Introduction → HYDRAFloods → what HYDRAFloods does → what they will use HF for

Hello everyone ,

My name is Micky Maganini, and I work for SERVIR, a U.S. Government organization and partner of ITC. Today I am going to introduce you to a Python application called HYDRAFloods that was developed by SERVIR. HYDRAFloods lowers the barrier to high quality surface water mapping workflows using the power of Google Earth Engine and Google Cloud Platform. You will be using HYDRAFloods to investigate the surface area change of two lakes in Africa, Lake Naivasha in Kenya, and Lake Xau in Botswana.

Context

Before we learn more about HYDRAFloods, I want to provide some context about What SERVIR is.

joint program → hubs

SERVIR is a joint program between NASA and the US Agency for International Development. We develop solutions to address environmental challenges using earth observation data. We work with organizations around the world in five regional hubs to create these solutions.

SERVIR network → ITC & SERVIR

Beyond our regional hub institutions, we partner with organizations in the private sector, intergovernmental organizations, NGOs, and research institutions like ITC. ITC and SERVIR have partnered with each other since 2018 as both institutions apply earth observations to sustainable development on a global scale.

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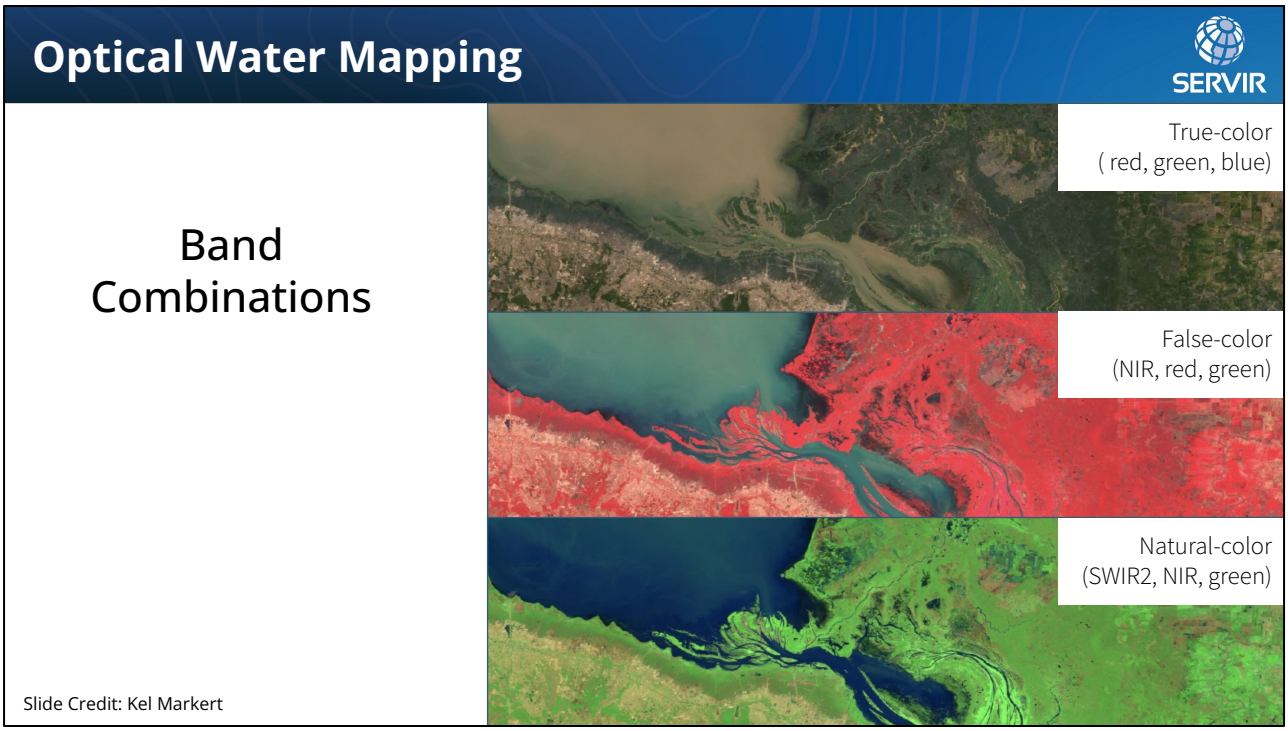
Surface Water Mapping

Overview

Before I delve into HYDRAFloods, I want to provide a brief overview of surface water mapping using both optical remote sensing data as well as synthetic aperture radar data.



channels → true color → false color → question

So first, let's start with optical water mapping. So as you may know, when we represent an image we do so by assigning different wavelengths of light to different channels, a red, green, and a blue channel. A true color image is when red light is assigned to the red channel, blue light to the blue channel, and green light to the green channel. We can create false color composites by having new combinations of bands. At the bottom, you can see a so-called "natural color" image, where short wave infrared electromagnetic radiation is assigned to the red band, near infrared radiation is assigned to the green band, and green visible light is assigned to the blue band. What does water look like in true color versus false color? Why might you use true color in some case? False Color? So in this image, if something appears as blue, it is reflecting green

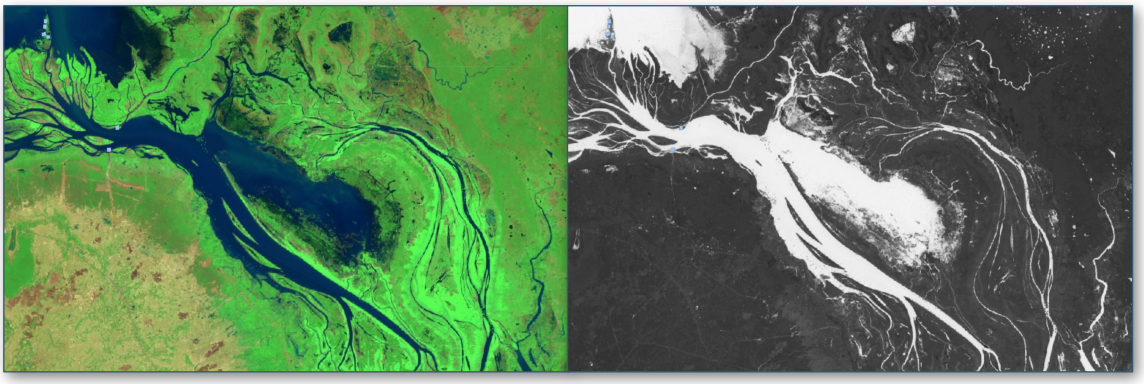
light strongly, but absorbing short wave infrared and near infrared light.

Slide Credit – Kel Markert

Water Indices

- Transform multispectral imagery to highlight water
- Rely heavily on shortwave infrared

$$MNDWI: \frac{(green - swir1)}{(green + swir1)}$$



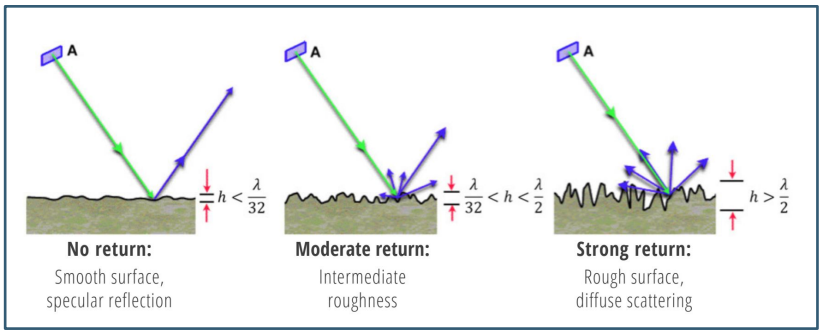
Question for students → natural color → MNDWI → range of values
How many of you have mapped water with an image? And how many have heard of or used a water index? If you haven't heard of an index, it refers to a mathematical formula applied to an image. It allows us to combine three signal-channel images into one image, which will help us to automatically map water as we will see later.

– On the left we have a "natural color image", and on the right we have a water index image on the right. In this case, we are using the modified normalized difference water index, which has a range of values between -1 and 1. 1 is assigned to white and -1 is assigned to black. Positive values are reflecting more green light than short wave infrared, and negative values are reflecting more shortwave than green. Thus, values closer to one

represent water and values closer to -1 represent land.

SAR Water Mapping

- Synthetic Aperture Radar (SAR) is a type of active remote sensing that is available in all weather conditions
- SAR measures the amount of energy returned to the sensor (backscatter)
  - Water – Low intensity due to specular reflection
  - Land – High intensity due to scattering by vegetation



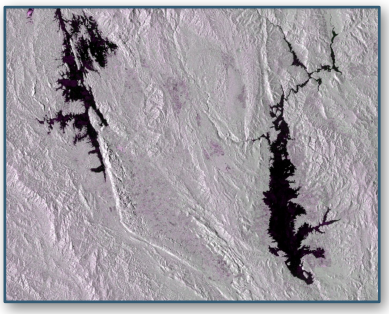


Image Credit: SERVIR SAR Handbook

SAR → active → thresholding → backscatter

Just as we use thresholding on passive data, we can also use it with active sensor data. So passive data refers to those optical images where light provided by the sun reflects of the Earth and hits our sensor. But an active sensor both transmits and receives radiation. For example, we have SAR data, which stands for Synthetic Aperture Radar, such as Sentinel 1. This is because SAR measures the amount of energy returned to the sensor – also known as backscatter. And backscatter is partially dependent on the roughness of a surface. Smooth surfaces like water show low intensity – represented as black – whereas rough surfaces like land show a stronger return to the sensor.

Thresholding Algorithms

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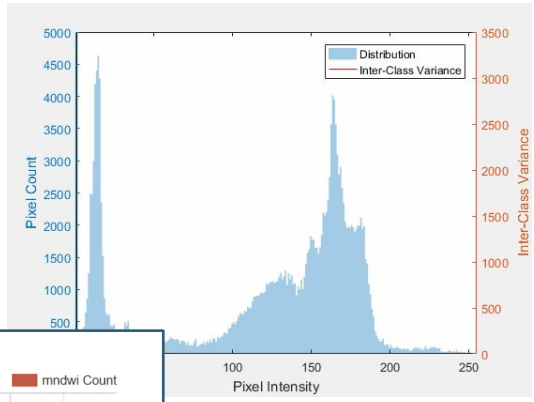
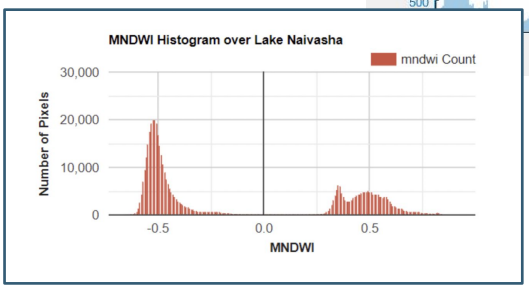
- Automated Histogram-based thresholding approach
- Maximized inter-class variance between two classes
- **Assumes there are only two classes**, a background and a foreground

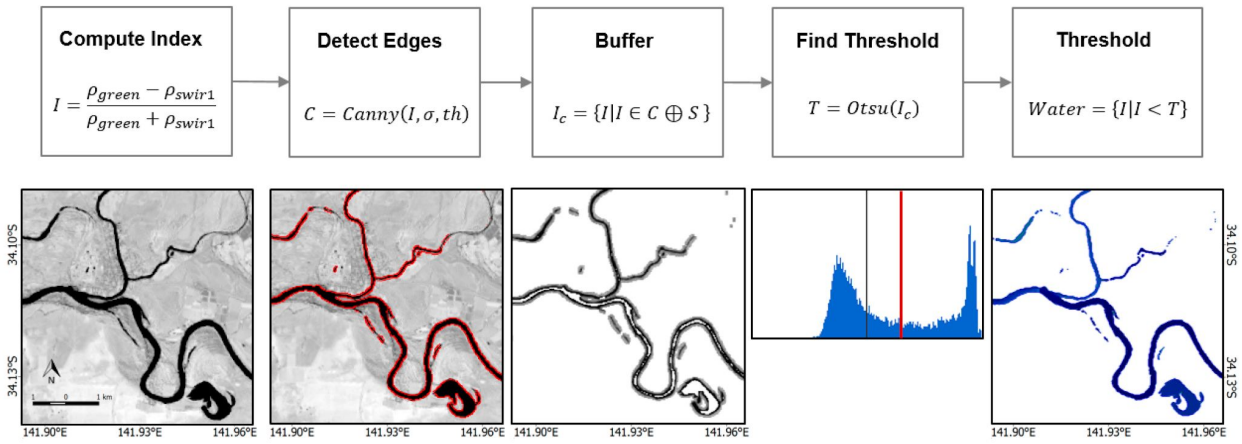




threshold → algorithm → histogram

So once we have our index image, we have to set a threshold value somewhere to distinguish between water and non-water. So we can do this on SAR Imagery or on optical imagery. And often, when we want to map surface water, they use a thresholding algorithm. This algorithm works on an image histogram, and works best when we have a bimodal histogram, or an image with two peaks. An image histogram has the pixel count on the vertical axis and pixel intensity on the horizontal. The limitations of this approach are that it only works on one band, and it assumes you are working on a bimodal histogram, which is a histogram with two peaks.

Otsu's Method



Otsu's method → steps → code

So here we can see a specific thresholding algorithm called Otsu's Method, which we can implement in HYDRAFloods. So there's several steps here we were compute a water index, detect edges, buffer the edges, find a threshold, and then finally construct our water image. HYDRAFloods allows us to do this entire process in two lines of code which we'll see later.

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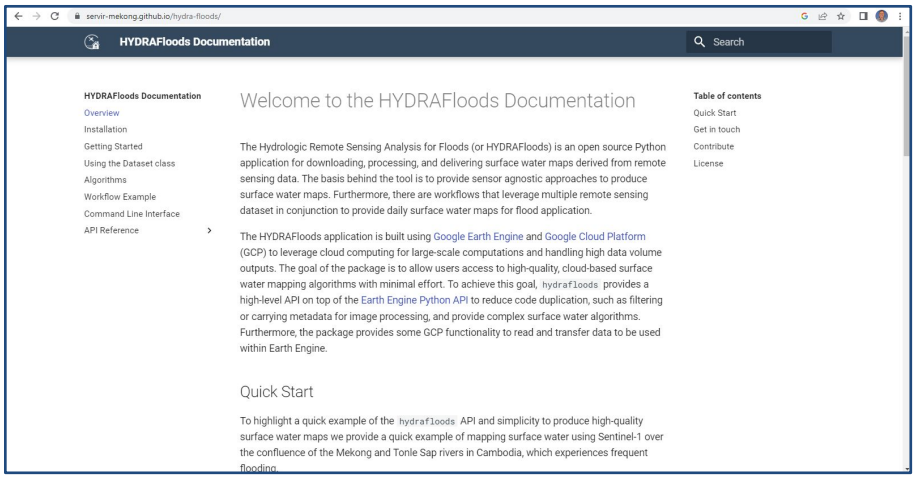
HYDRAFloods

Now that we know how water mapping works in general, let's look at HYDRAFloods

HYDRAFloods Background

HYDRAFloods is …

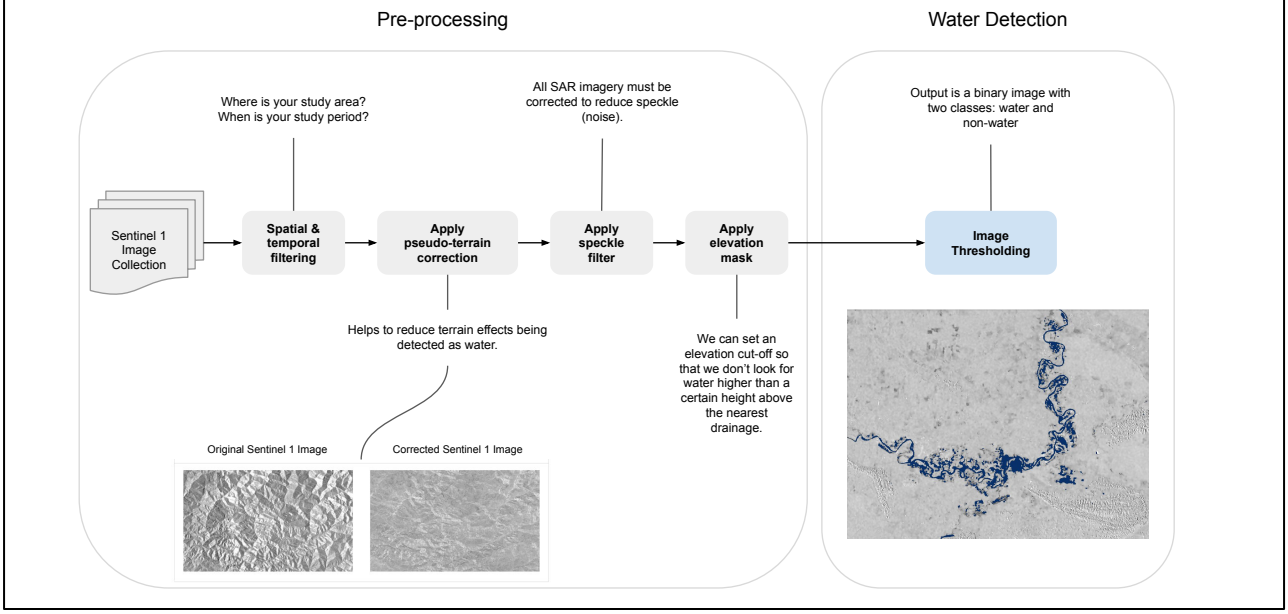
- Open Source
- Documented
- Cloud-Based
- Customizable
- Used in the Real World!



Why HYDRAFloods? → benefits → real world

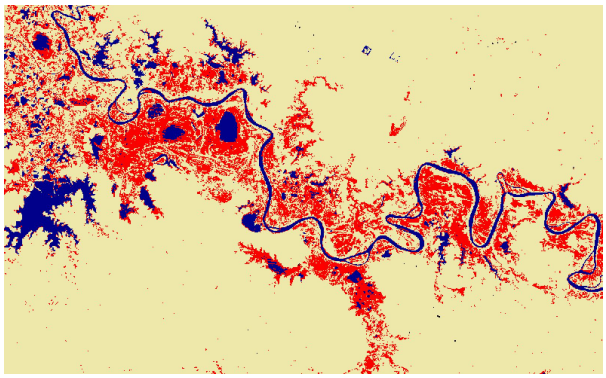
So why would you want to use HYDRAFloods as opposed to a different surface water mapping tool? Well, HYDRAFloods is completely open source, its fully documented, and its cloud based. This means that you don't need computational resources to implement high level surface water mapping workflows. And most importantly, HYDRAFloods is used to map surface water in the real world.

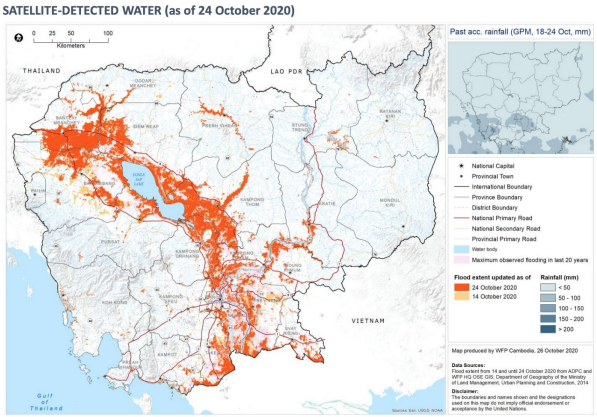
HYDRAFloods Workflow



Another benefit of HYDRAFloods is it allows for end to end processing, so it allows us to acquire data, pre-process the data, and do image thresholding.

HYDRAFloods Use Cases

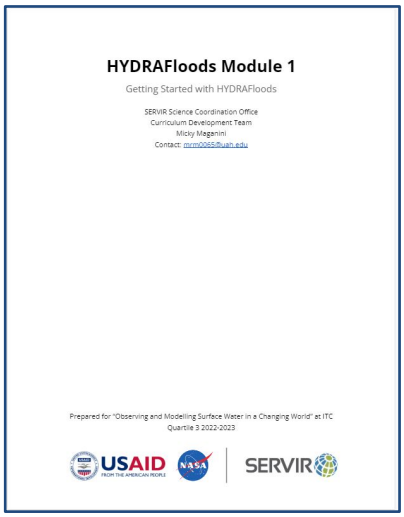


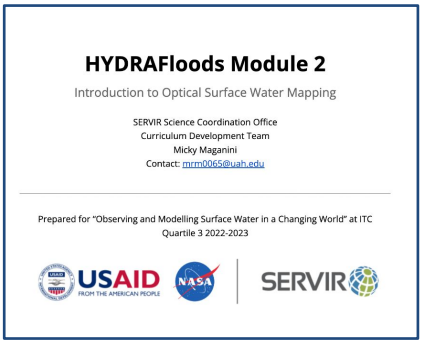


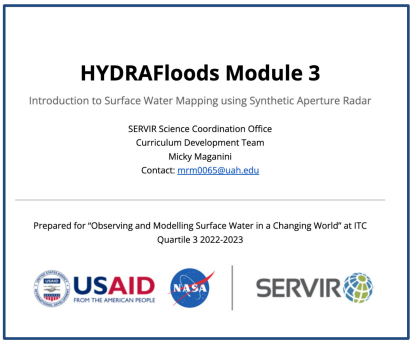
HF Use → Eta, Iota → WFP

As mentioned earlier, this isn't just a tool used by scientists, SERVIR uses HYDRAFloods to help disaster managers prepare for and prioritize relief and reduce impacts. On the right, you can see an example of how SERVIR's Southeast Asia hub works with disaster management agencies and the World Food Programme to target relief supplies in order to reduce the impacts of floods on crop losses and food insecurity. On the left, you can see how HYDRAFloods was used in Central America in the wake of Hurricanes Eta and Iota. These are just two examples of how HYDRAFloods is operational, the code is automatically running on a daily basis and is part of the decision making process

HYDRAFloods Materials







materials

To help you learn how to use HYDRAFloods, we at SERVIR have created some materials to help.

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Live Demonstration

So now I will provide a brief demonstration of HYDRAFloods to show you how it works in action

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