

The background of the slide is a photograph of a vast, misty landscape. It features rolling hills and mountains covered in dense evergreen forests. The atmosphere is hazy, with a blue-green tint, suggesting a cool, possibly early morning or late evening setting. The text is overlaid on this background.

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Next generation tools for measuring emissions
from the land sector

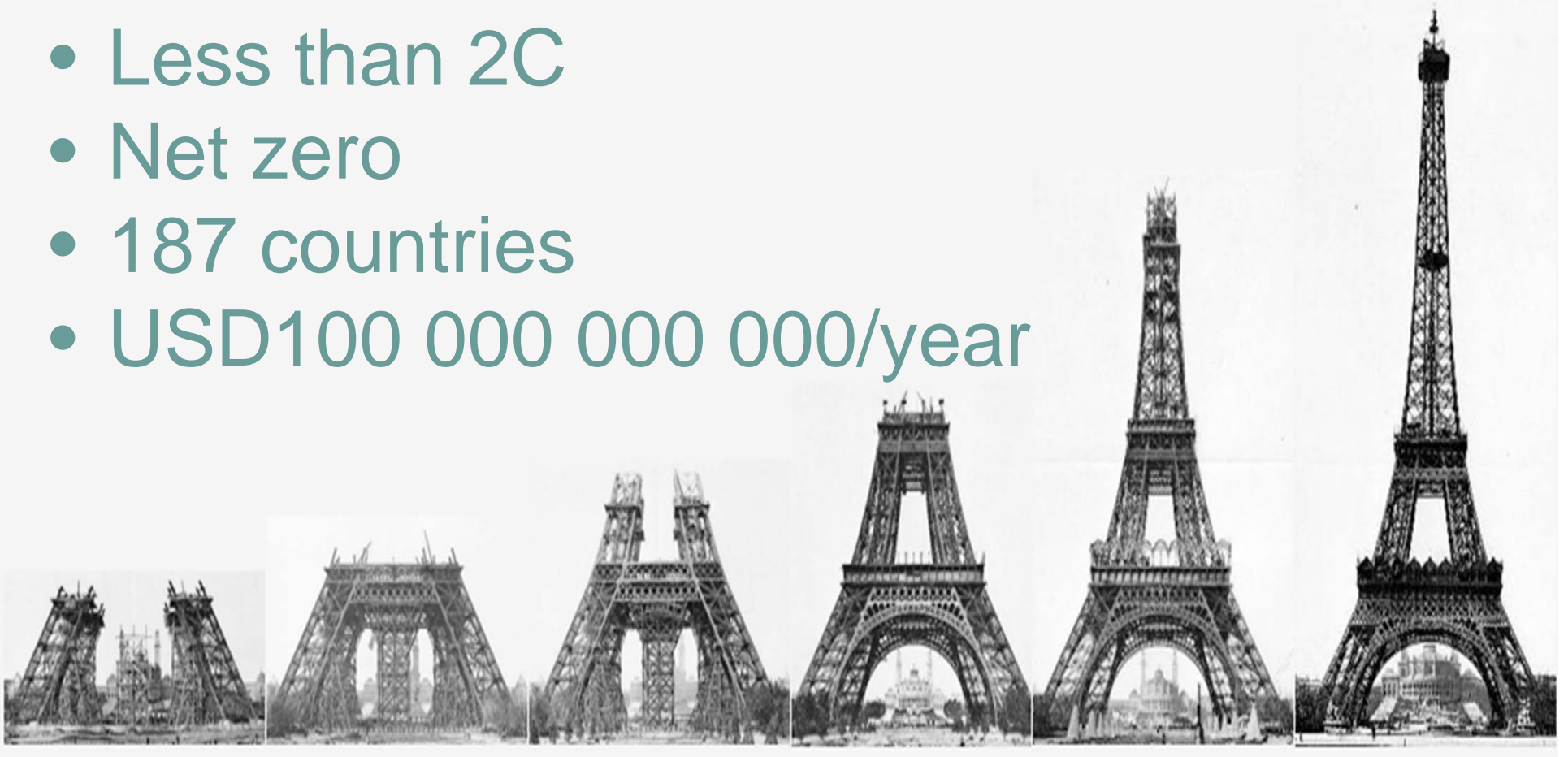
Climate change is one of the biggest challenges of this century



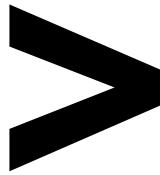
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Global agreement reached in Paris

- Less than 2C
- Net zero
- 187 countries
- USD100 000 000 000/year

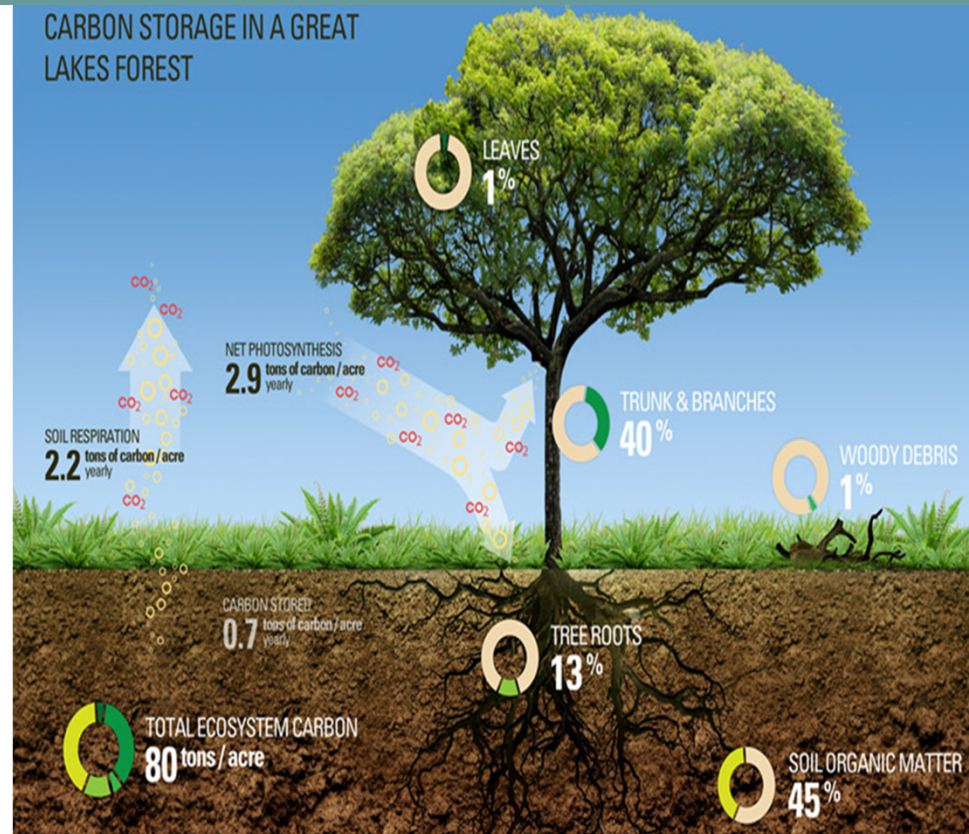


Deforestation is responsible for up to 17% of the world's emissions



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Land must be part of the solution



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Measuring progress is key to unlocking climate finance



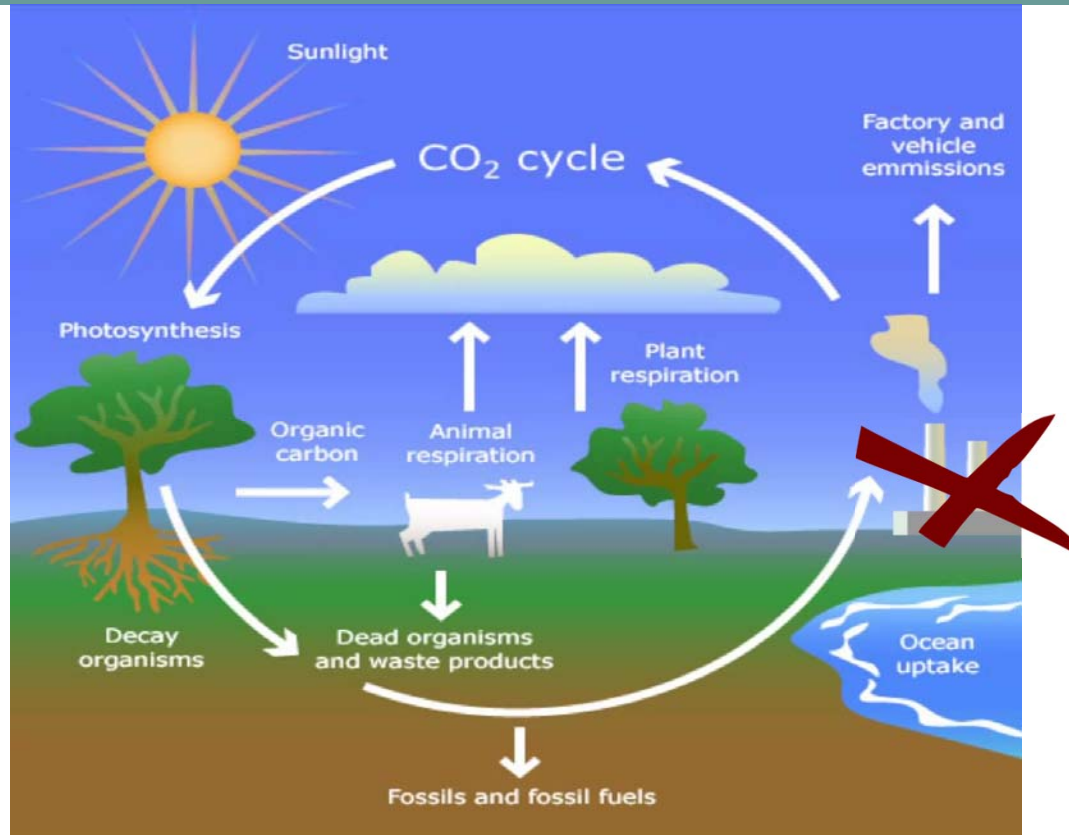
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Full Lands Integration Tool (FLINT)

Full Lands Integration Tool (FLINT)

Follow
The
~~Money~~
Carbon



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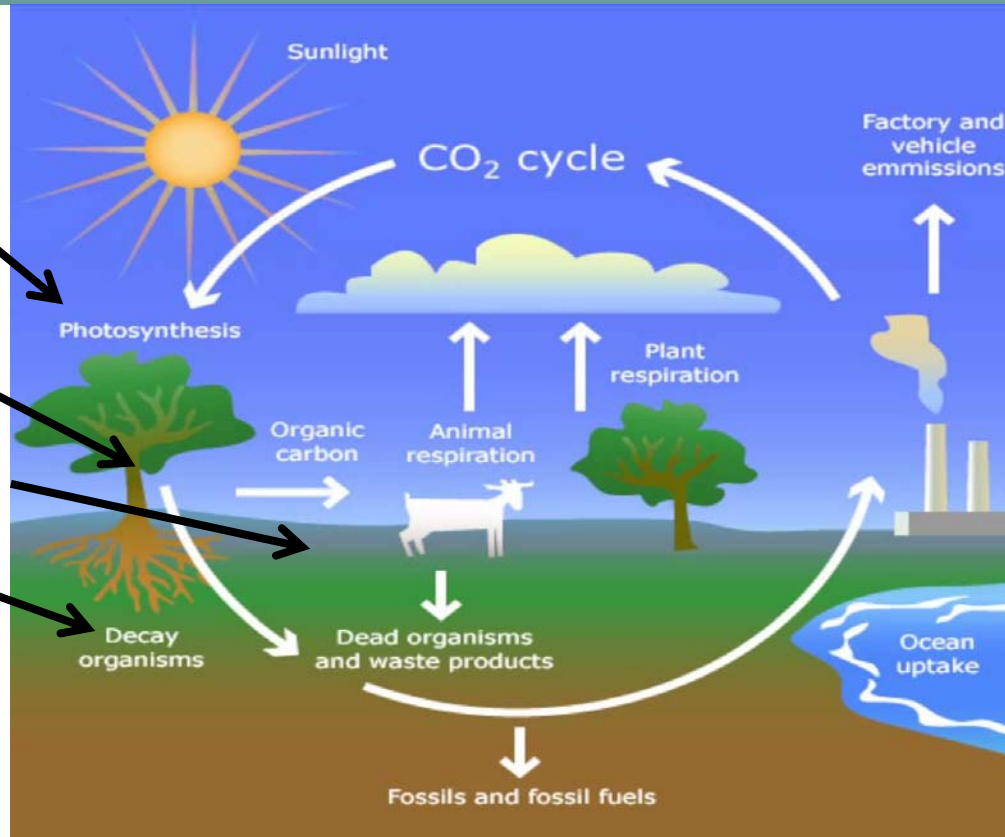
Full Lands Integration Tool (FLINT)

Growth Model

Litter Model

Product Model

Decay Model



Event Models:

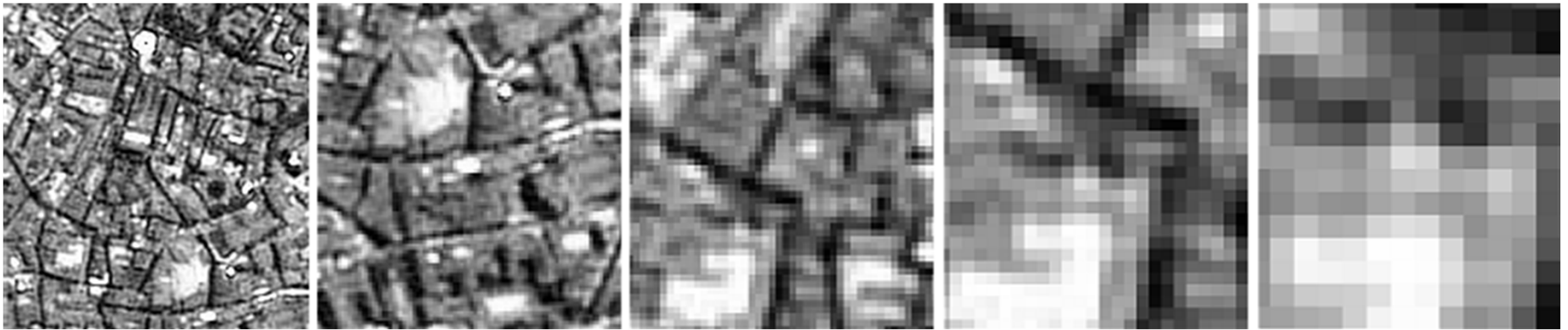
- Fires
- Harvest
- Insects
- Windstorms
- Floods
- etc

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The background of the slide is a photograph of a vast, hazy mountain landscape. In the foreground, there are dark, silhouetted evergreen trees. Beyond them, rolling hills and mountains are covered in dense green forests. The sky is a pale, hazy blue, suggesting a misty or overcast day. The overall tone is serene and natural.

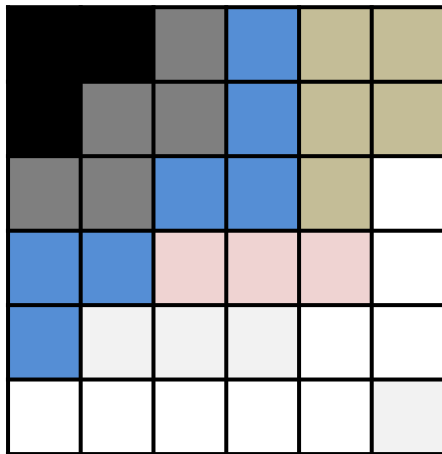
Data Requirements e.g. Kenya

Satellite Image to Pixel



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Pixel to Land Class classification



Photograph



0	0	69	84	120	120
0	69	69	84	120	120
69	69	84	84	120	255
84	84	170	170	170	255
84	237	237	237	255	255
255	255	255	255	255	237

Reflection Value

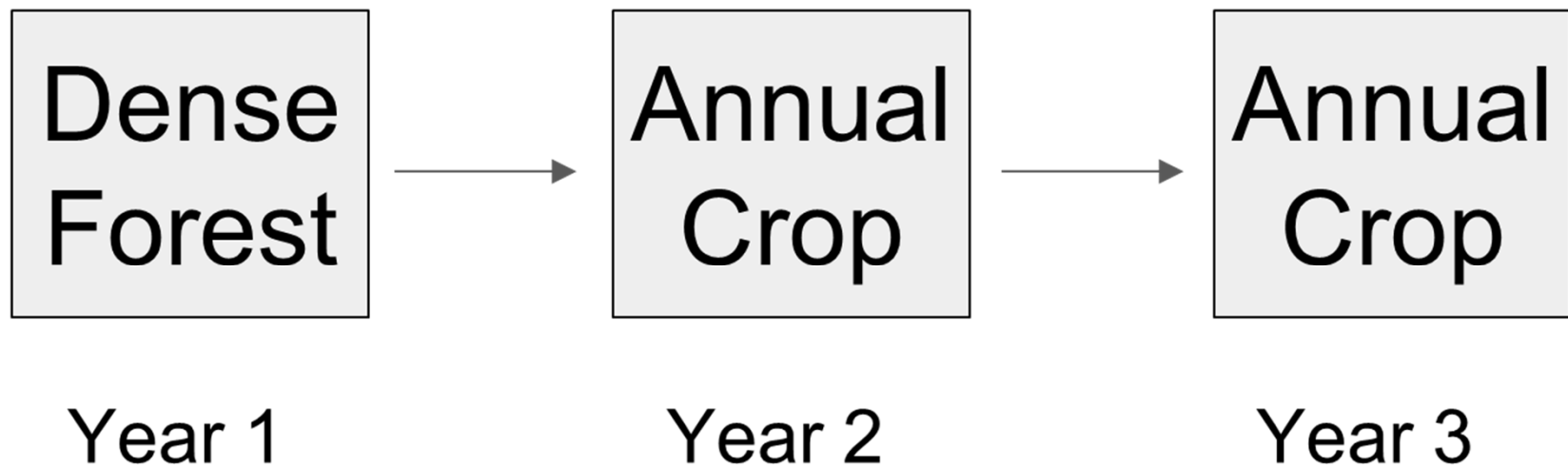


DF	DF	MF	OF	WG	WG
DF	MF	MF	OF	WG	WG
MF	MF	OF	OF	WG	OW
OF	OF	OG	OG	OG	OW
OF	AC	AC	AC	OW	OW
OW	OW	OW	OW	OW	AC

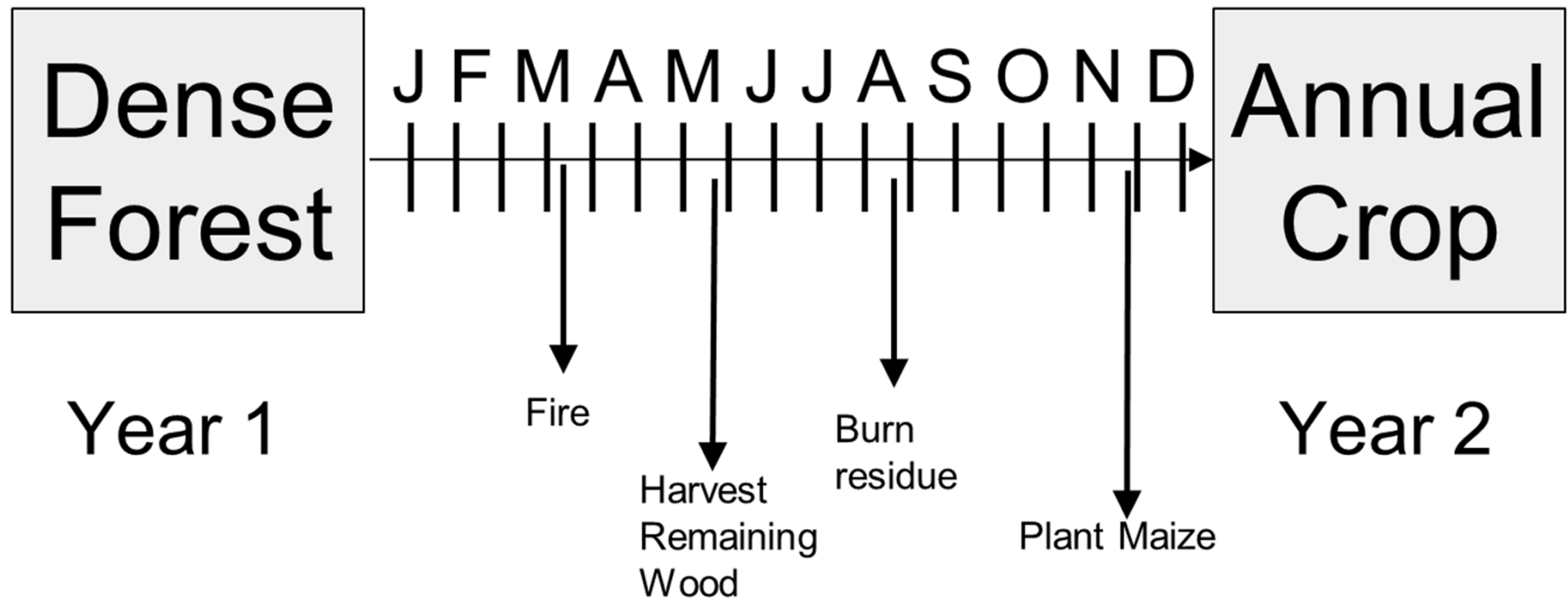
Classification

DF = Dense Forest
MF = Medium Forest
OF = Open Forest
WG = Wooded Grassland
OG = Open Grassland
AC = Annual Crop
OW = Open Water

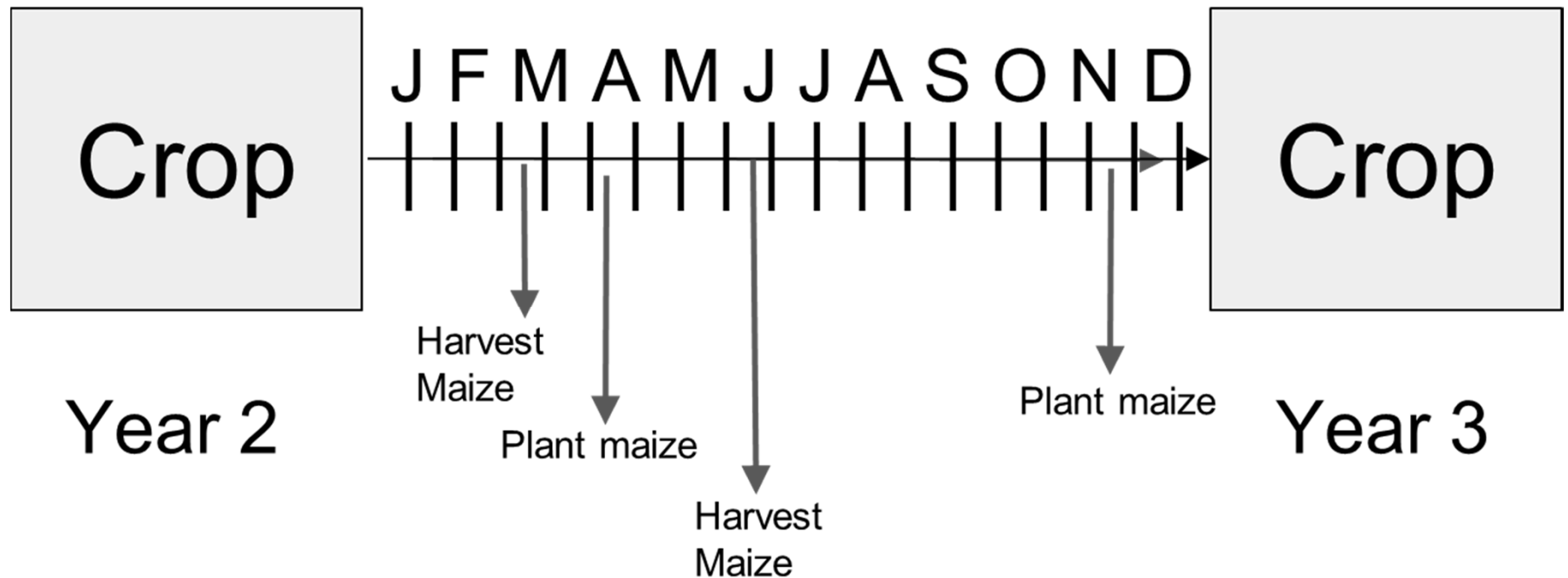
Classification to Time series



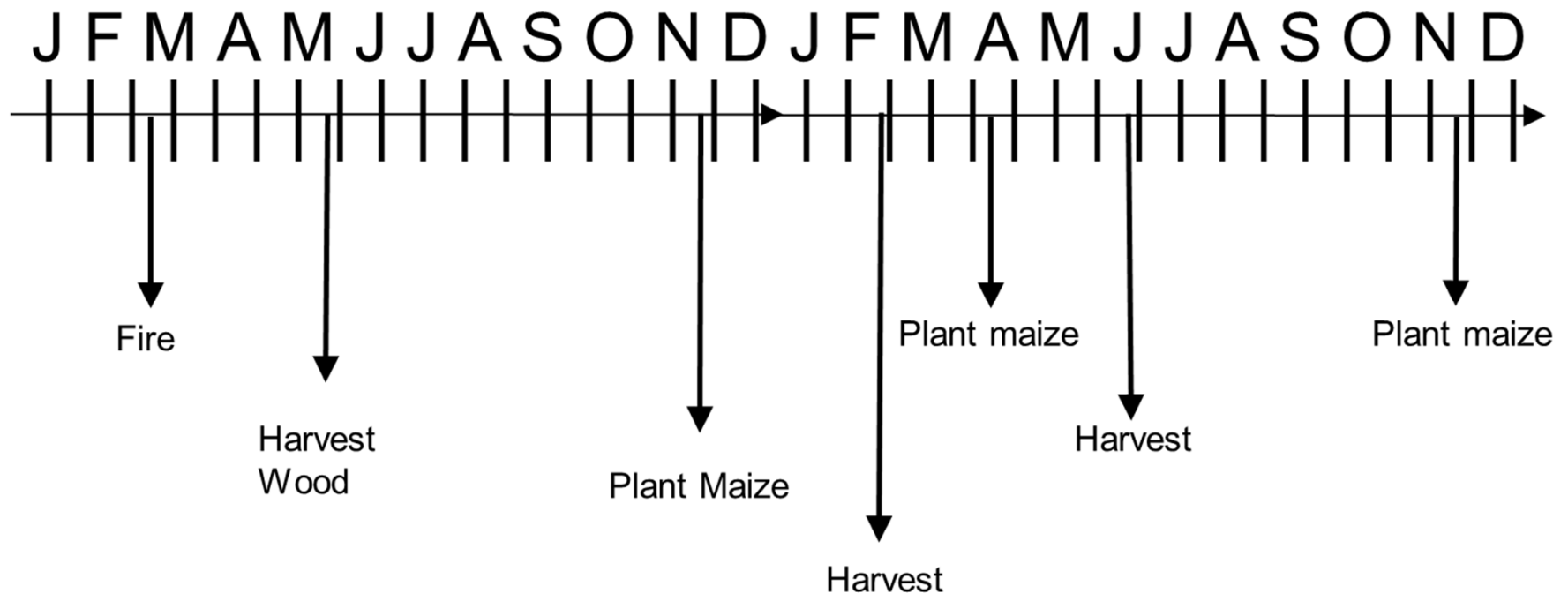
From Time Series to Events



From Time Series to Events



From Events to Events Queue



Remote sensing data



Satellite Images for 35 years

Identify changes of land use and the reason for those changes for each pixel: 8 classes.



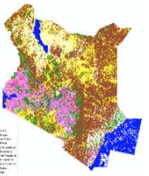
Land cover and use data



778 million pixels for Kenya processed individually, each with 2^{15} possible changes

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Remote sensing data

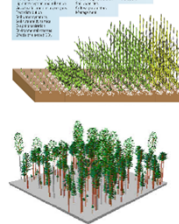


Land cover and use data

Develop models for each type of vegetation, debris and soil for different land management practices (e.g. harvest)



Kenya specific models



Measurements



Calibrate each model to the specific circumstances in the country, using field studies.

Ground data

Forest inventory plots

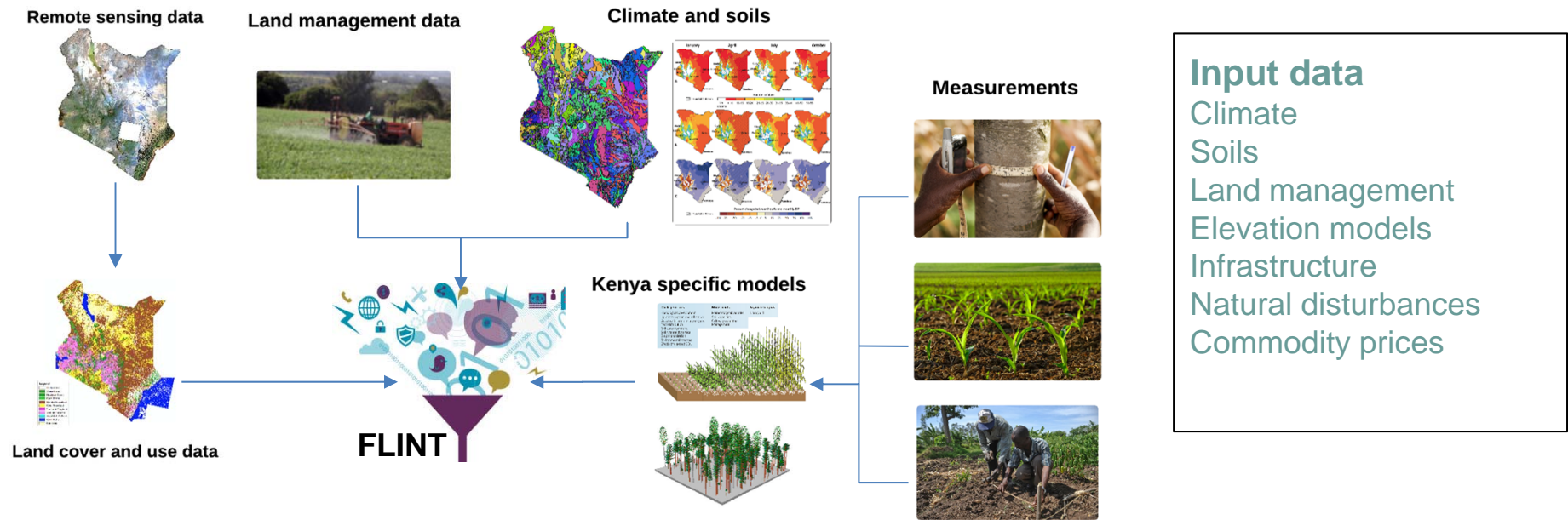
Research sites

Growth models

Community engagement

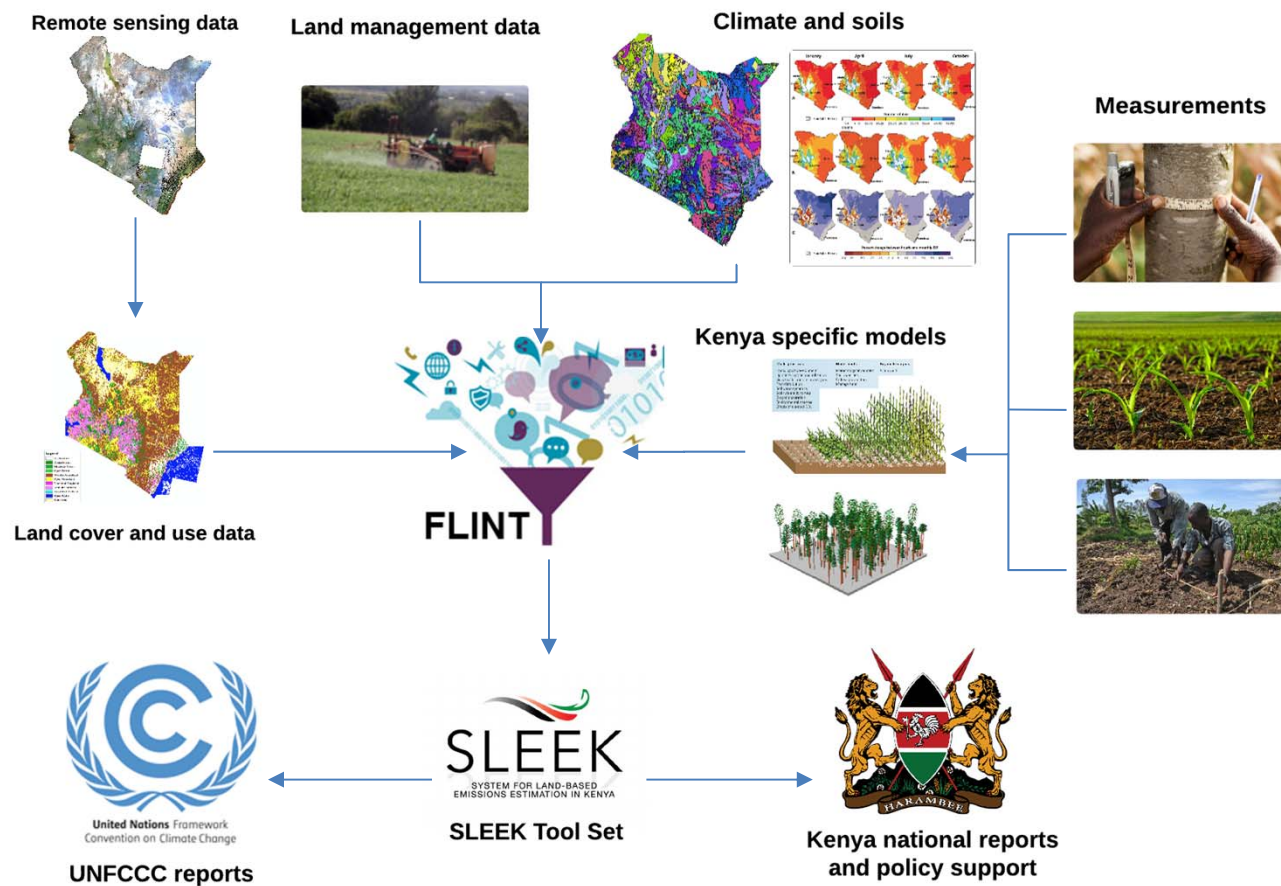
Social studies

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Provide input data to run every pixel through time: each pixel runs for >12500 time steps (daily, 35 years)

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Processing requirements (Kenya)

4 TB of data of input data

+/- 1 Billion individual simulations

Each simulation runs for 12775 time steps (daily, 35 years)

>500 possible outputs each step

Petabytes of potential information

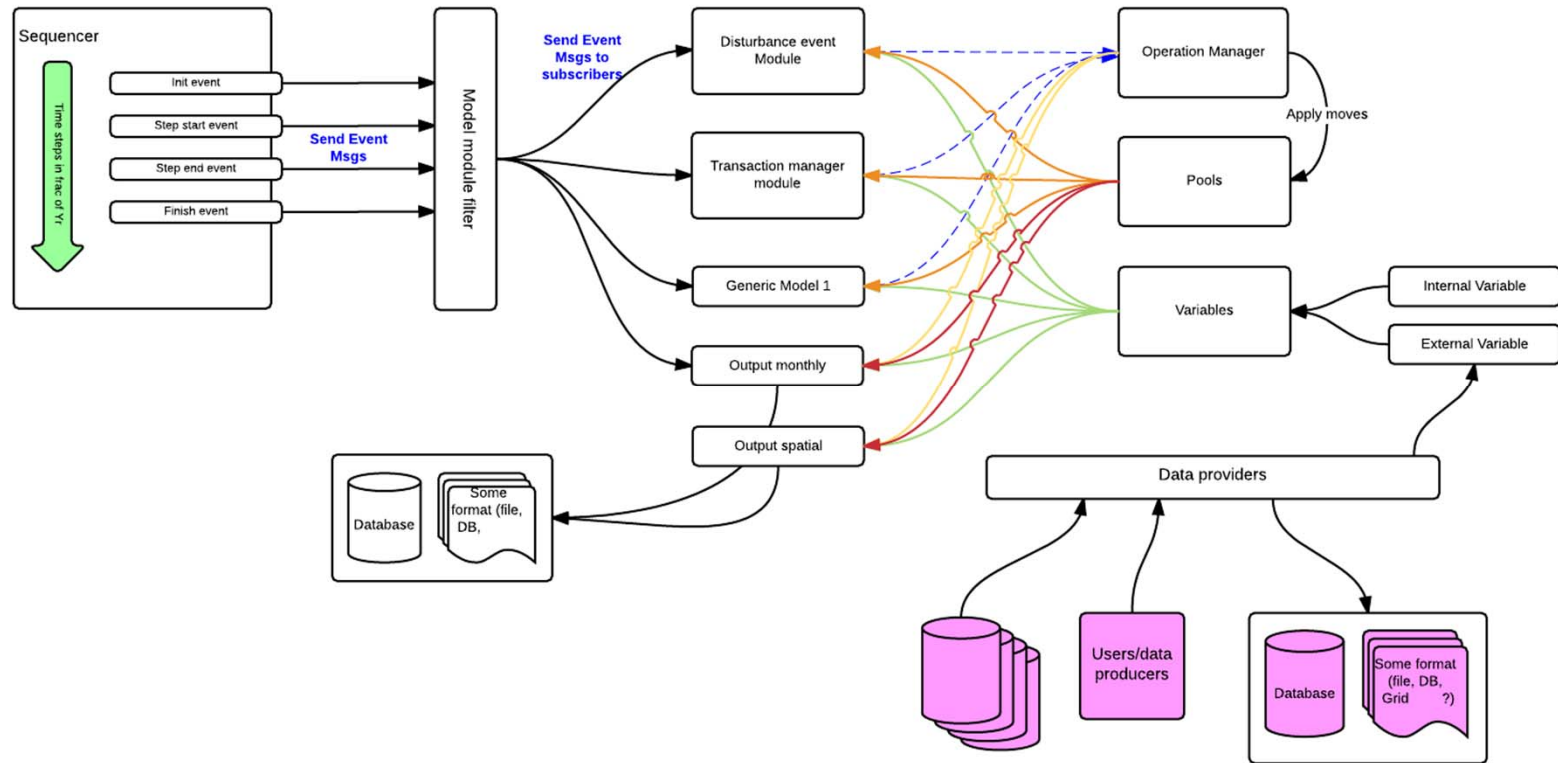
Business intelligence to make sense of it all

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A photograph of a vast, misty mountain landscape. The foreground is filled with dark, dense evergreen trees. In the background, rolling hills and mountains are covered in a thick forest, with a light mist or fog hanging between the ridges. The sky is a pale, hazy blue. The text "The Code" is centered in the middle of the image in a white, sans-serif font.

The Code

What does the code look like?



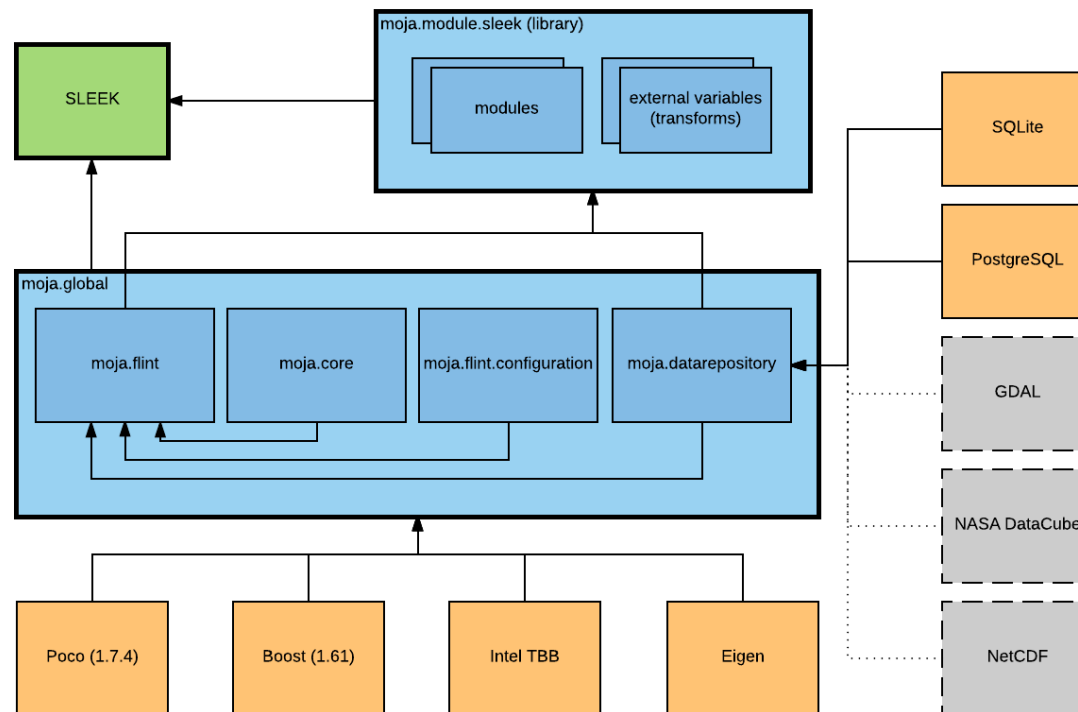
Code base

- Git repository
 - C++ project
 - Under Mozilla Public License, version 2.0
 - moja.global
 - contains FLINT framework for Modules, Carbon pool operations & Simulations. Including basic system Modules and Configurations.
- Current projects:
 - moja.sleek (Kenyan system)
 - moja.canada (Canadian CBM system)

Tools

- Uses CMake for cross platform build: Currently built on Windows, Ubuntu 16.04, Docker (Ubuntu 16.04) (Distributed MS HPC – Docker SWARM)
- Majority of code C++11 (50K lines of code)
- Libraries used:
 - Boost (1.61)
 - Poco (1.7.4)
 - PostgreSQL (9.5.4)
 - SQLite (3.14.1)
 - Eigen (3.2.9) – Matrix library
 - Intel Threading Building Blocks Library
 - Turtle (1.3.0) – Mock objects for Boost

FLINT Libraries



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High Level Projects

1. FLINT framework

- Core FLINT framework (C++ libraries)
- Module wrapper extensions for other languages (C++, C#, Python, R)
- Data repository framework (C++ library)
- Results aggregation and analysis (C++, Docker, Spark, MongoDB, ...)

2. User interfaces

- Web interfaces to run versions of FLINT
- Input Database editors
- Websites for viewing Simulation results

High Level Projects

3. Data inputs and outputs

- Input data pre-processing and QA/QC
- Input database design
- Results storage, querying and business intelligence tools

4. Distributed systems

- Containers (Docker Swarm)
- Open source Apache projects Hadoop, Spark, and Kafka
- Cloud based solutions (AWS, Azure)

High Level Projects

5. Policy, science and reporting

- Module design and assessment
- Configuration set-up and management
- Default data input assessment
- Management of default systems
- Alignment with international policy and reporting requirements



Will you join us?

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