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Modeling burned areas in Indonesia: the FLAM approach

Johannes Pirker (on behalf of Andrey Krasovskii)

Center for Landscape Resilience & Management (CLR)
Ecosystem Services and Management (ESM) Program
International Institute for Applied Systems Analysis (IIASA)
Laxenburg, Austria

pirker@iiasa.ac.at
www.iiasa.ac.at/esm


Systems Approaches in Support of Sustainability
World Population (POP)
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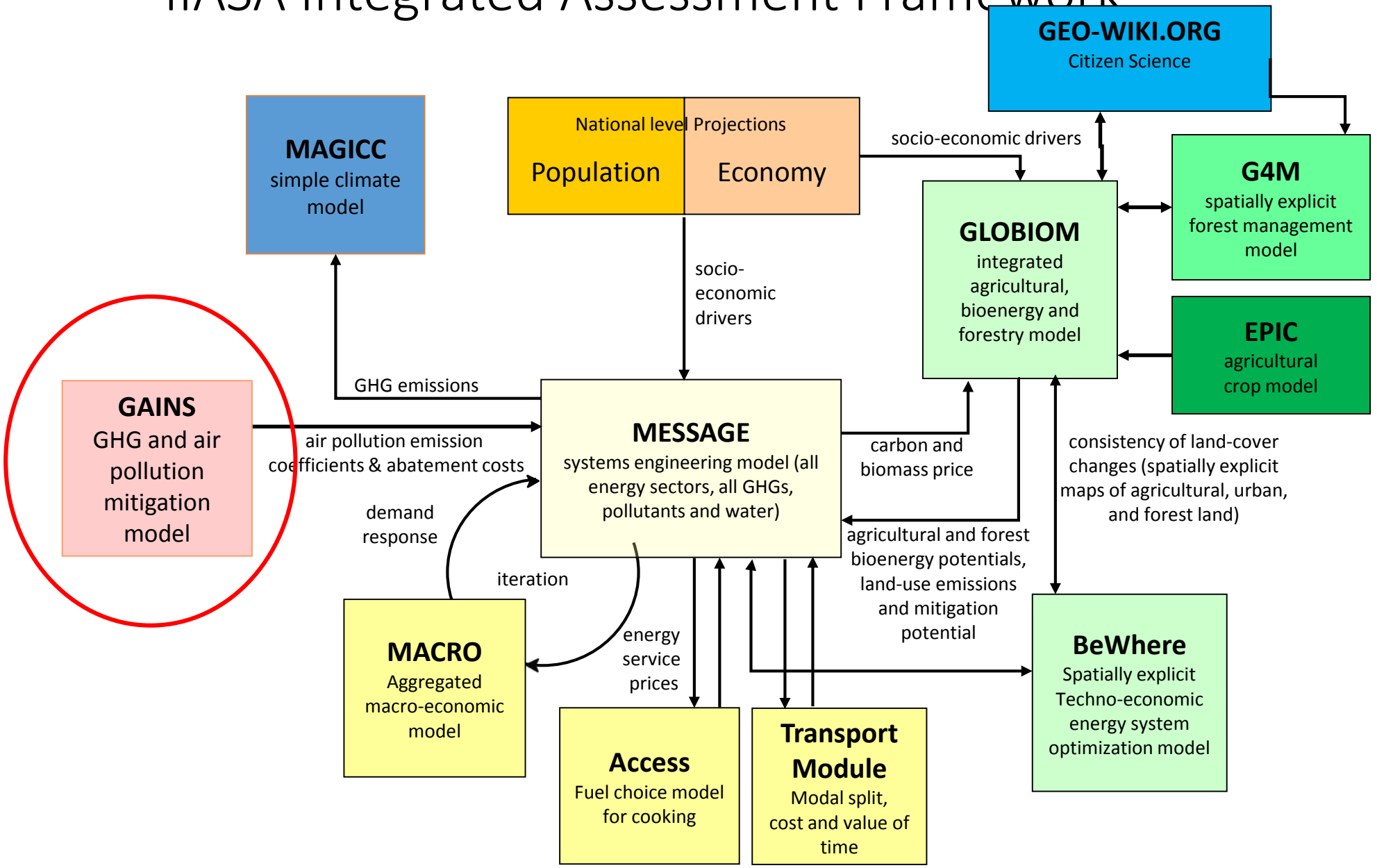
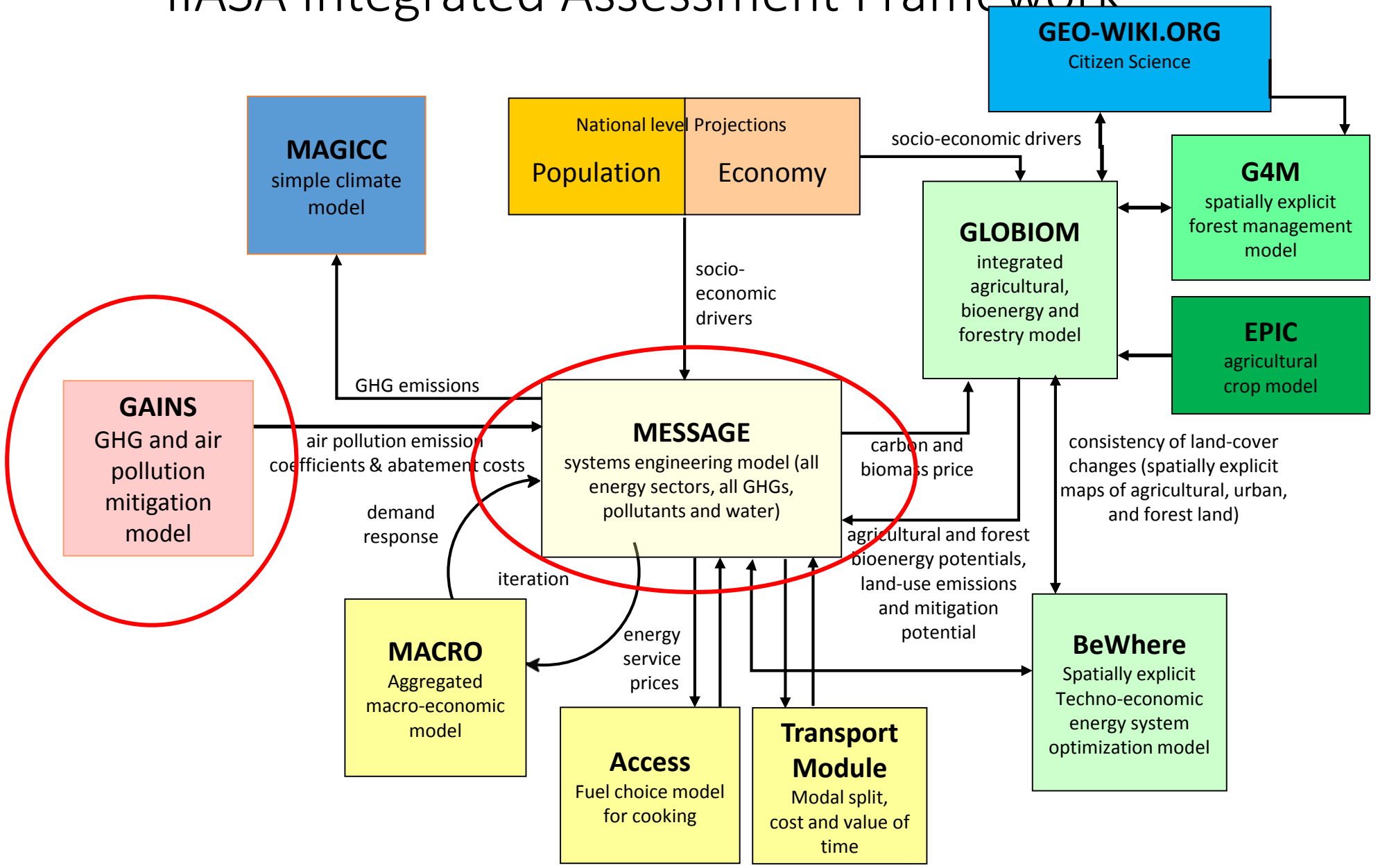
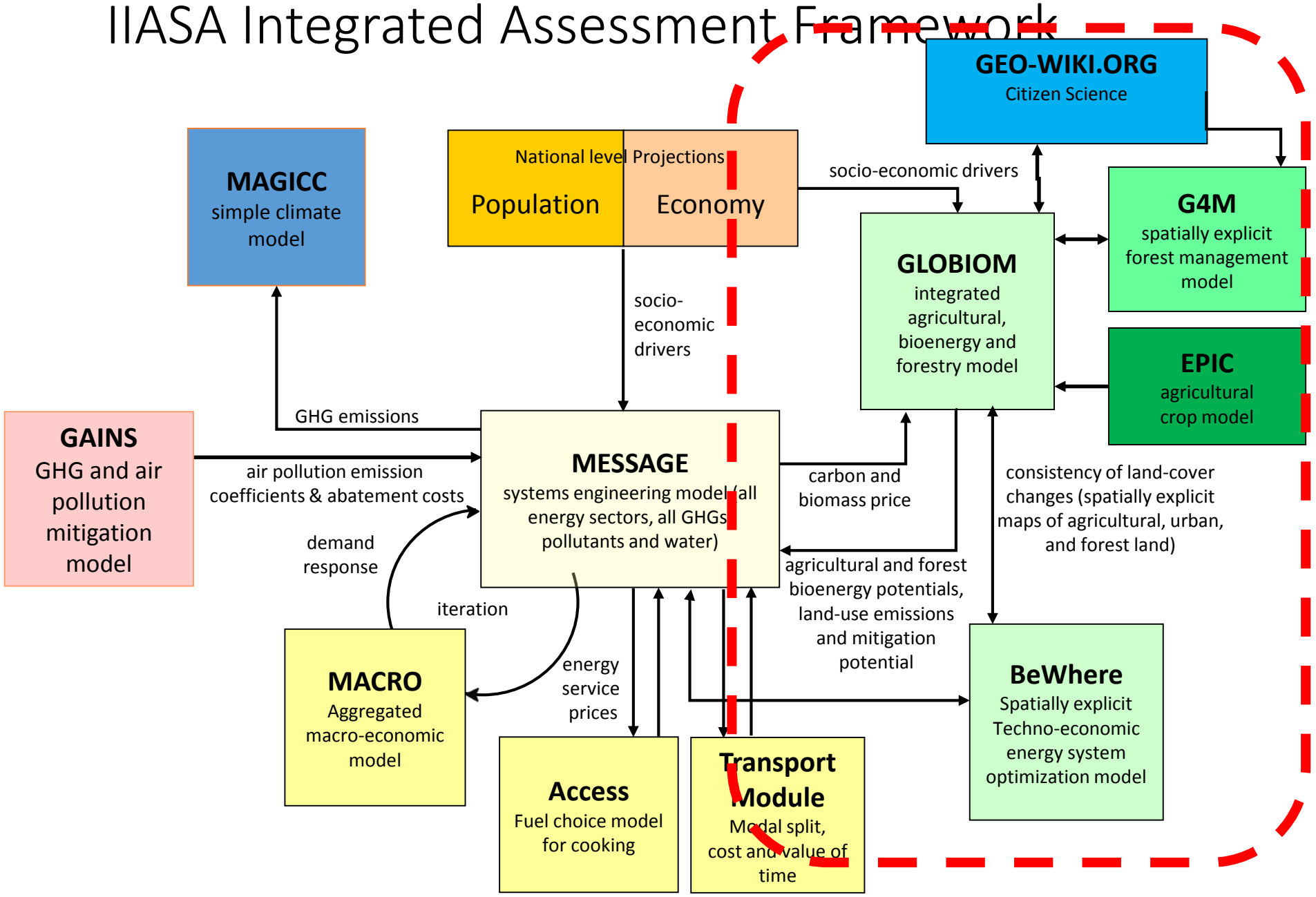
IIASA Integrated Assessment Framework



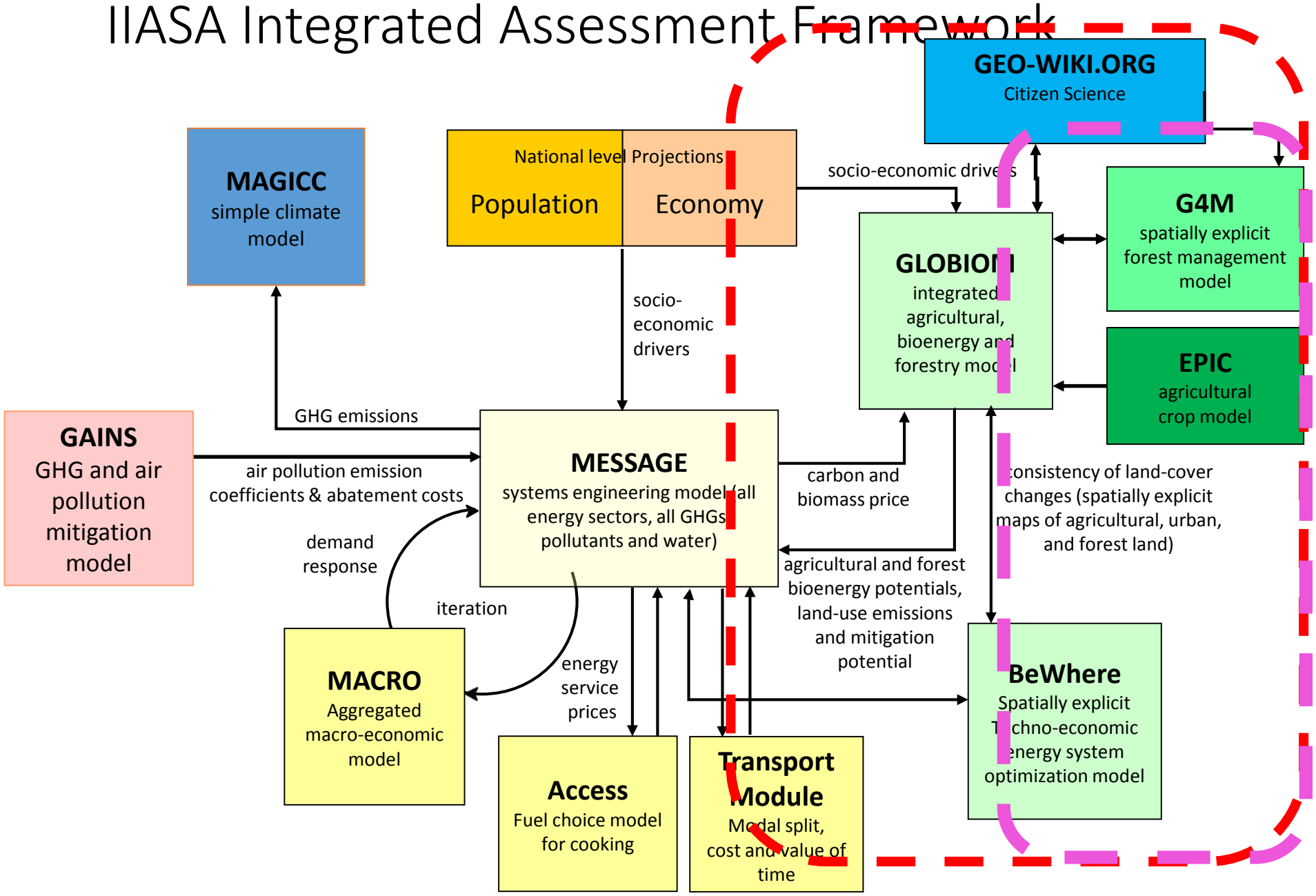
IIASA Integrated Assessment Framework



IIASA Integrated Assessment Framework



IIASA Integrated Assessment Framework

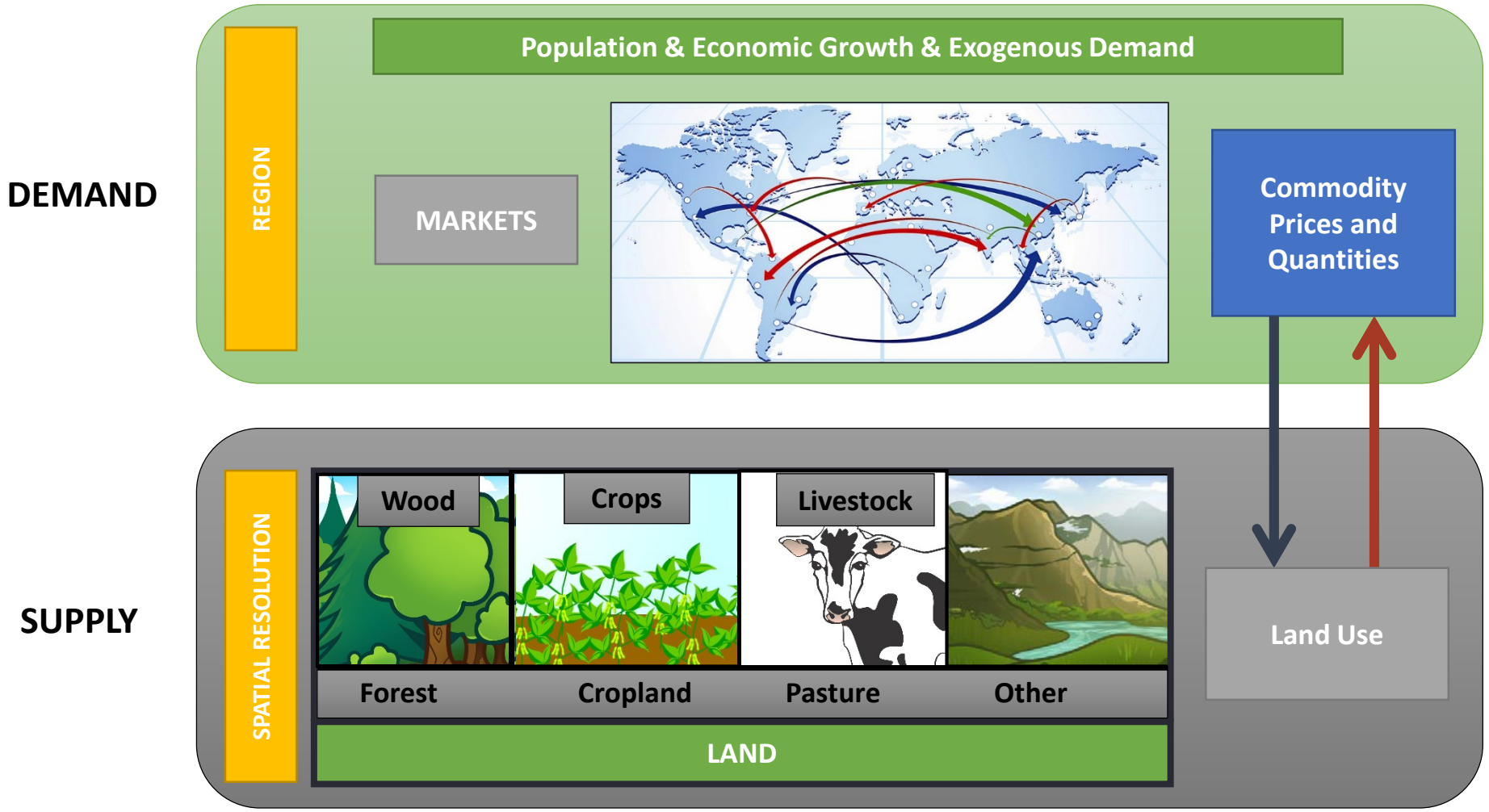


Land Use Models

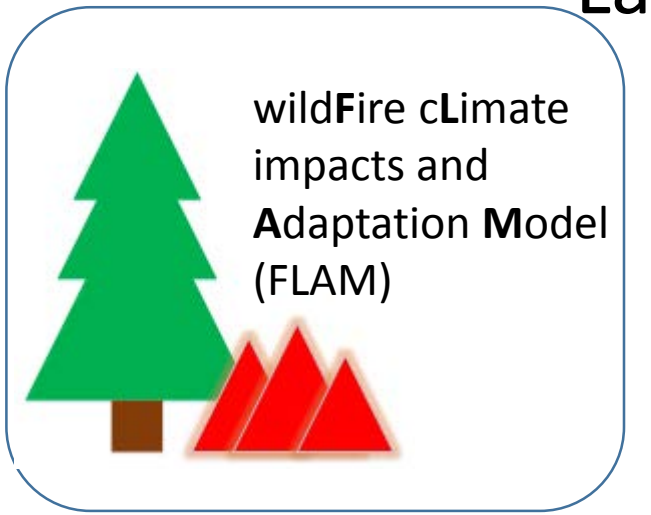
Activities in the region

- RESTORE+
  - 5 years with partners in Indonesia (ICRAF, WRI, WWF)
  - Focus on forest restoration potentials and links with bioeconomy
- Sustainable palm oil futures in Indonesia (completed)
  - 2 years support project to CIFOR FTA Program
- Sustainable Bioeconomy Futures
  - 2 years project in Malaysia with UTM
  - Focus on palm oil sector & potentials for bio-energy
- Private sector
  - Food company Ferrero funding mostly for YSSP
  - Focus on palm oil in Malaysia: remote sensing, bio-energy

Land Use Model Cluster at IIASA-ESM



Land Use Model Cluster at IIASA-ESM



wildFire cLimate impacts and Adaptation Model (FLAM)

DEMAND

Beyond Homo economicus

SUPPLY

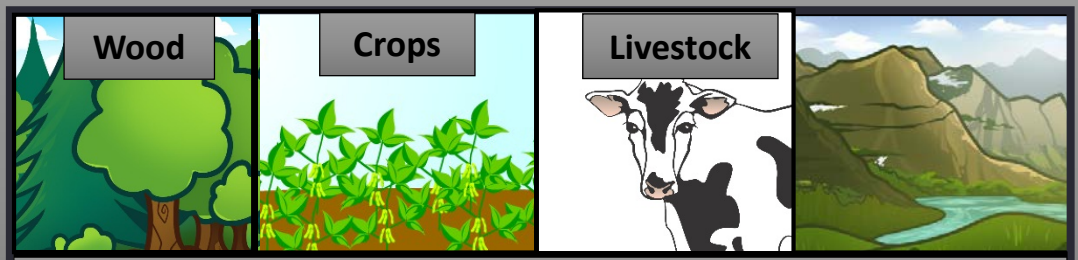
REGION

Population & Economic Growth & Exogenous Demand

MARKETS

Commodity Prices and Quantities

SPATIAL RESOLUTION



Forest | Cropland | Pasture | Other

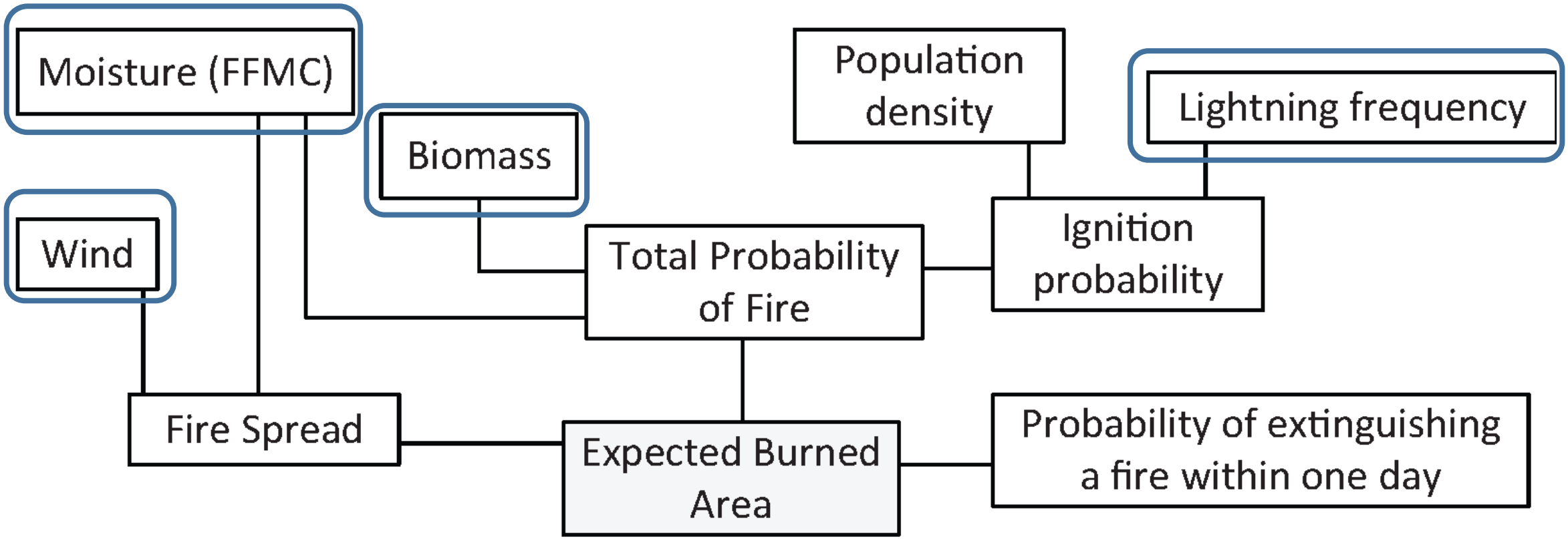
LAND

Land Use

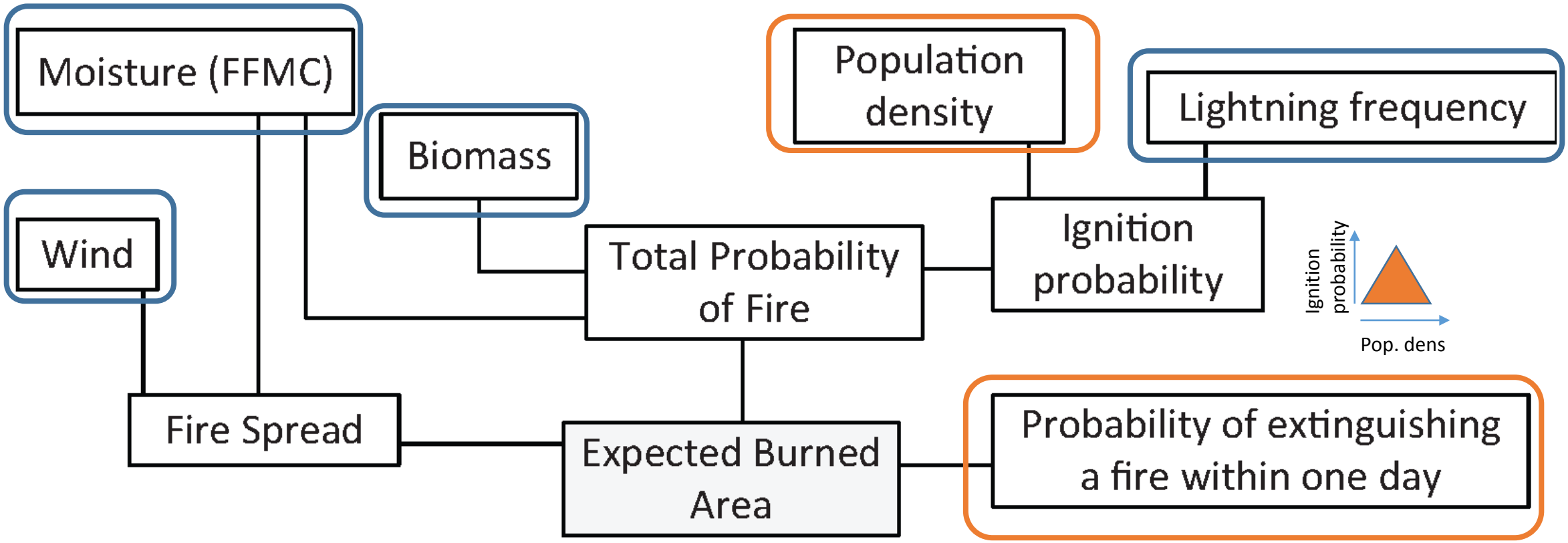
Introduction

- Large-scale wildfires affect millions of hectares of land in Indonesia, produce severe smoke haze pollution and carbon emissions with negative impacts on climate change, health, economy, and biodiversity
- Drivers generally known: weather/climate, land use, human activity
- We develop a mechanistic wildfire model (FLAM) to estimate burnt areas & locations in Indonesia for the first time
- Model validation against remotely sensed evidence of fires (GFED database)

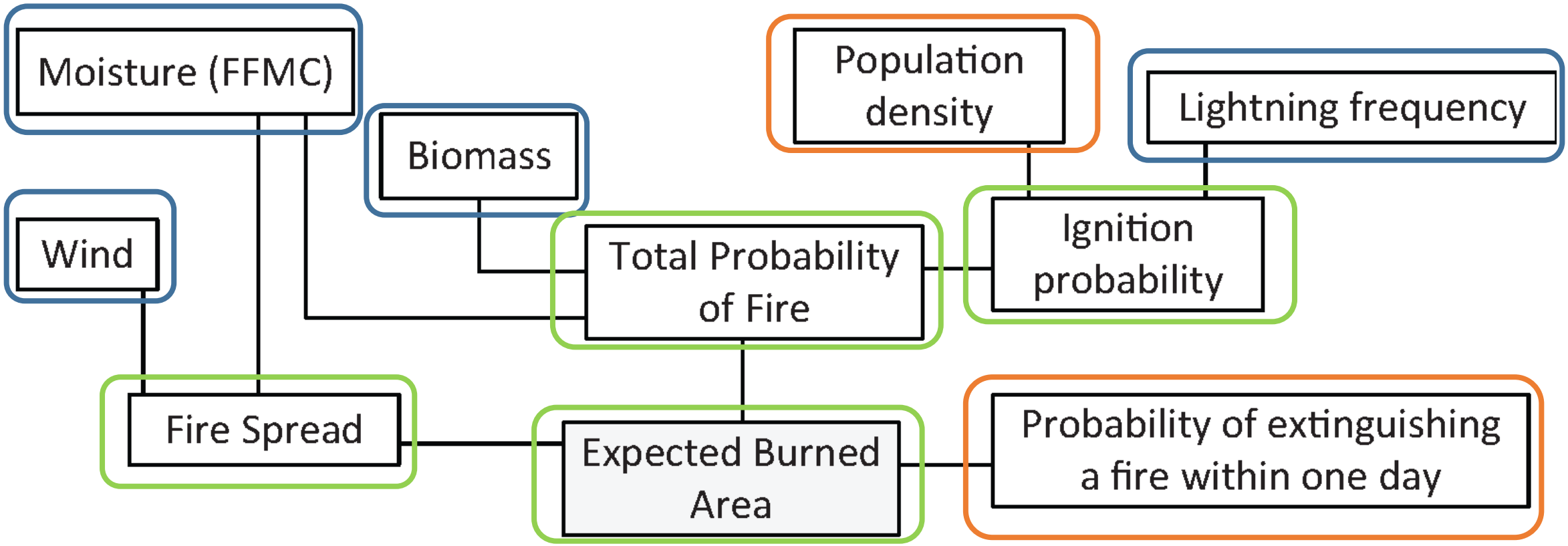
FLAM flowchart



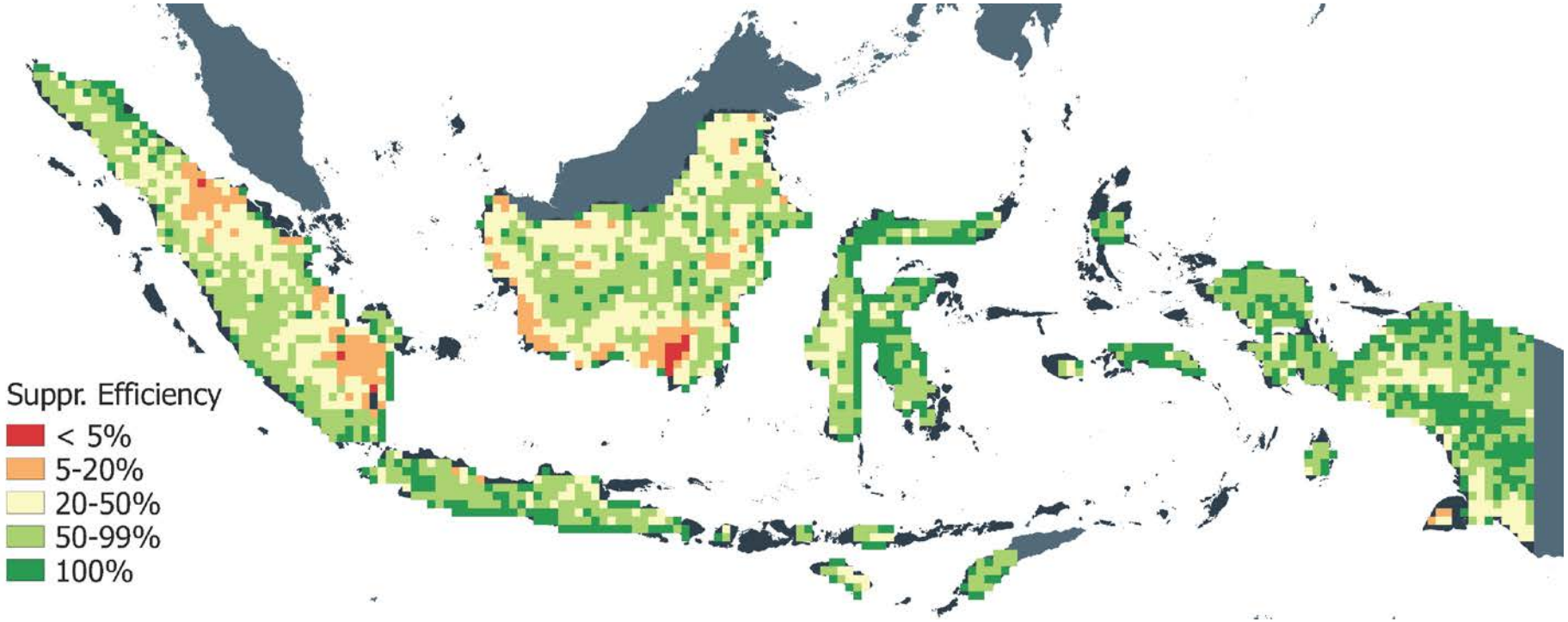
FLAM flowchart



FLAM flowchart



Calibration of spatial suppression efficiency

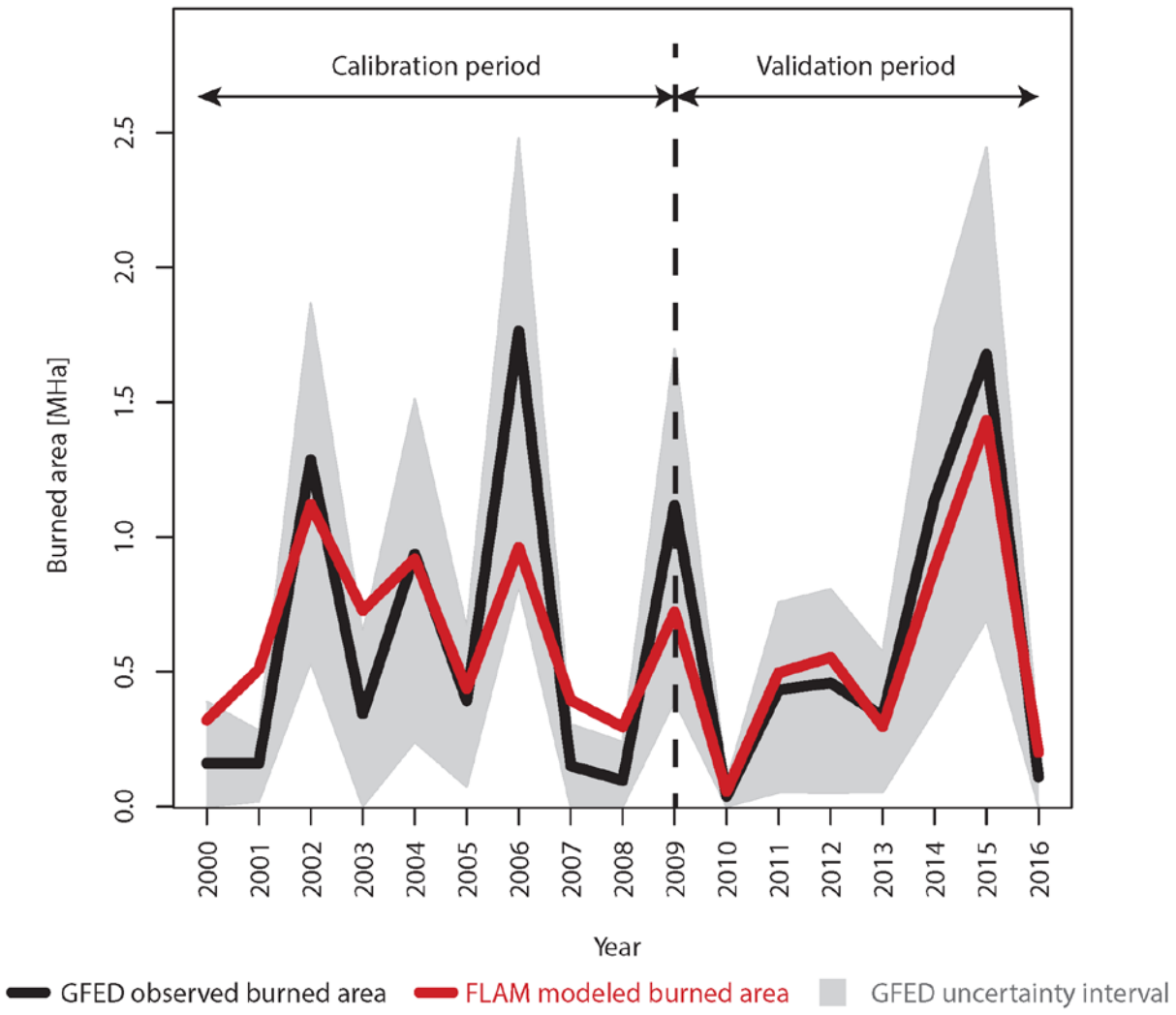


Spatial suppression efficiency calibrated in FLAM using burned area reported in GFED for wildfire in Indonesia, accumulated over 2000-2009.

Table 2. Calibrated suppression efficiency (q_c) in the wildfire and its connection to area burned.

Suppression Efficiency Threshold	$q_c < 0.1$	$q_c < 0.2$	$q_c < 0.3$	$q_c < 0.4$	$q_c < 0.5$	$0.5 \leq q_c < 1$	$q_c = 1$
Ratio of pixels within threshold	0.02	0.07	0.14	0.24	0.35	0.42	0.23
Ratio of aggregated burned area							
FLAM = GFED	0.35	0.63	0.8	0.9	0.95	0.05	0
Original fire algorithm ($q = 0.5$)	0.01	0.02	0.07	0.13	0.19	0.35	0.46

Results of temporal validation



Results of temporal validation

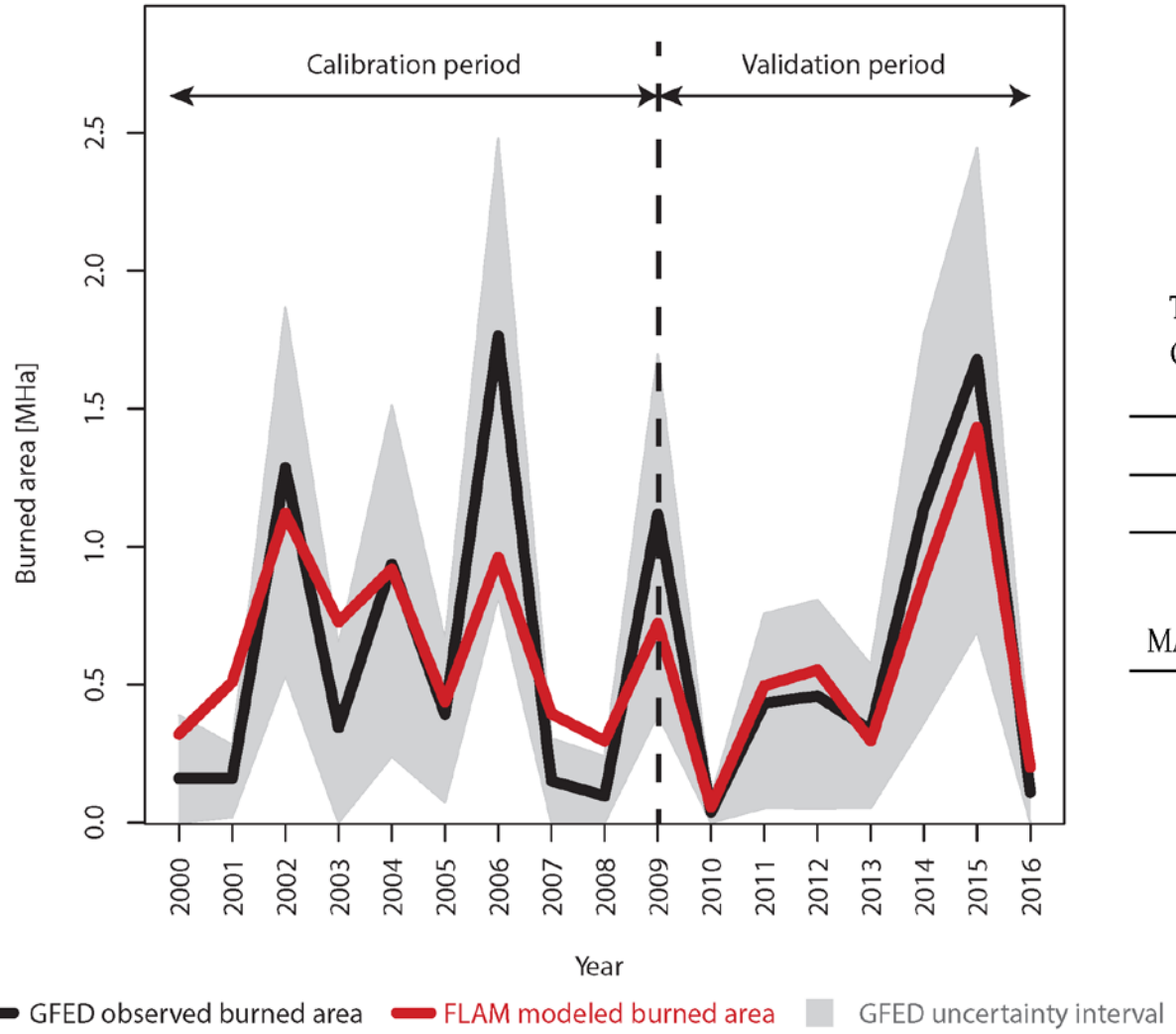
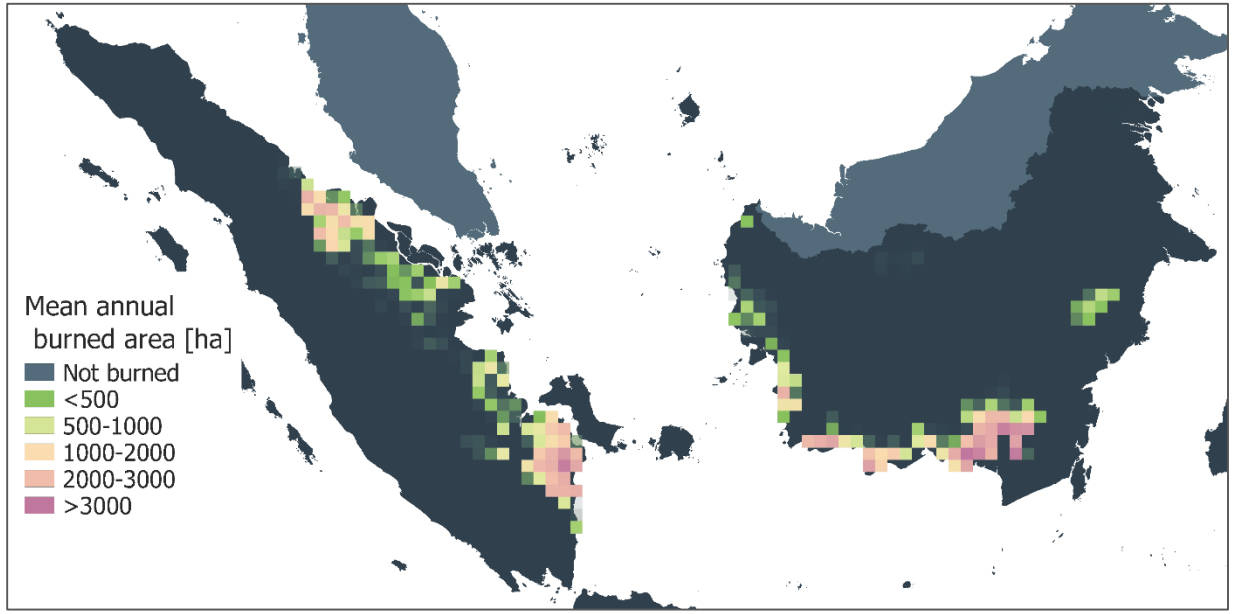


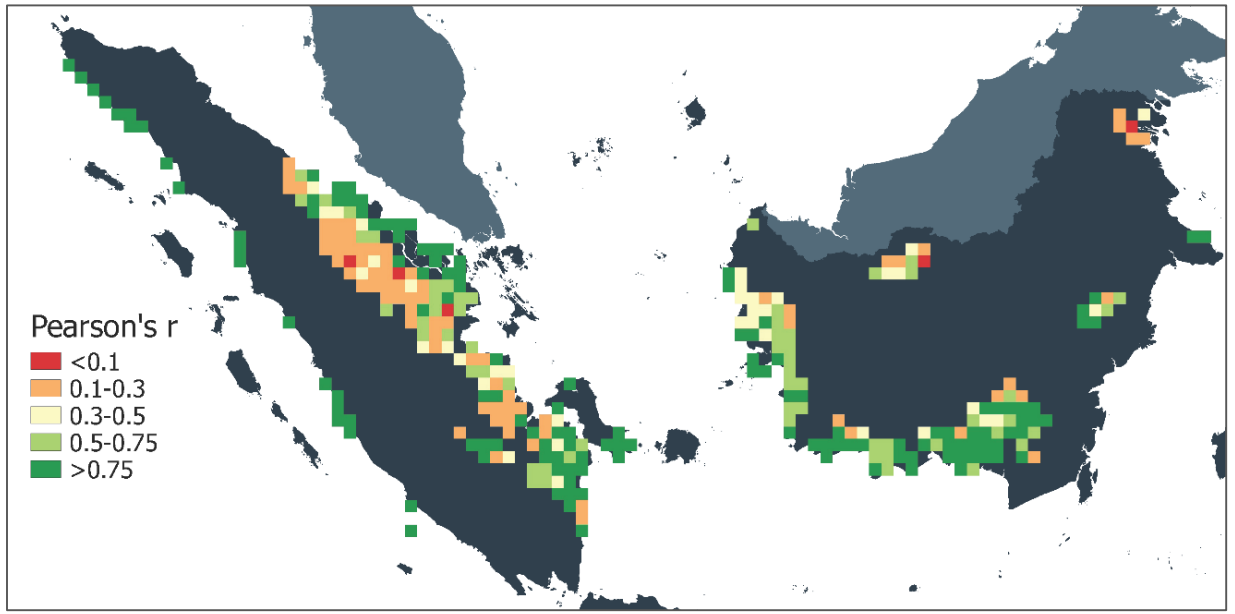
Table 1. Mean Absolute Error (MAE) and Pearson's *r* for annual country level burned areas reported in GFED and modeled in FLAM for the calibration period 2000–2009 and the validation period 2010–2016.

Period	Calibration Period (2000–2009)		Validation Period (2010–2016)	
Type of Fire	Peat Fire	Wildfire	Peat Fire	Wildfire
Pearson's *r*	0.857	0.865	0.988	0.988
MAE (thousands of ha)	169.25	257.93	35.56	106.71
MAE relative to average burned area	47%	43%	11%	19%

Results of spatial validation (years 2010-2016)



Observed (GFED)



Correlation FLAM results vs Observed Fires

Conclusions

- Integration of socio-economics AND bio-physical information is key
- FLAM was able to correctly estimate the magnitude of extreme events such as the 2015 fire season
- From wildfires to haze: Information on fire intensity and emission factors needed

Thank you for your attention!

www.iiasa.ac.at/flam

pirker@iiasa.ac.at

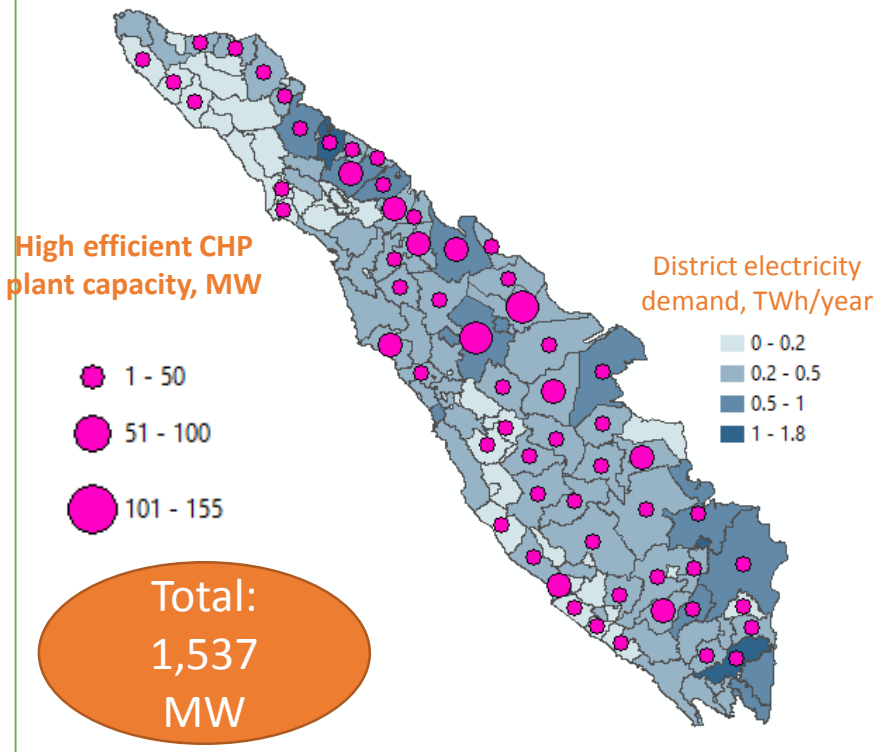
More Information about IIASA-ESM

- FLAM Forest Fire modeling: https://doi.org/10.3390/f9070437
- Oil palm deforestation patterns in Indonesia: DOI:10.1016/j.landusepol.2017.08.036
- With oil palm private sector company: https://goo.gl/8LLEjT
- A Global oil palm suitability map: DOI:10.1016/j.gloenvcha.2016.06.007
- On the Indonesian zero-deforestation moratorium DOI:10.17528/cifor/006468
- On EU biofuels and land use impact: DOI:BIENL13120
- RESTORE+ project: http://www.restoreplus.org/
- ILUC Quantification Study of EU Biofuels: http://www.globiom-iluc.eu/

Example private sector YSSP funding: Results - Can the oil palm industry contribute to meet the bioenergy target?

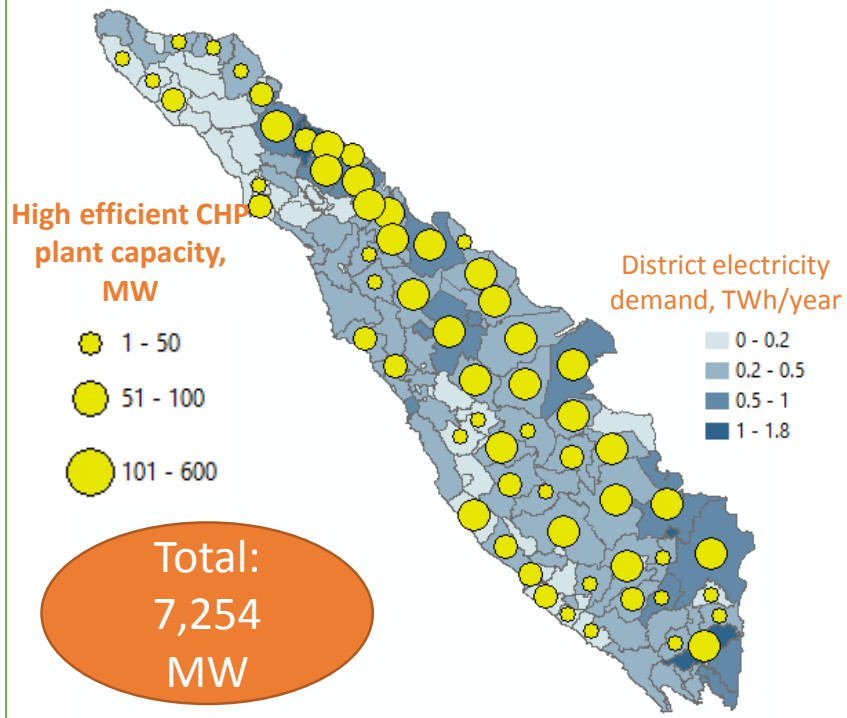
RESULTS

Reference scenario



- **28%** of bioenergy target
- New investment **0.3 billion USD/year**

Scenario 2: Increase bio-electricity demand

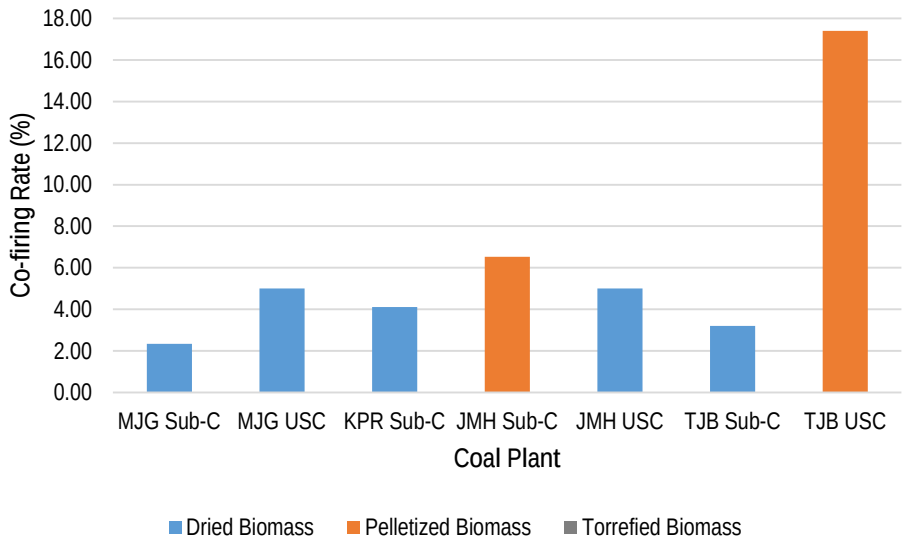


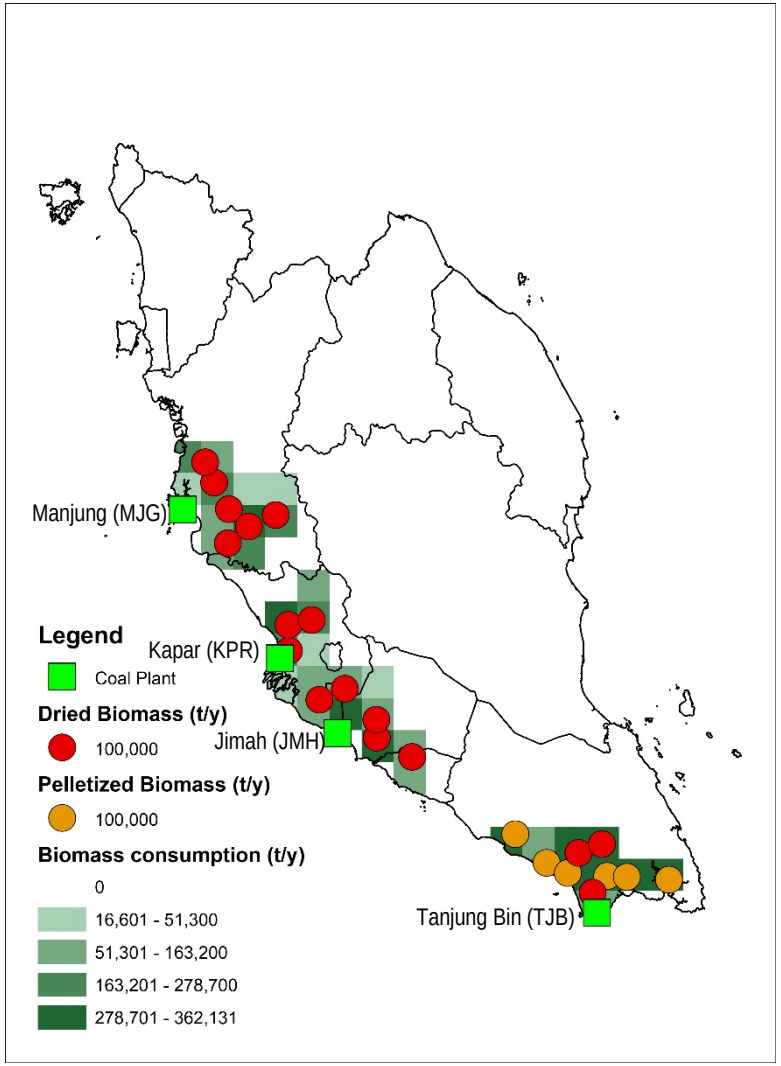
- **100%** of renewable energy target
- New investment **1.2 billion USD/year**

Source: Fumi Harahap KTH (Sweden)

Example private sector YSSP funding: Results - Co-firing and pre-treatment plant selections

FiT:
70 USD/MWh





Source: Muhammad Nurariffudin
Universiti Teknologi Malaysia (UTM)