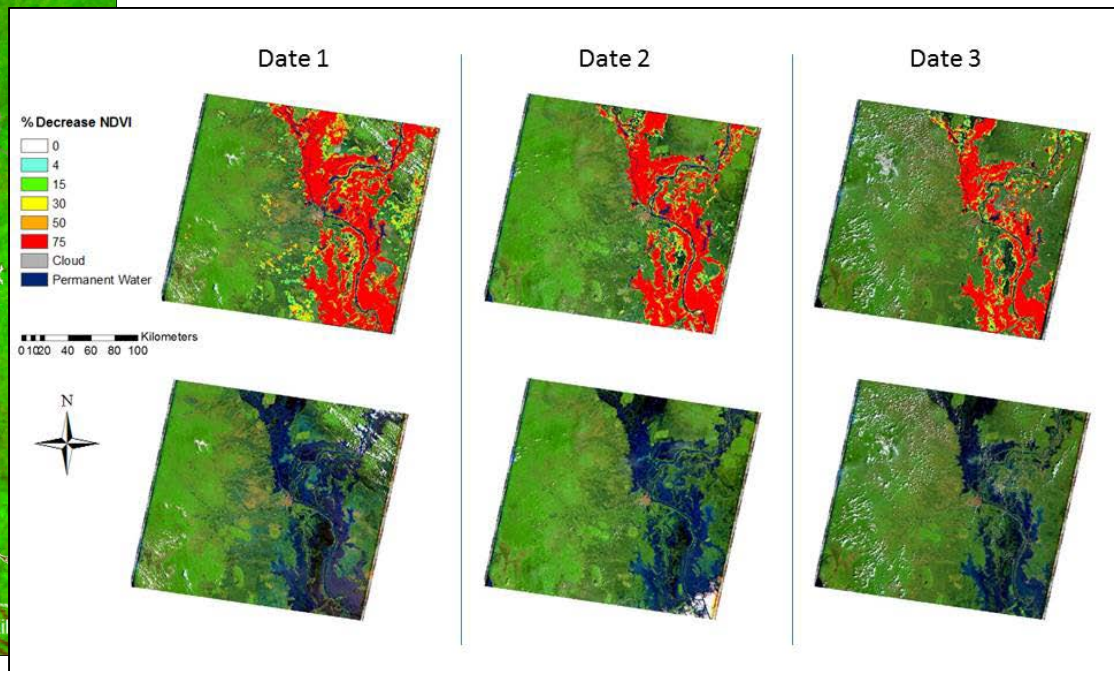
Dry Season Baseline NDVI

Flood Detection Results



Flood Detection



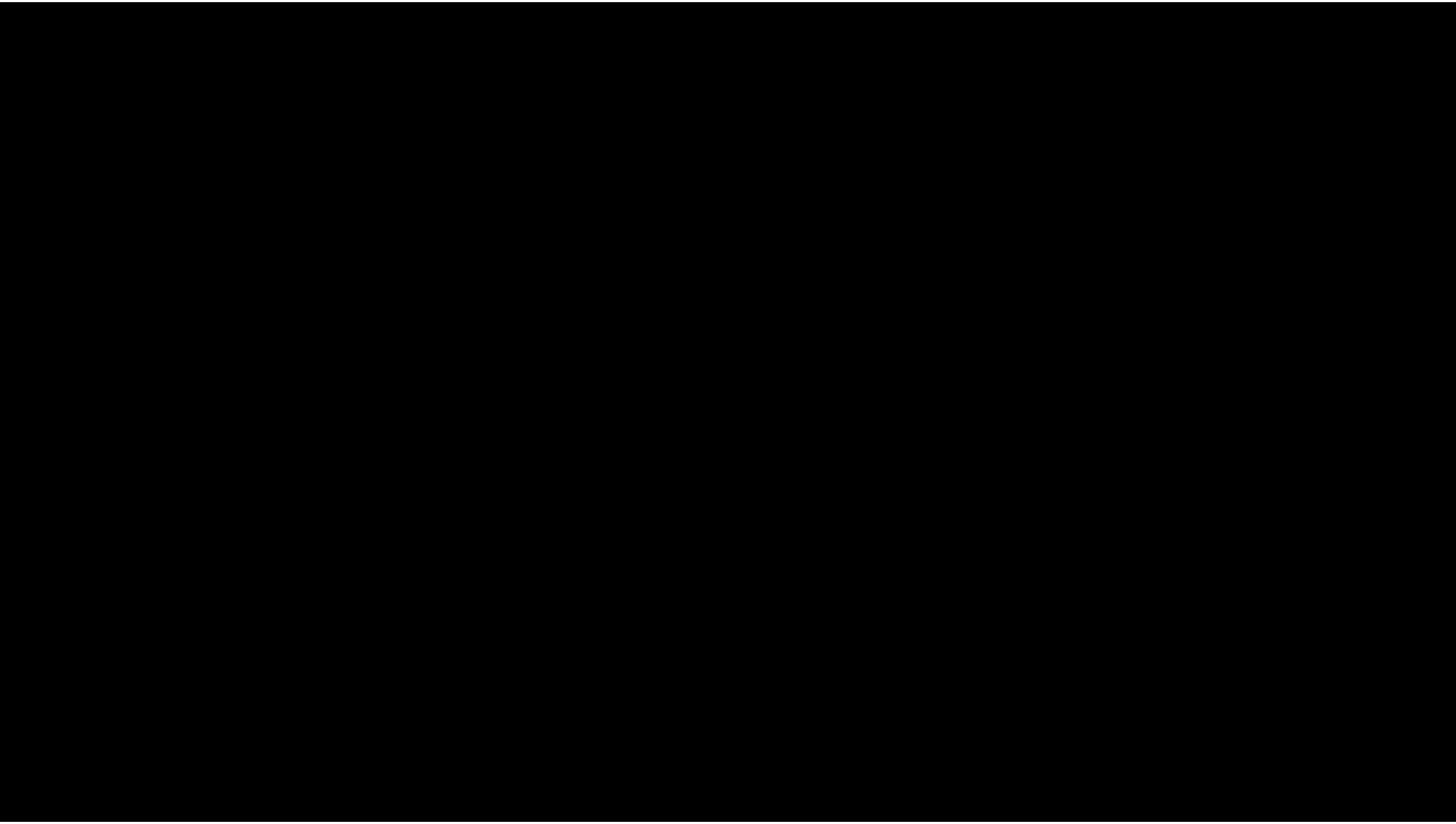


Validated Against:

1) Landsat (Top Right)
2) UNOSAT SAR (Above)
3) ISERV (ISS) (Not Shown)

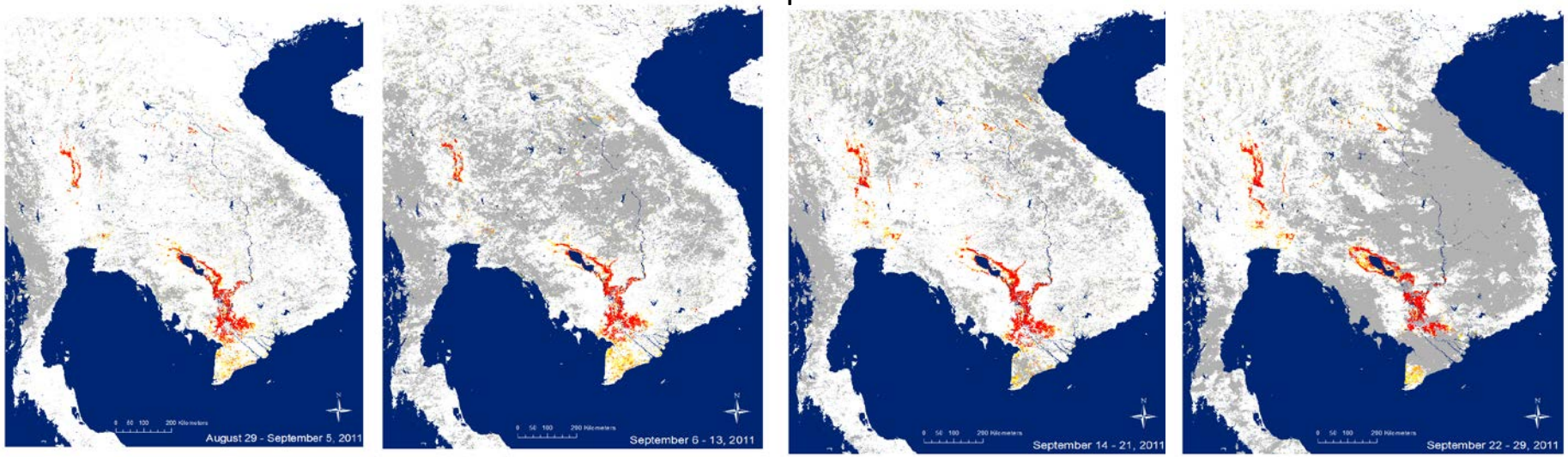
Validation Date	MODIS Composite	Reference Data	Class	Producer's Agreement	User's Agreement	Overall Agreement	Kappa
Date 1	8/29 - 9/5/2006	Landsat 5 9/3/2006	Flood	95.00%	89.33%	92.33% (277/300)	0.8467
			Not Flood	89.90%	95.33%		
Date 2	10/16 - 10/23/2006	Landsat 5 10/21/2006	Flood	94.67%	94.67%	94.67% (284/300)	0.8933
			Not Flood	94.67%	94.67%		
Date 3	11/1- 11/8/2006	Landsat 5 11/6/2006	Flood	95.74%	90.00%	93.00% (279/300)	0.8600
			Not Flood	90.57%	96.00%		

2011 Flood Progression



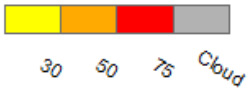
2011 Flood Progression

*In case video on previous slide does not work

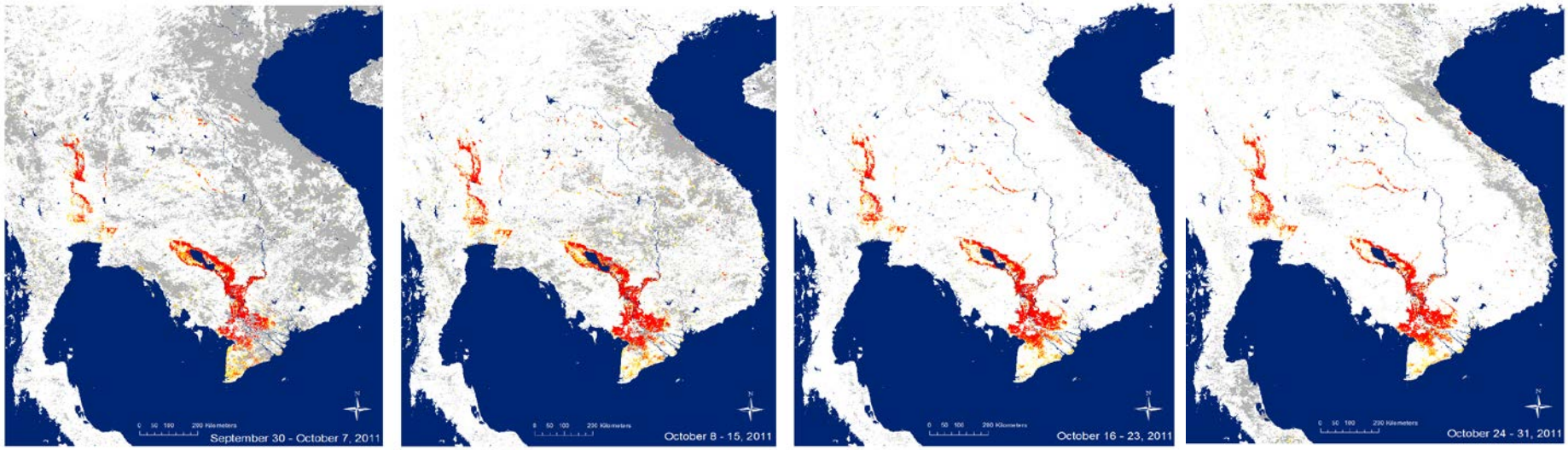


September

% Decrease NDVI



Permanent Water



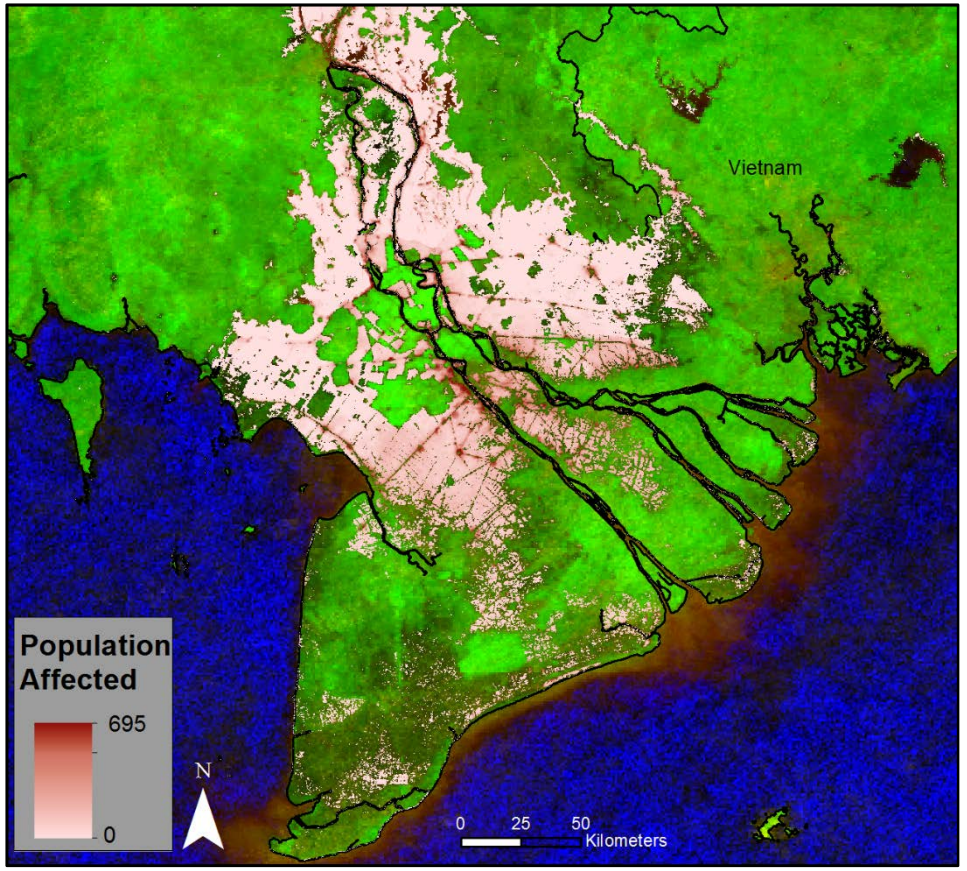
October

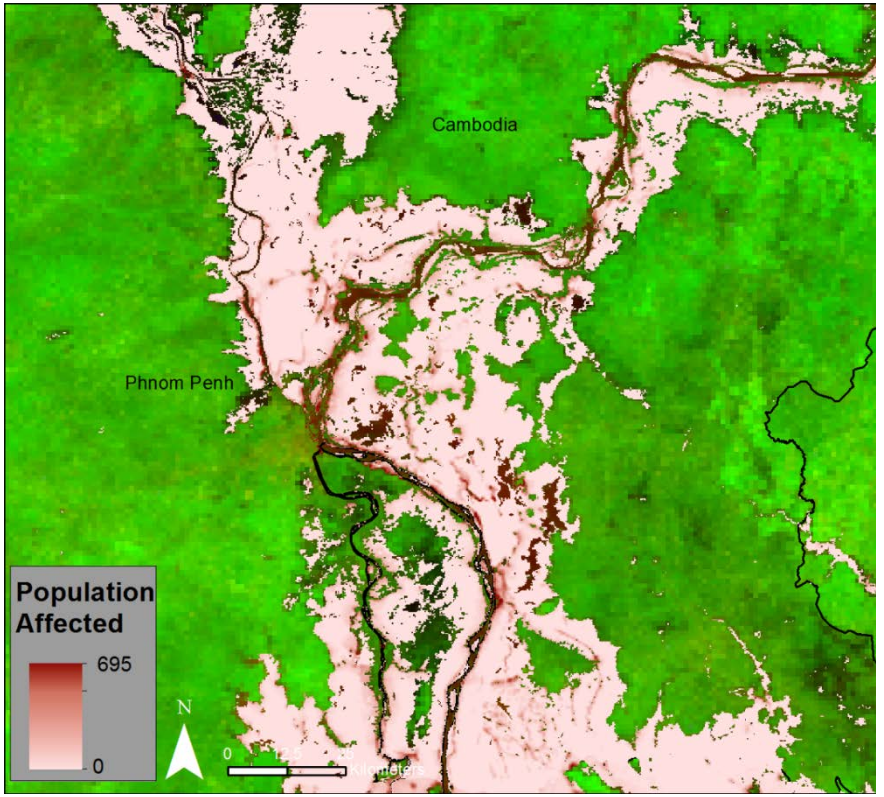
Courtesy: C. Doyle

Affected Population Estimates

2011 Flooding	Cambodia	Thailand	Vietnam	Laos
Population Affected (MODIS Est.)	1,864,988	1,409,507	4,078,799	25,386
Population Affected (Agency Est.)	1,500,000	2,100,000	700,000	430,000

Table 1. Estimates of Population Impacted by 2011 Flooding modeled from 4 day image composited on October 16, 2011.
USAID Source: http://pdf.usaid.gov/pdf_docs/PA00J4C7.pdf



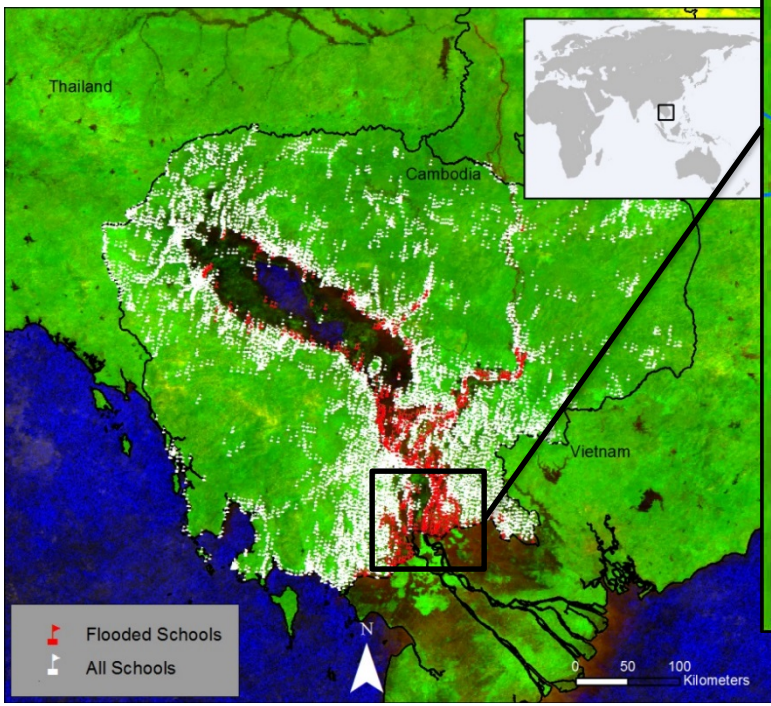


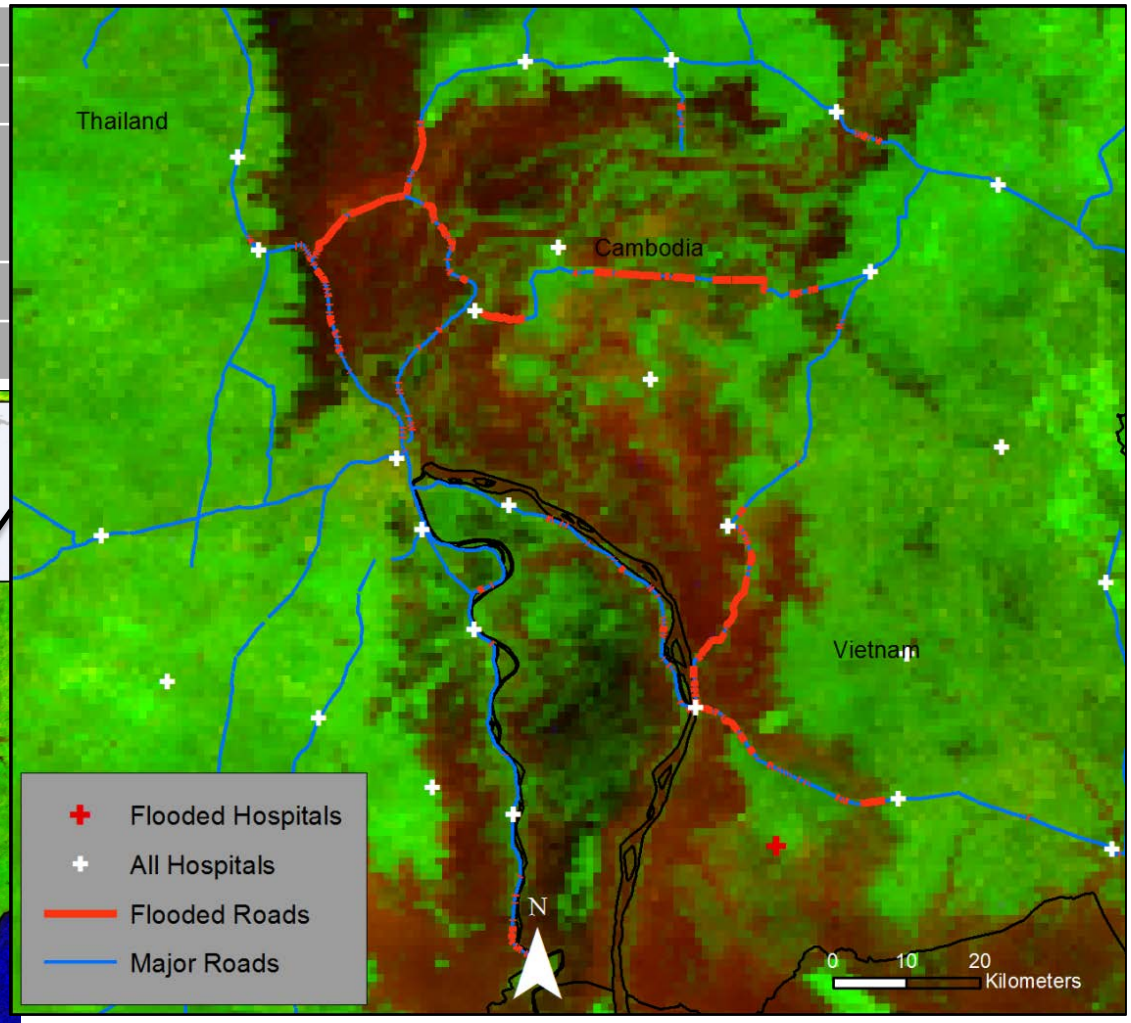
Population Density in flooded areas, Phnom Penh, Cambodia (Above), Vietnam Delta (Left)

Input MODIS Data: 4 Day Terra composite, October 12 – 16, 2011 **Population Data**: Worldpop (Stevens et al., 2015)

Infrastructure In Cambodia

2011 Flood Metric	Estimate	Other Estimate
Major Roadways (km)	208	180[2]
Schools (count)	818	1,132[2] 1,360[3]
Hospitals	1	N/A
Airports	0	N/A





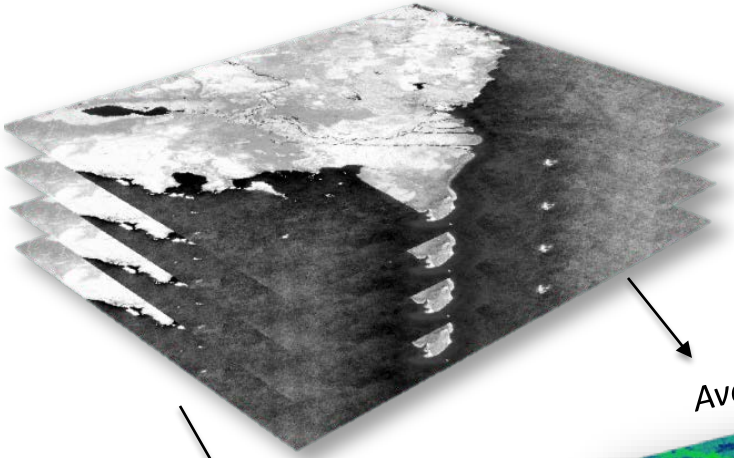
Input MODIS Image: MOD.2011-10-16 (4 day composite) **Infrastructure Data**: UNOCHA, Pacific Disaster Center[1]

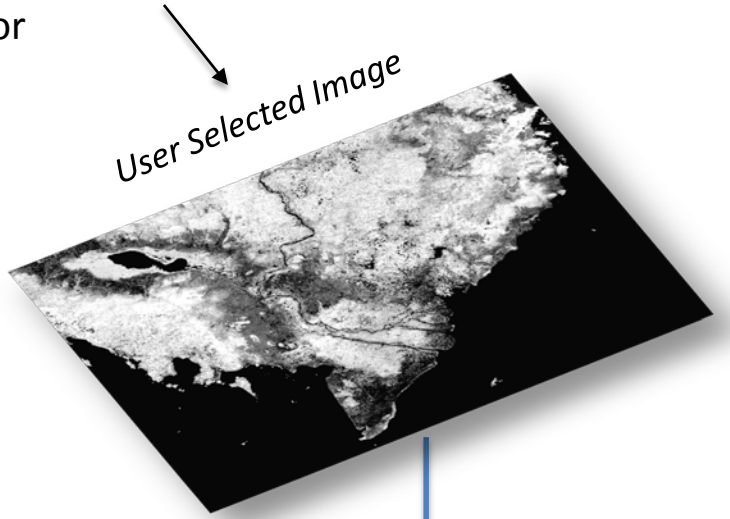
[1] Roads data: http://geodata.pdc.org/geodata/unocha/
[2] National Center for Disaster Management, Cambodia.
[3] Chea, S., and Sharp, A., (2015). Flood Management in Cambodia: Case Studies of Flood in 2009 and 2011.

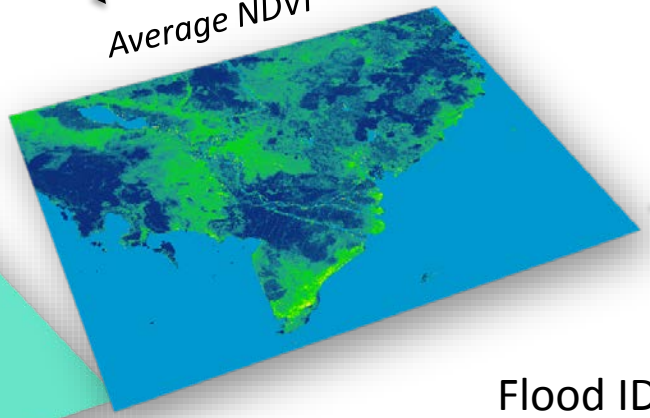
NDVI Anomaly Tool

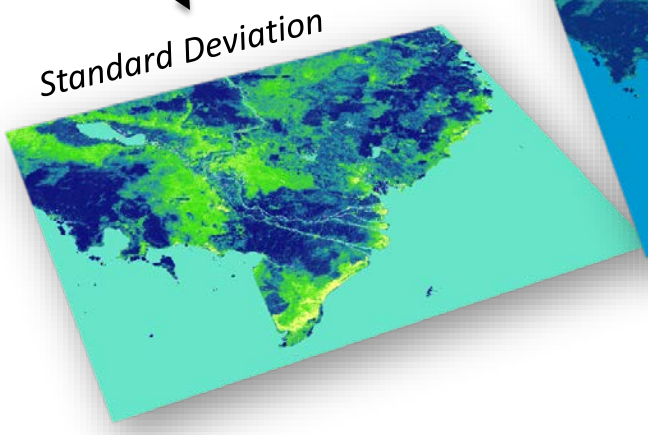
Inputs: Day of year: 1-365, Product: GQ (Daily), Q1 (8day), NRT

Collects MODIS imagery on input day (or nearest 8day composite) for length of record, creating ~30 image stack. Masks clouds and shadows, computes average NDVI









NDVI differences relative to historic averages

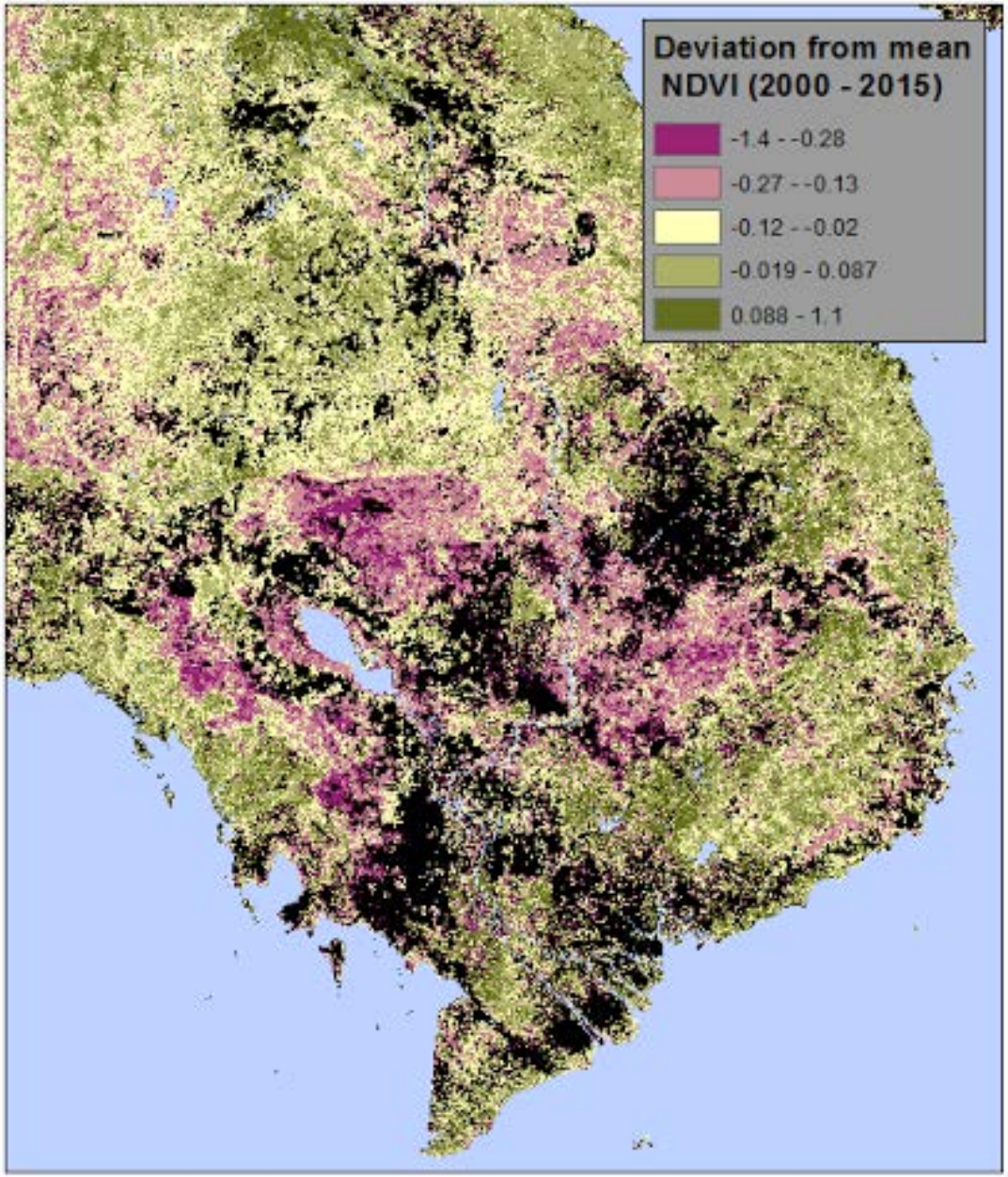
Flood ID

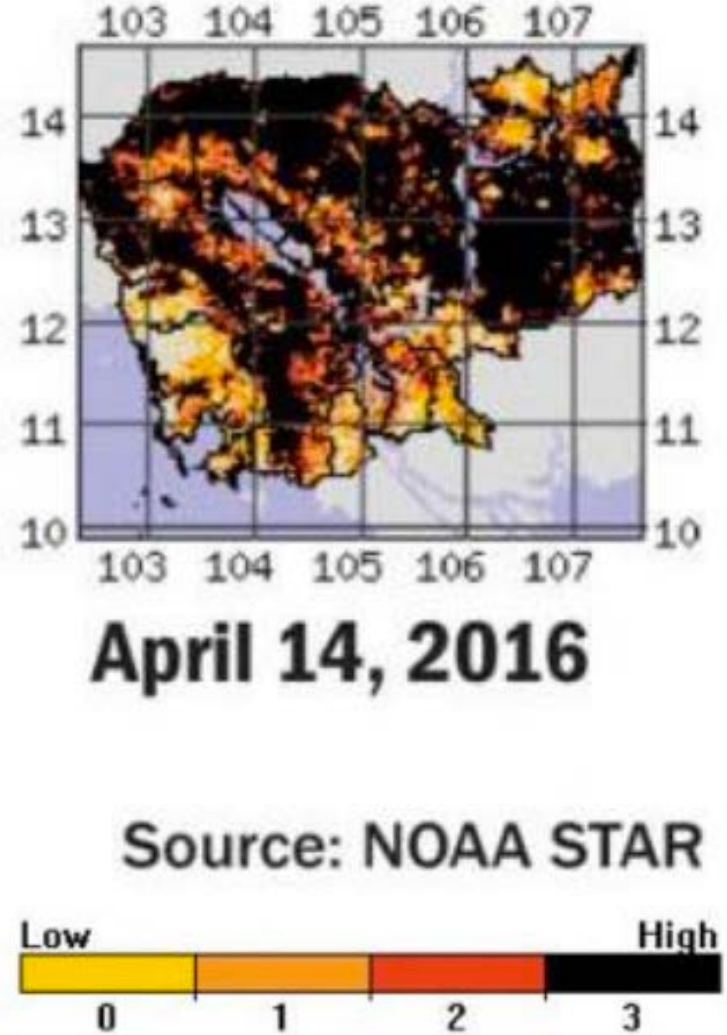
Vegetation Phenology?

LU/LUC?

Drought ID?

Preliminary Result: Drought





Source: Phnom Penh Post 22/04/2016

NOAA STAR Data: AVHRR
MODIS Data: MOD09Q12016121

Web Interface (In development)

http://mekongflood.appspot.com

mekongflood.appspot.com

Apps | Bookmarks | Flood Work | MODIS stuff | Sediments | Website | Lit Review | Socioeconomics

Project Mekong | Home | About | People | Contact | Research

Near Real Time Flooding in Southeast Asia

Flood Extent Derived from MODIS NDVI Change Detection Algorithms

Algorithms and website currently under development at NASA Goddard Space Flight Center

Clouds | Flooding | more | Changes Detected | less

Flood Extent Raw Data

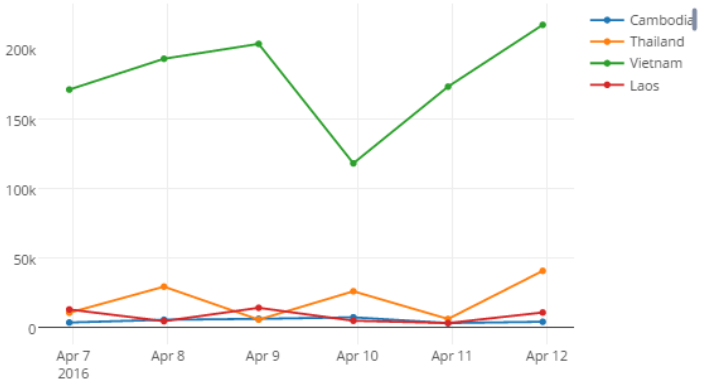
Flood Layer Opacity

0.75

Additional Layers

- Mekong River
- Dams (MRC)
- River Gauges (MRC)
- 3 Hour Rainfall (NASA)
- 24 Hour Rainfall (NASA)
- 72 Hour Rainfall (NASA)
- Flood Potential (NASA)
- Traffic (Google)

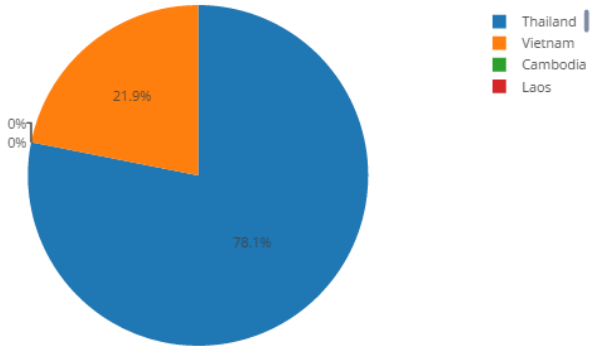
Population At Risk Time Series (Beta)



Edit chart »

Data Source: Worldpop

Building Footprints At Risk (Beta)



Edit chart »

Data Source: Open Street Map

Further Information

Submitted Publications:

1) Ahamed, A., Bolten, J.D., Doyle, C.S., (In Review). Near Real-Time Flood Impact Assessment Systems for Southeast Asia. Submitted to *International Journal of Applied Earth Observation and Geoinformation.*

2) Fayne, J.V., Bolten, J.D., Doyle, C.S., Fuhrmann, S., Rice, M.T., Houser, P.R., Lakshmi, V., (In Review). Flood Inundation Mapping Using Daily MODIS Observations. Submitted to *International Journal of Remote Sensing.*

3) Ahamed, A., Bolten, J.D., Doyle, C.S., (In Review). Near Real Time Flood Detection and Impact Assessment. Mekong River Basin Case Study. In *Remote Sensing of Hydrological Extremes*.

4) Fayne, J. V., Bolten, J.D., Lakshmi, V., Ahamed, A., (In Review). Optical and Physical methods for Mapping Flooding with Satellite imagery. In *Remote Sensing of Hydrological Extremes.*

Conference Presentations:

1) Ahamed, A., Bolten, J.D., Doyle, C.S., (2016). Assessment of Monsoon Flood Disaster Impacts in Southeast Asia: Implications for Rapid Disaster Response. EGU General Assembly, Vienna, Austria, April 17-22, 2016.

2) Doyle, C., Bolten, J.D., Spruce, J., Ahamed, A., (2016). A Rapid-Response Flood Impact Assessment Tool for Southeast Asia. AAG Annual Meeting, San Francisco, California, March 29 – April 2, 2016.

3) Fayne, J.V., Bolten, J.D., Fuhrmann, S., Rice, M.T., (2015). Real-Time Multi-Scale mapping for Emergency Management. Proceedings of the International Cartographic Conference, Rio De Janeiro, Brazil, August 24-28, 2015.

Funding: NASA Applied Sciences, NASA DEVELOP
Computational Infrastructure: Open Science Data Cloud
Knowledge Exchange: Stack Overflow