Objectives and guiding principles for change detection using remote sensing

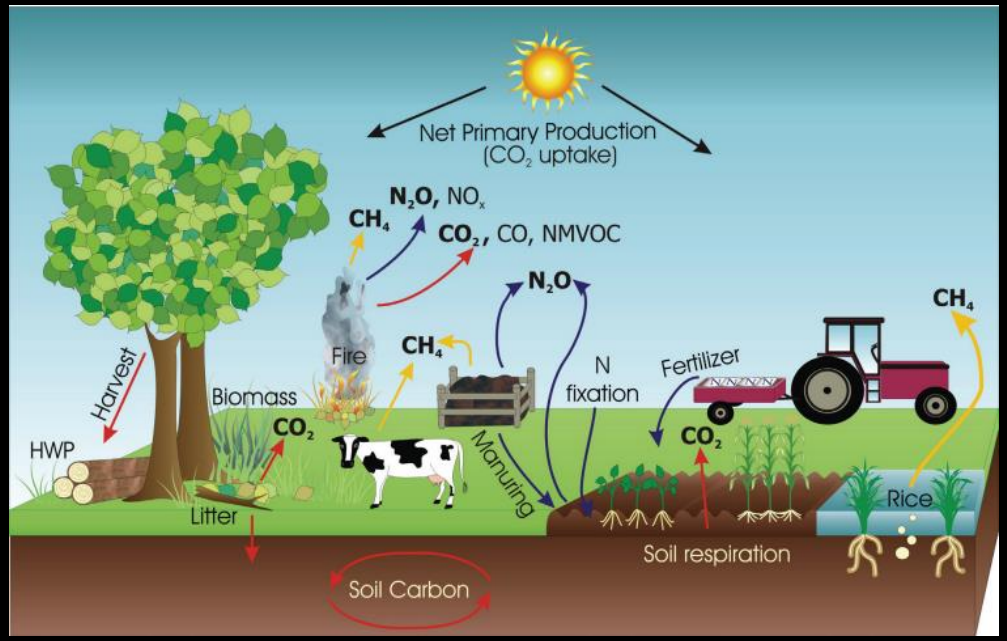
Developed by remote sensing specialists at the USFS Geospatial Technology and Applications Center (GTAC), located in Salt Lake City, Utah

Objectives

- Build capacity and knowledge of remote sensing image processing
  - Specifically in regards to detecting and monitoring landscape change

Why use remote sensing?

- We want to **inventory** and **monitor** our resources in the most cost effective and efficient manner (save money and time)
- Our focus is on Forest Resources



How will this help you?

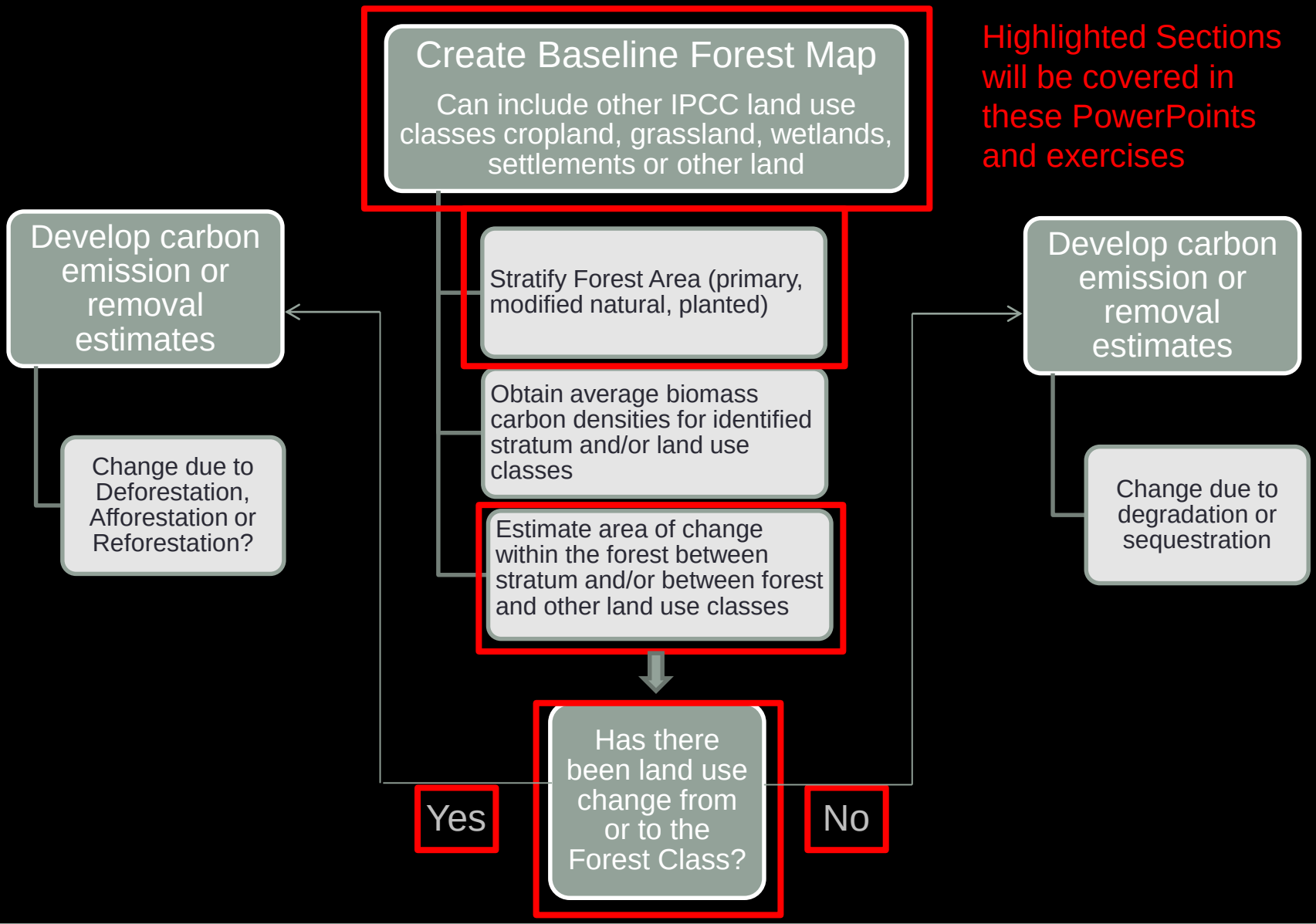
- It will provide you with the ***knowledge*** and a set of associated ***tools*** to implement a processing ***workflow***
- You will be able to… “Produce reliable, consistent and comparable reports on **change in forest cover and forest use** and associated anthropogenic greenhouse gas emissions or removals”

GFOI (2013) Integrating remote-sensing and ground-based observations for estimation of emissions and removals of greenhouse gases in forests: Methods and Guidance from the Global Forest Observations Initiative: Pub: Group on Earth Observations, Geneva, Switzerland, 2014.

Remote Sensing for Forest Monitoring

- Remote Sensing is a tool to help us make better Resource Management Decisions
- It can inform us in 4 areas:
  - Inventory – how much is there (hectares)?
  - Mapping – where is it (map)?
  - Classification – what is it (stratum)?
  - Monitoring – has it changed (gain or loss of forest)?

Forest Emissions and Removal Workflow



Resulting Map Products

Map Products	Description
Forest/Non-Forest	Maps of forest cover through time
Forest/Non-Forest Change	Maps of change in the area of forest land
Forest Stratification	Forest/Non-Forest map, but with forest stratification according to primary forest, modified natural forest, and planted forest (or equivalent national stratification)
All Land Use Categories	Default is the UN-FAO Land cover Classification (forest, cropland, grassland, wetland, settlements and other land) or an equivalent national classification
Land Use Change	Map of conversions between the six IPCC land categories, can include forest stratification
Change within Forest Land	Map of conversions between forest stratum

Guiding Principles

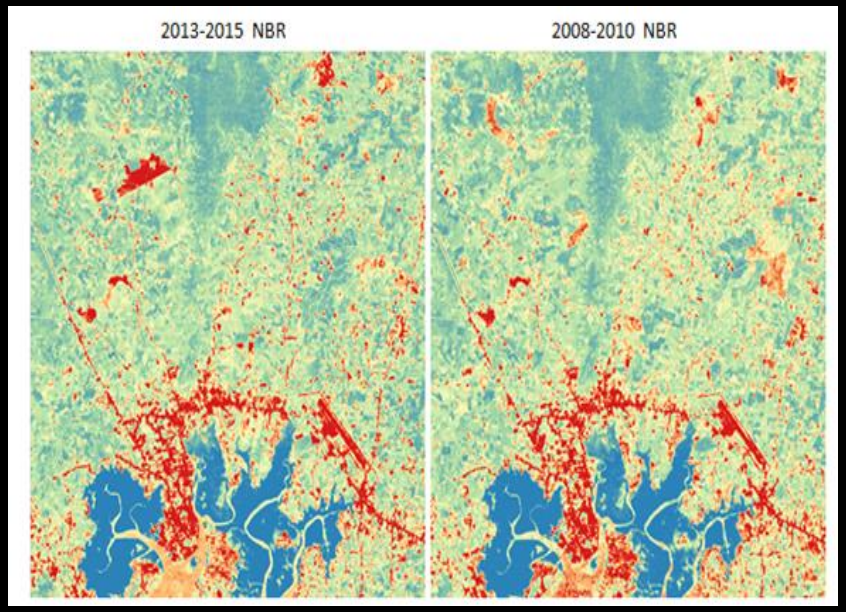
- GFOI (Global Forest Observation Initiative) – Guiding principles for remote sensing data sources and methods

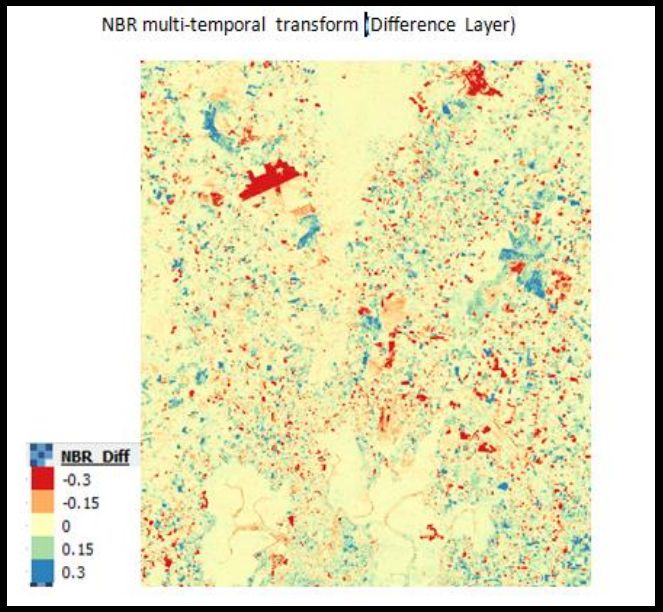
These principles are suggested to help countries decide on the combination of data sources and methods used to support reporting on GHG emissions and removals

https://www.reddcompass.org

Guiding Principle 1

- To find change, compare images, not maps
- Images contain more information and are collected on a frequent basis





Guiding Principle 2

- Time series Analysis and Consistency
- When data are available from many time-steps, it is better to use the information from the entire time series of images rather than comparing only the end-dates.

```
//GEE provides access to the entire Landsat Archive
//Composite time period
var years = [2008, 2013];
var startJulian = 305;
var endJulian = 90;
var compositingPeriod = 2;
```

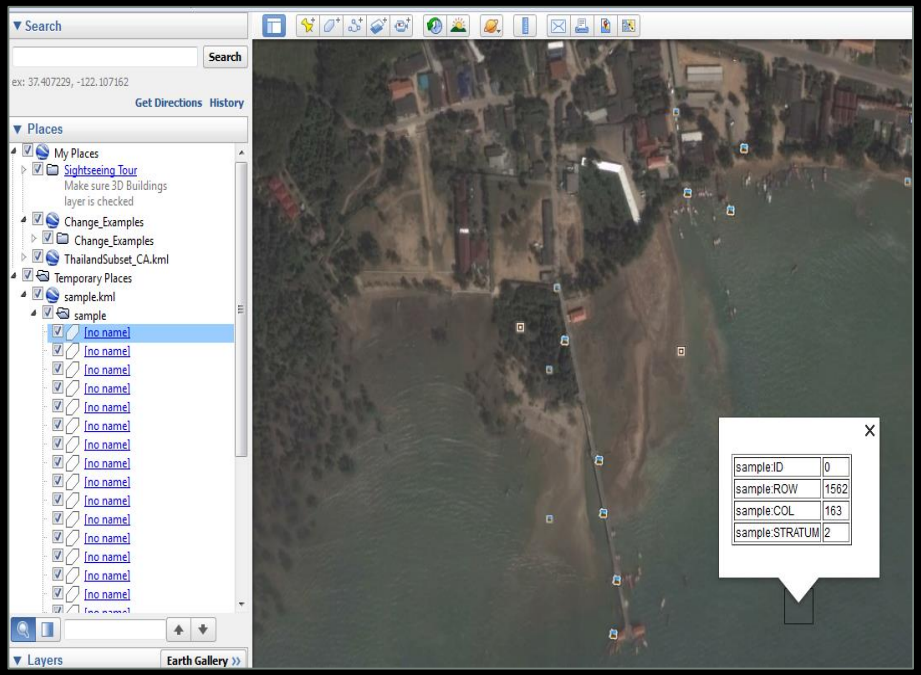
1986-1989 Landsat 5 Composite

2013-2015 Landsat 8 Composite

Guiding Principle 3

- Always assess results from remote sensing
  - The goal of the remote sensing analysis is to estimate the areas of the classes in activity data or provide information that can be used to guide sampling strategies.

Collect Reference Data



Generate an Error Matrix

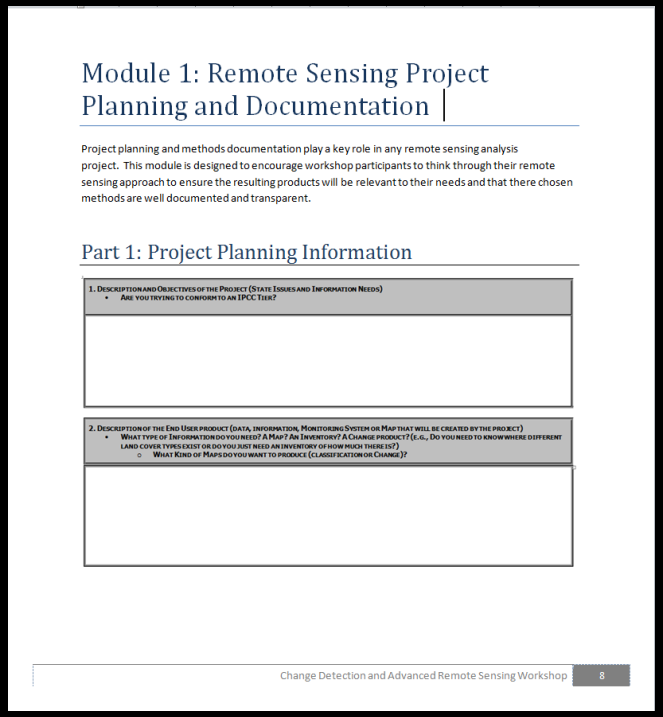
F18

	A	B	C	D	E	F
1		forest map	water map	other map		
2	forest reference	8	4	5		
3	water reference	1	6	0		
4	other reference	1	0	5		
5						
6		forest reference	water reference	other reference	**Map Total**	**User's Accuracy**
7	forest map	5	0	5	**10**	
8	water map	0	10	0	**10**	
9	other map	3	0	7	**10**	
10	**Reference Total**	**8**	**10**	**12**		
11	**Producer's Accuracy**					

Guiding Principle 4

- Document and archive steps taken

Project Planning Worksheet



Module 1: Remote Sensing Project Planning and Documentation

Project planning and methods documentation play a key role in any remote sensing analysis project. This module is designed to encourage workshop participants to think through their remote sensing approach to ensure the resulting products will be relevant to their needs and that there chosen methods are well documented and transparent.

Part 1: Project Planning Information

1. Description and Objectives of the Project (State Issues and Information Needs)
   - Are you trying to conform to an IPCC Tier?

2. Description of the End User product (data, information, Monitoring System or Map that will be created by the project)
   - What type of Information do you need? A Map? An Inventory? A Change product? (e.g., Do you need to know where different land cover types exist or do you just need an inventory of how much there is?)
     - What Kind of Maps do you want to produce (classification or Change)?

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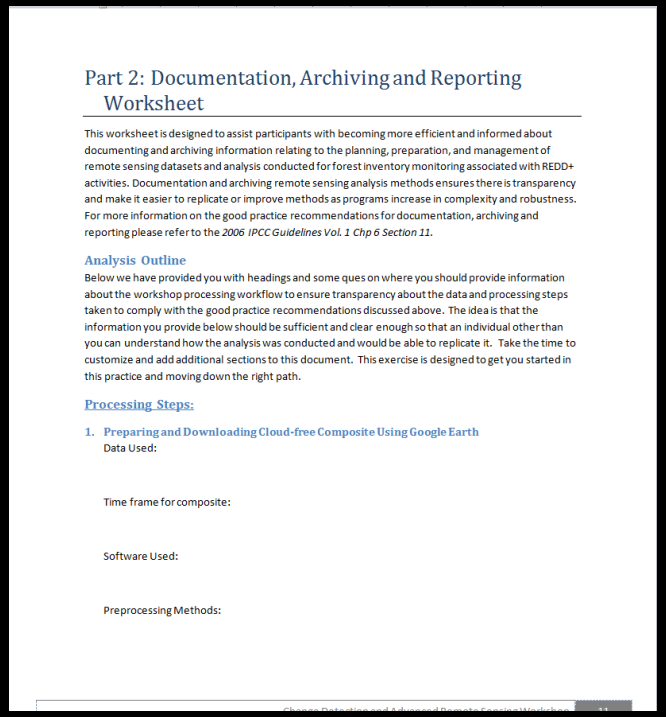
Documentation Worksheet



Part 2: Documentation, Archiving and Reporting Worksheet

This worksheet is designed to assist participants with becoming more efficient and informed about documenting and archiving information relating to the planning, preparation, and management of remote sensing datasets and analysis conducted for forest inventory monitoring associated with REDD+ activities. Documentation and archiving remote sensing analysis methods ensures there is transparency and make it easier to replicate or improve methods as programs increase in complexity and robustness. For more information on the good practice recommendations for documentation, archiving and reporting please refer to the *2006 IPCC Guidelines Vol. 1 Chp 6 Section 11.*

Analysis Outline

Below we have provided you with headings and some ques on where you should provide information about the workshop processing workflow to ensure transparency about the data and processing steps taken to comply with the good practice recommendations discussed above. The idea is that the information you provide below should be sufficient and clear enough so that an individual other than you can understand how the analysis was conducted and would be able to replicate it. Take the time to customize and add additional sections to this document. This exercise is designed to get you started in this practice and moving down the right path.

Processing Steps:

1. **Preparing and Downloading Cloud-free Composite Using Google Earth**

   Data Used:

   Time frame for composite:

   Software Used:

   Preprocessing Methods:

Useful Remote Sensing Tips

- *Creating good remote sensing models is an iterative process.*

- *"All models are wrong, but some are useful"*

  - George Box

Project Planning

Objectives

- Bridge the gap between training and project implementation.
  - Share appropriate remote sensing workflows and project development strategies (hands on materials)
  - Develop a preliminary workflow for participants (project planning document)
  - Provide assistance and project consultation (capstone project)

Remote Sensing Applicability

- Clearly define project scope and objectives:
  - What are the information needs?
    - Communicate with end users (…ologists other ministries)
    - What will be a useable product
    - What are their expectations
  - Project area: size, shape, ruggedness, remoteness…?
  - Scale, resolution, and extent?
  - Is timing a concern?

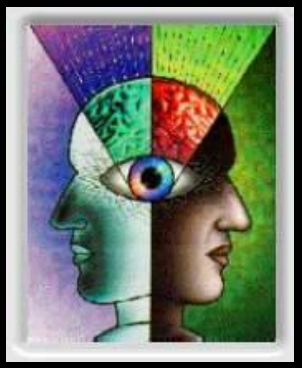
When you have a new hammer, every problem looks like a nail…

Remote Sensing Applicability

- Identify similar work to yours:
  - Research results, explore end products, what did/not work
  - Contact key staff involved in similar work to yours

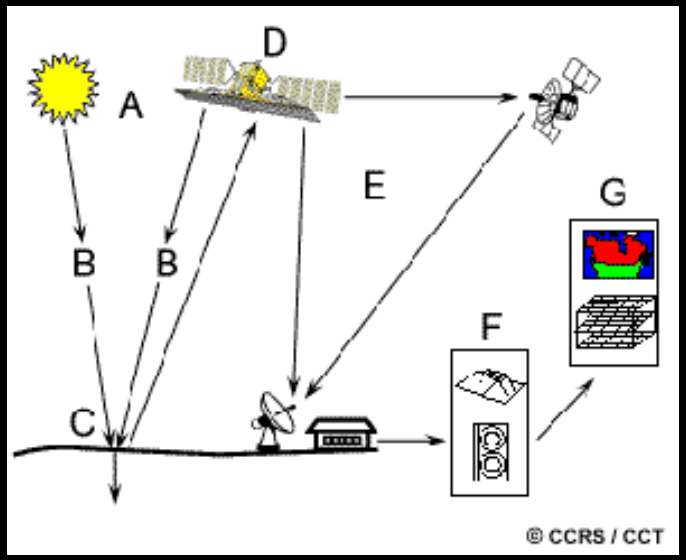
The wheel has been invented!

Remote Sensing Applicability



- The human eye and brain is a very effective and complex remote sensing sensor, we derive information using the following image attributes
  - Size
  - Shape
  - Tone/color
  - Texture
  - Shadow
  - Association
  - Pattern

- Remote Sensing technology attempts to duplicate that process, generally using only a couple of the attributes listed above.
  - Advantages of remote sensing technology
    - Virtually unlimited storage capacity
    - Computer Processing power
    - Automated processing
    - Large landscapes at multiple scales
    - Analyze full EM spectrum



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