Overview of Rice Production Methods, Agricultural Production, and Methane Emissions Estimates

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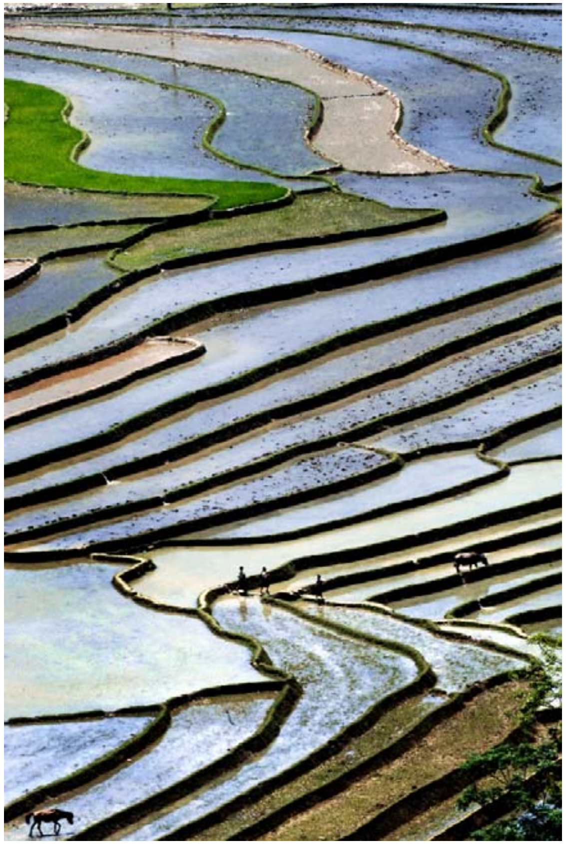
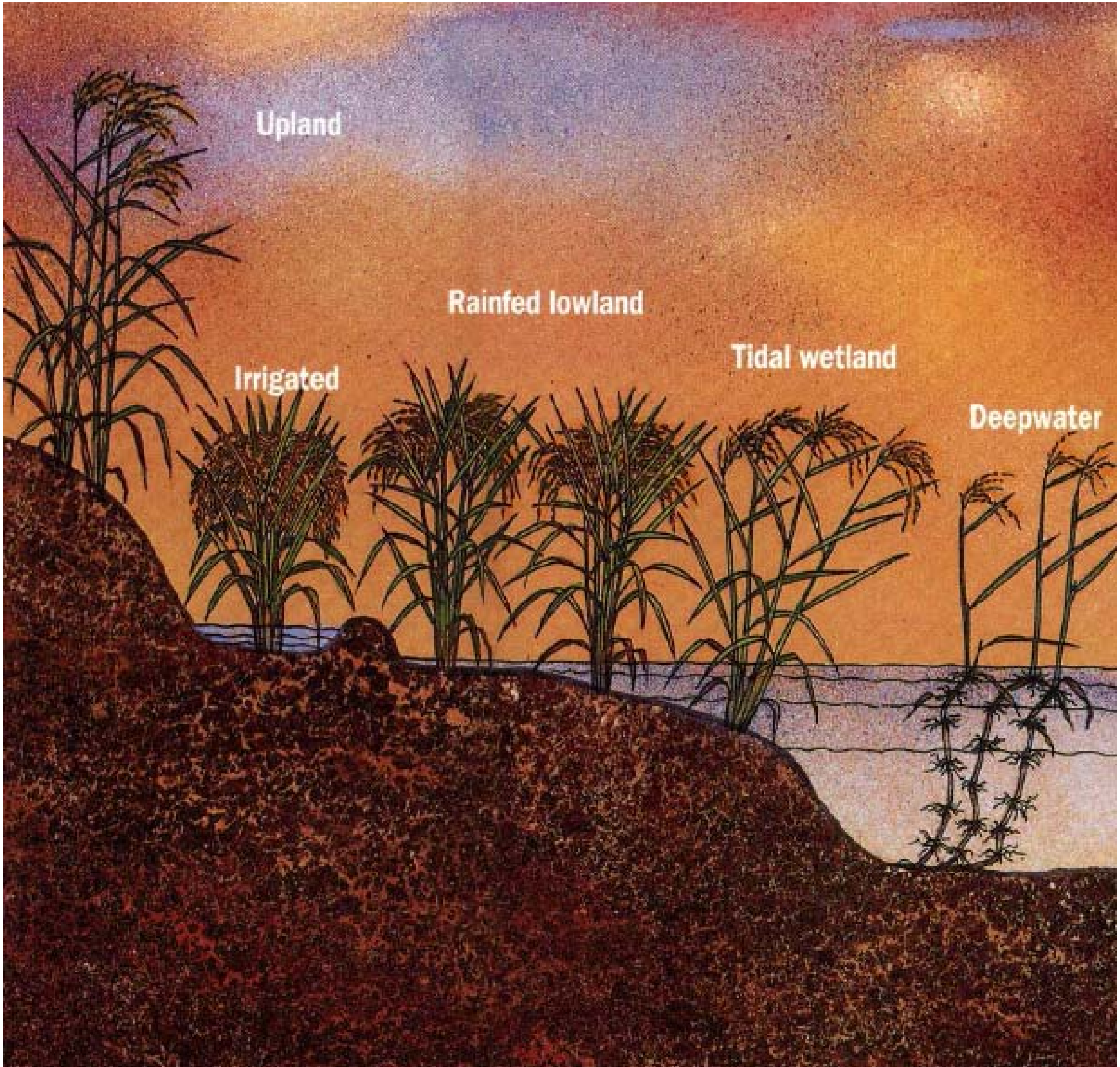


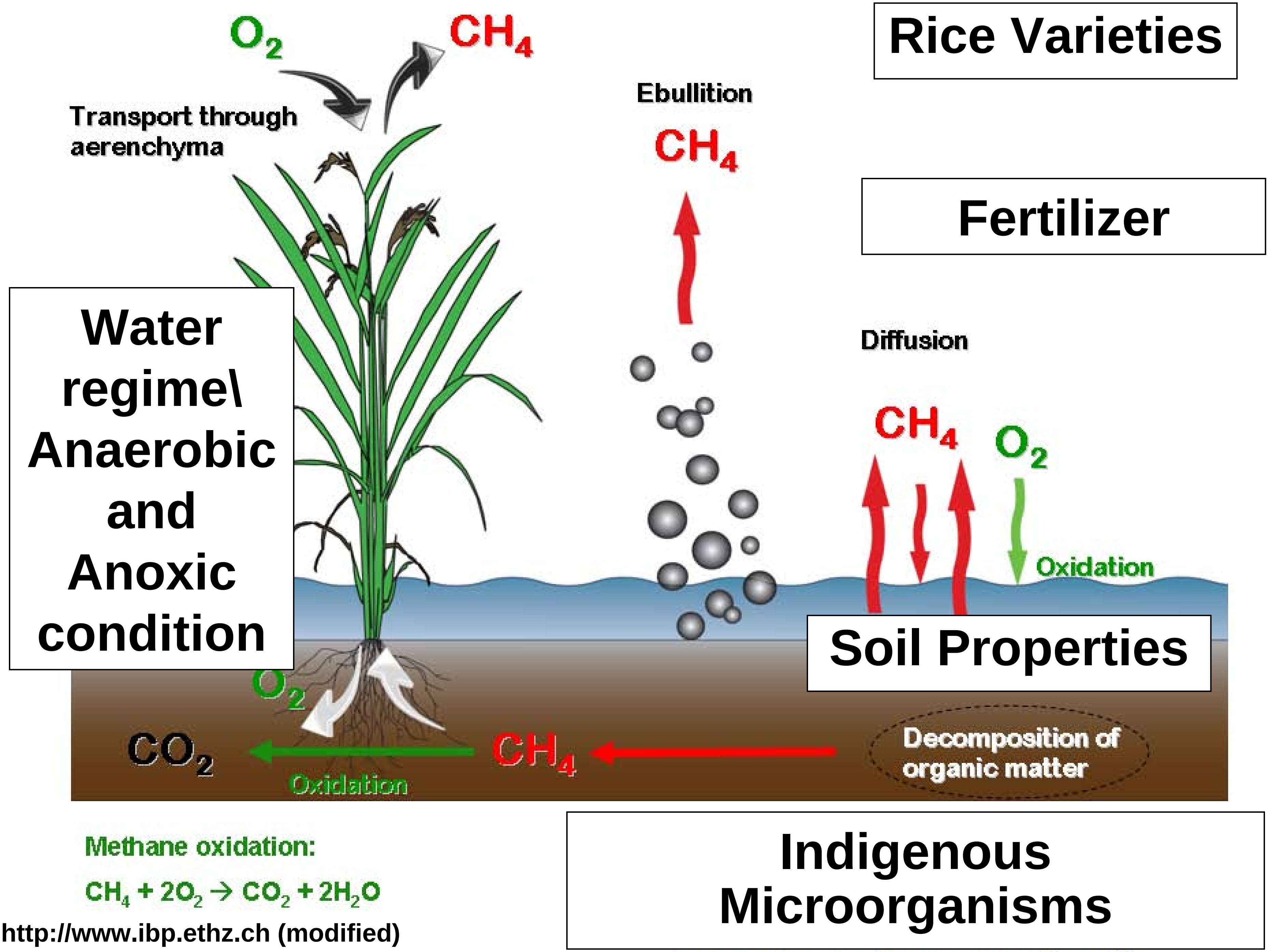
Outline of Presentation

- Background and Context
  - GHG emissions from Asian Rice Fields, Geographic View
  - Underlying natural and anthropogenic factors

- Current GHG Reporting
    - National Inventory
    - Emission factors for Rice Agriculture under different Management
- Remote sensing as tool for agricultural monitoring
- Broad scale applicable agricultural monitoring concepts to generate **Certified Emission Reductions from Rice agriculture**

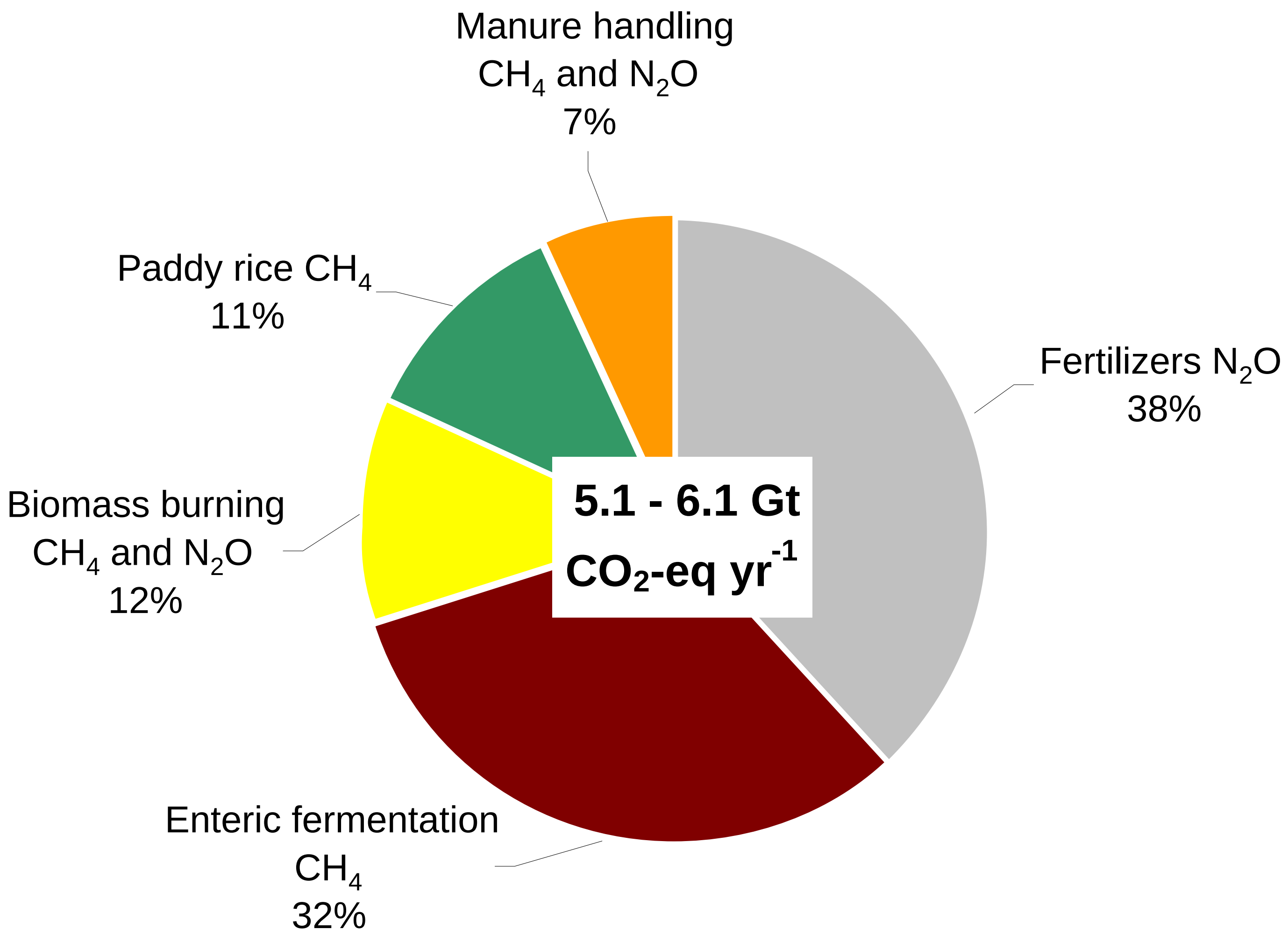
Rice Ecosystems





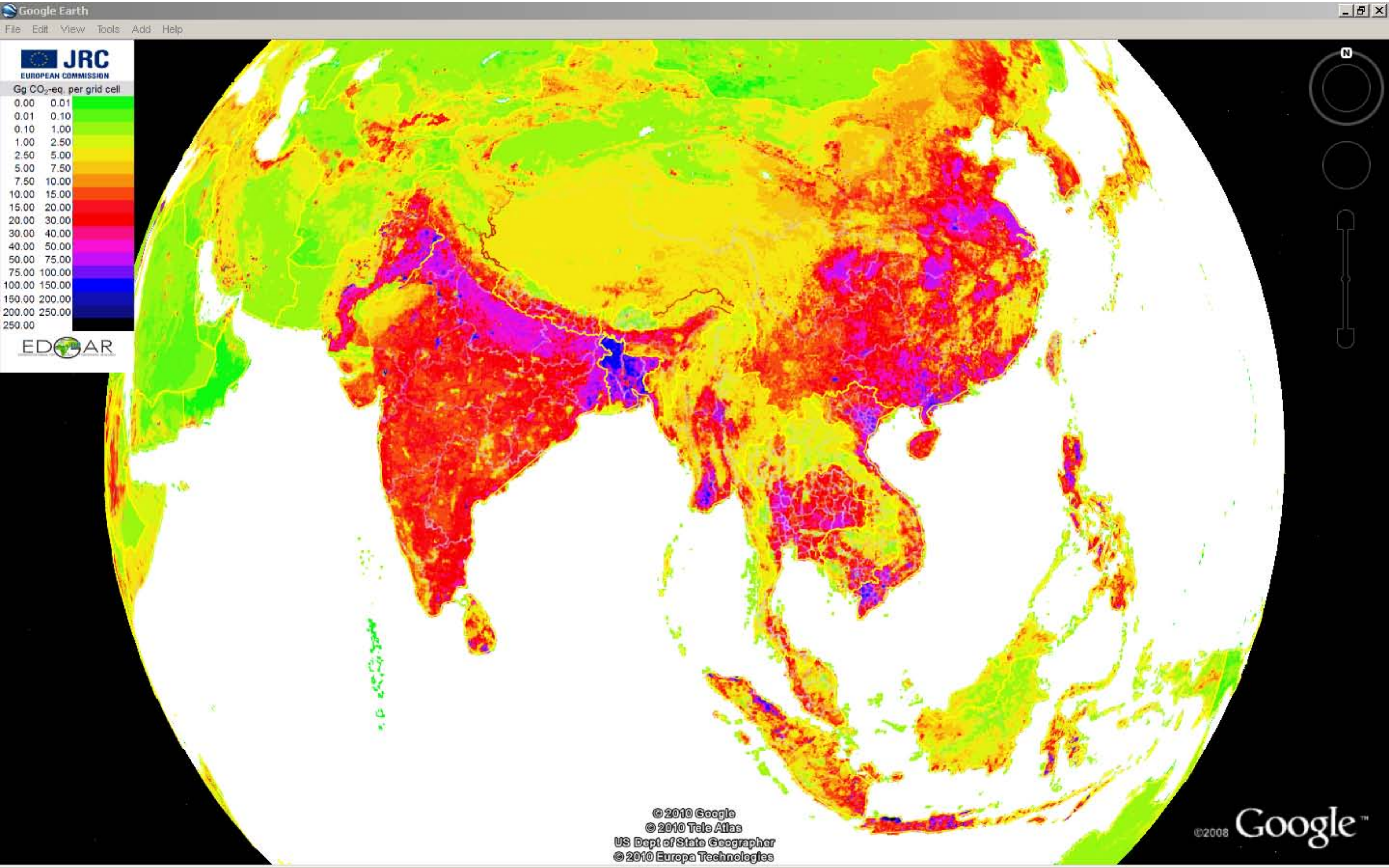
http://www.ibp.ethz.ch (modified)

Global GHG emissions by agriculture



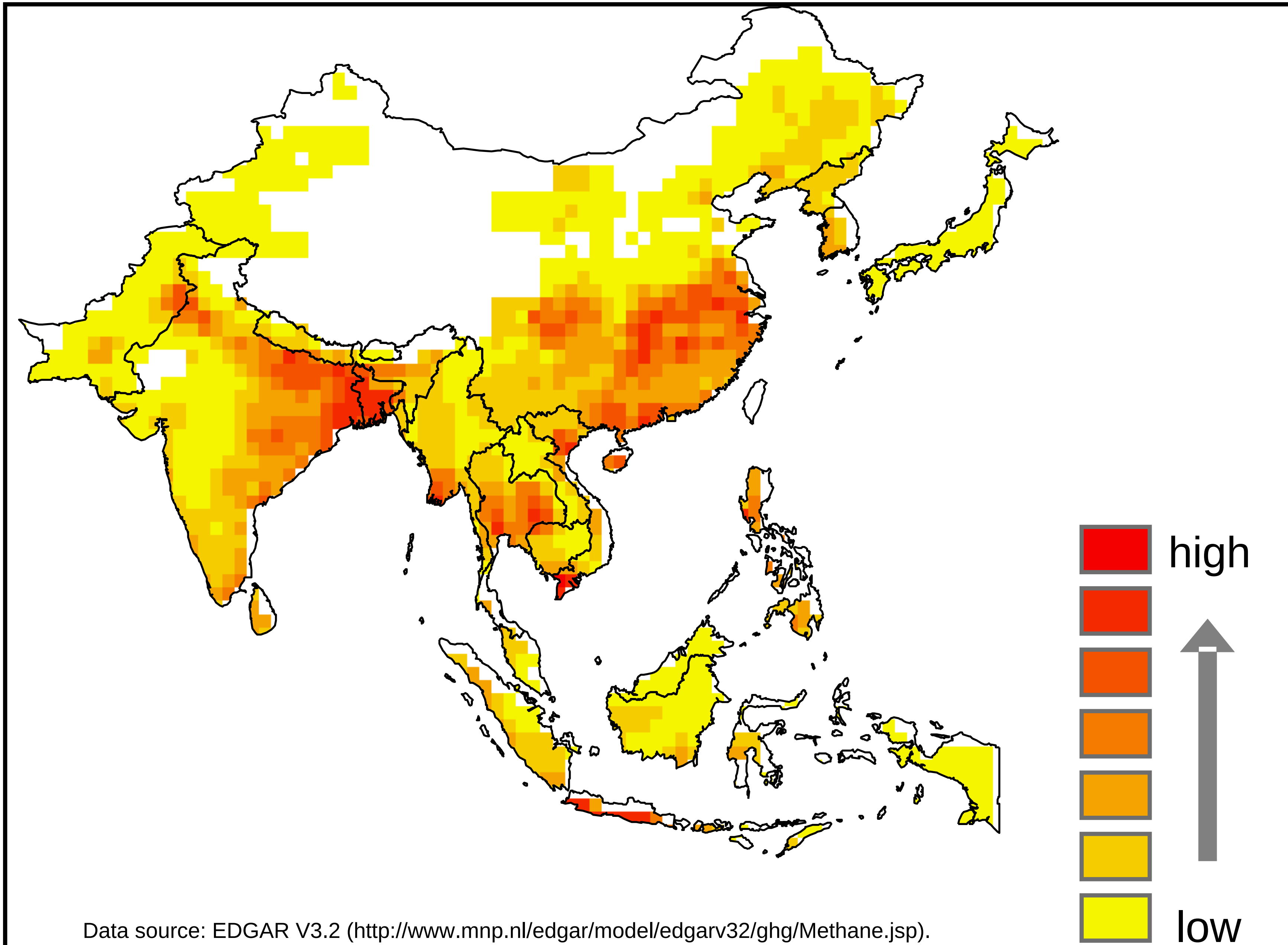
Emissions of the agricultural sector (Smith et al., 2007)

GHG CO_2-eq per grid cell for the agricultural sector



Data source: EDGAR V3.2 (http://www.mnp.nl/edgar/model/edgarv32/).

CH_4 emissions in Asia



Data source: EDGAR V3.2 (http://www.mnp.nl/edgar/model/edgarv32/ghg/Methane.jsp).

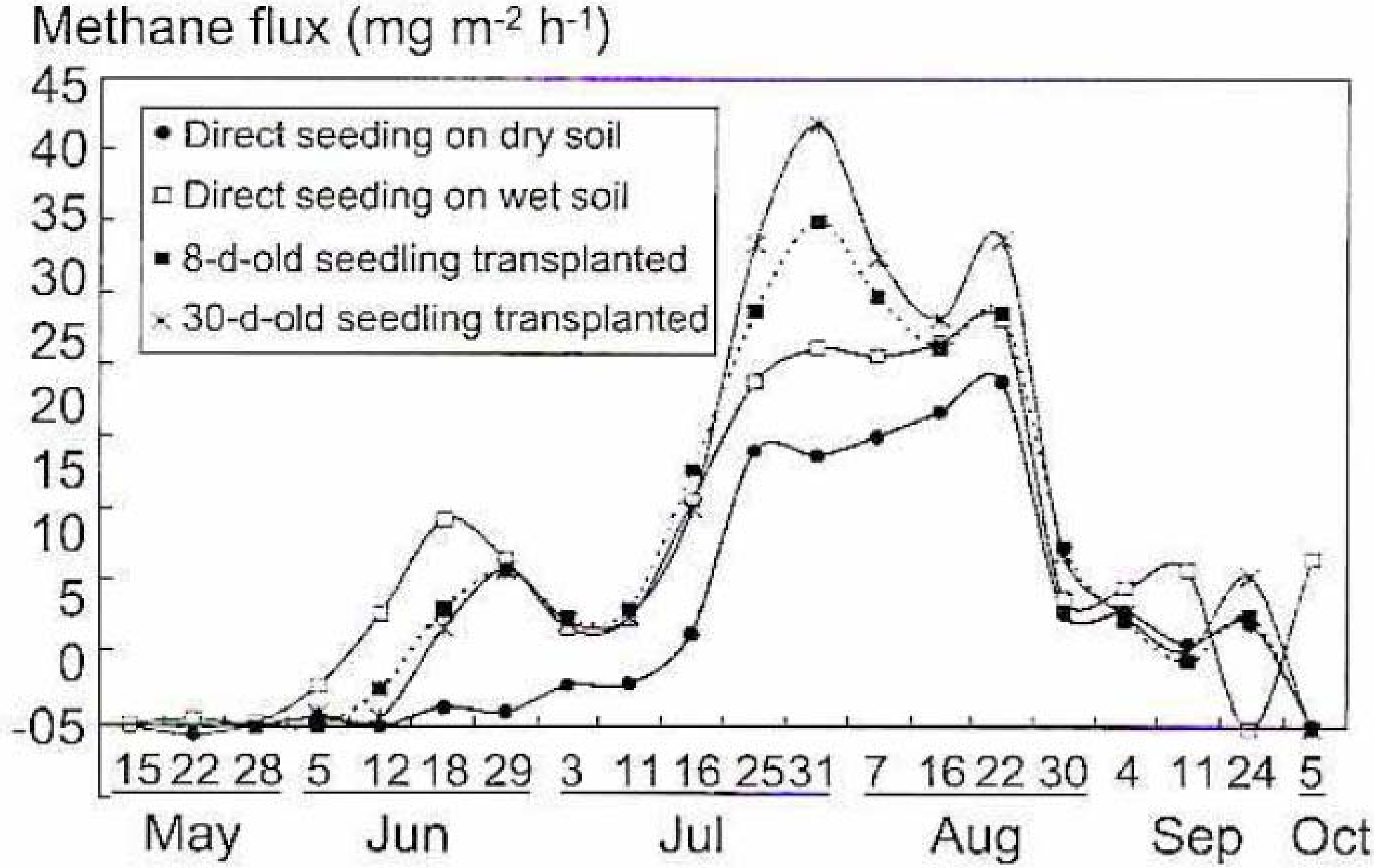
RICE CULTIVATION and CURRENT GHG reporting

Methodological issues

- 1996 IPCC Guidelines outline one method, that uses annual harvested areas and area-based seasonally integrated emission factors
- **In its most simple form, the method can be implemented using national total area harvested and a single EF → TIER 1**
- High variability in growing conditions (water management practices, organic fertilizer use, soil type) will significantly affect seasonal CH_4 emissions
- Method can be modified by disaggregating national total harvested area into sub-units (e.g. areas under different water management regimes or soil types), and multiplying the harvested area for each sub-unit by an specific EF → **TIER 2**
- For **TIER 3** data is hardly available for developing countries

Emission factors under different (water) management

(automated measurements at IRRI, Reiner Wassmann)



Variations in CH_4 emission as affected by different cultural practices

Ko and Kang, 2000

Nutrient Cycling in Agroecosystems **58:** 311–314, 2000.

Emission factors for Rice Agriculture under different Management are essential for developing new Methodologies under CDM or others

Ecosystem	Mean emission (mg/m^2/day) from Sites			Emission Factor (kg/ha/day)		% Decrease from IPCC
	Los Baños (IRRI)	Maligaya (PhilRice)	Mean	Derived	IPCC default (T=27°C)	
Irrigated	233.1	225.5	229.3	2.3	5.9	61
Rainfed	40.3	-	40.3	0.4	3.54	89

The role of the Clean Development Mechanism (CDM)

Developed countries can reduce emissions anywhere in the world

They can count these reductions towards their own targets

CDM allows developed countries to generate ‘carbon credits’ (Certified Emission Reductions, CERs) in developing countries

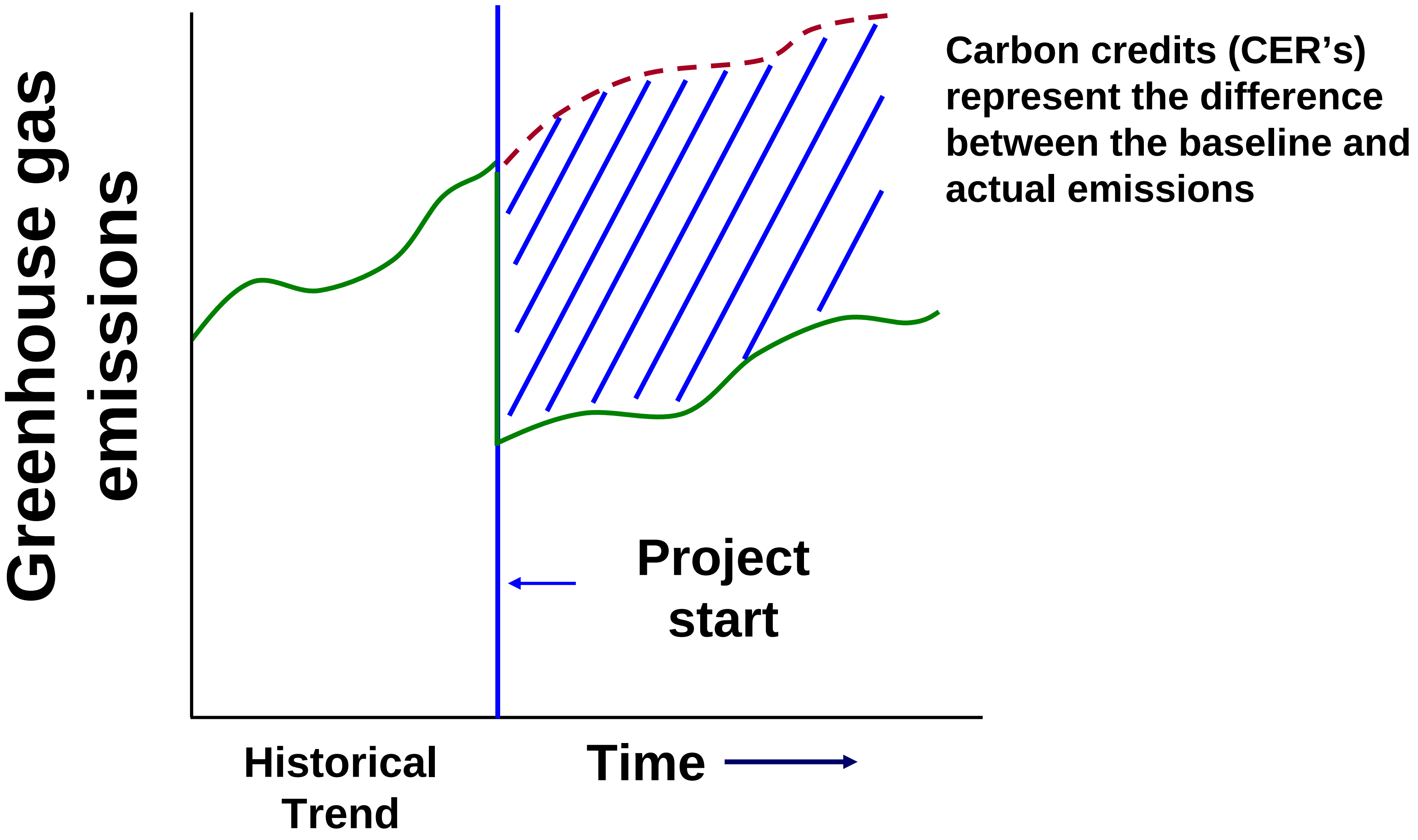
<u>Advantages for developed countries</u>:

relatively low-cost & politically acceptable

<u>Advantages for developing countries</u>:

inward investment, environmental & technology benefits

How a CDM project generates carbon credits



Data we need for developing baseline methodologies studies

Site specific GHG emission factor

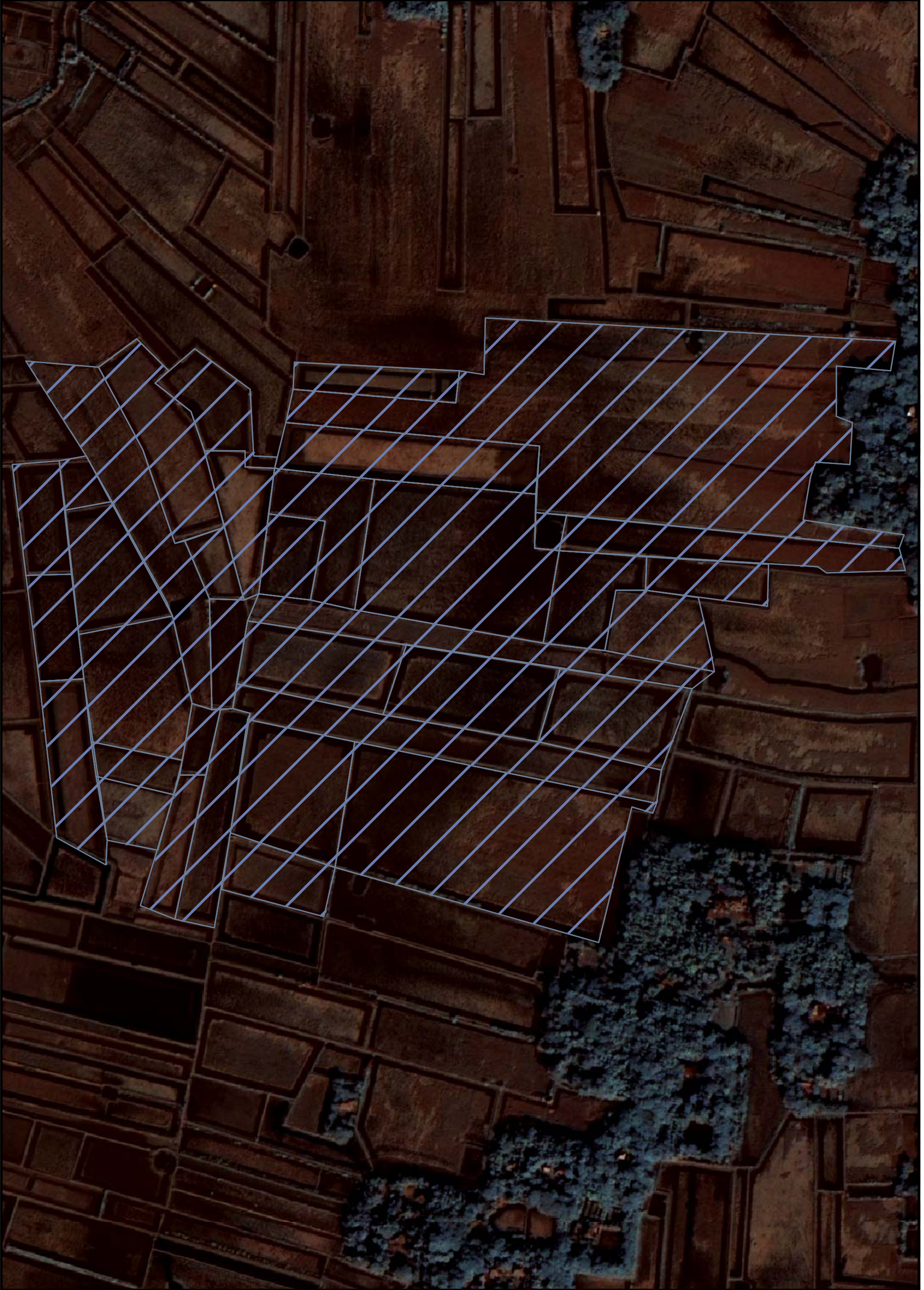
- Measurements of GHG fluxes

Harvested area / area under rice cultivation / cropping systems

- Remote sensing and/or field surveys

(very!) Small non-financial numerical example

- Assumptions and key source conditions:
  - Hypothetical country located in South Asia
  - All is irrigated and continously flooded
  - Conversion to intermitently flooded and single aereated



Field size estimation

Easy but expensive (high resolution remote sensing images and worktime for digitzing)

Quickbird

Area of interest

16.5 km by 16.5 km

60 cm panchromatic

2.4m multispectral

Price: ~ 1000$

Fields 36 under rice cultivation
Average field size: 0.54 ha, Sum: 19.4 ha (! just a very small area)

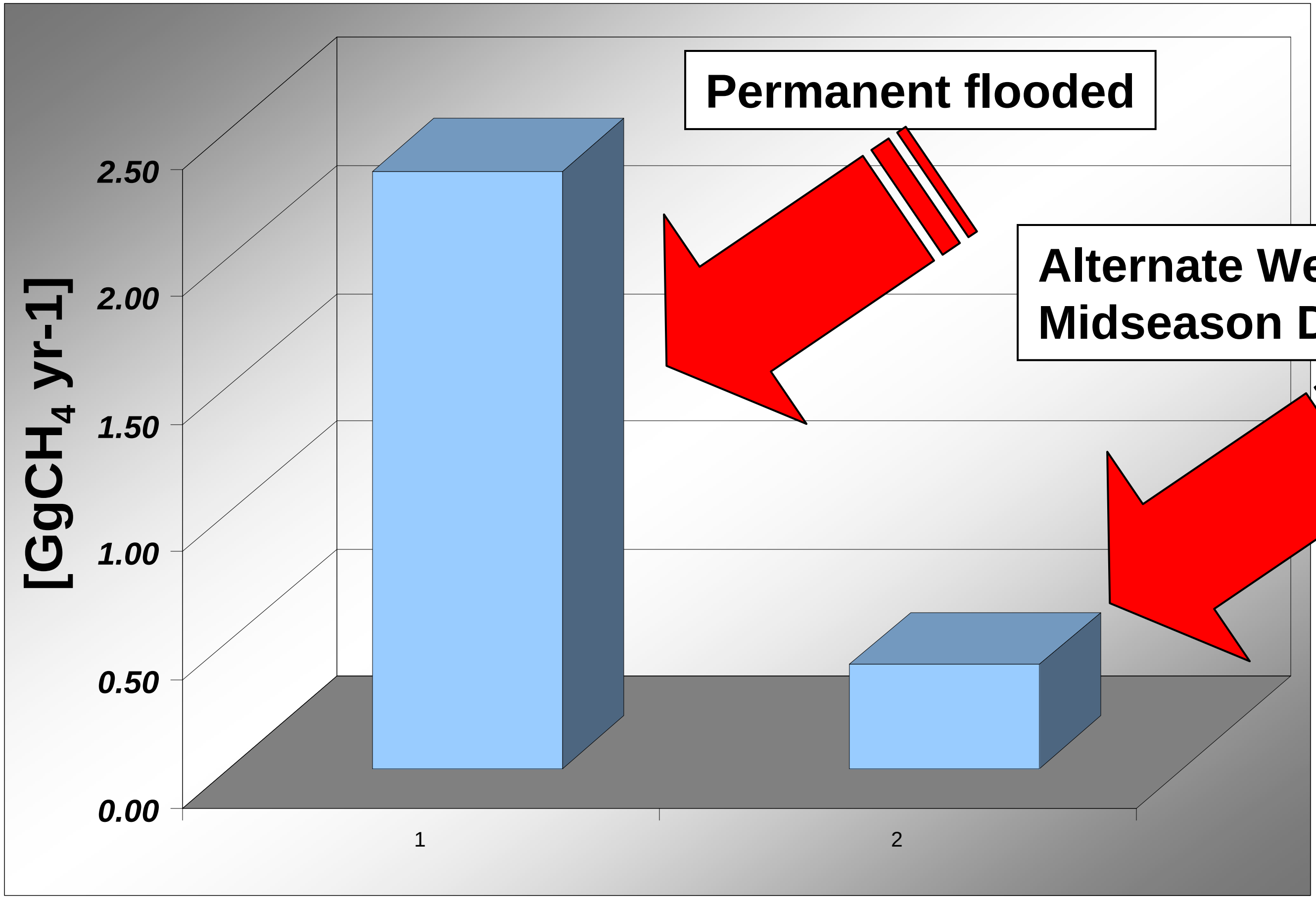
Equation		Equation 5.1				Equation 5.2			Equation 5.3	
Rice Ecosystem (Water regime)	Area	**Annual harvested area (wet and dry season**		**Cultiv. period of rice**	**Baseline emission factor for continuously flooded fields without organic amendments**	**Scaling factor to account for the differences in water regime during the cultivation**	**Scaling factor to account for the differences in water regime in the pre-season before the cultivation period**	**Application rate of organic amendment in fresh weight**	**Conversion factor for organic amendment**	**Scaling factor for both types and amount of organic amendment applied**
		($ha\ yr^{-1}$)		(day)	$kg\ CH_4\ ha^{-1}\ day^{-1}$	(-)	(-)	t ha-1	(-)	(-)
					Table 5.11	Table 5.12	Table 5.13		Table 5.14	$SF_o = (1+ROA_i * CFOA_i)0.59$
		A		t	EF_c	SF_W	SF_p	ROA_i	$CFOA_i$	SF_o
$({}_{cont}f)$	CF	19,37	0.75	110	1.30	1.00	1.00	2.5	0.50	1.33
$({}_{sing}f)$	AWD	19,37	0.25	110	1.30	0.52	1.00	2.5	0.50	1.33

Equation	Equation 2.2		Equation 5.1	Equation 5.3
Rice Ecosys-tem	Subcategories for reporting year1	**Scaling factor for soil type, rice cultivar, etc., if available**	**Adjusted daily emission factor for a particular harvested area**	**Annual CH_4 emission from Rice Cultivation**
		(-)	($kg\ CH_4\ ha^{-1}\ day^{-1}$)	$Gg\ CH_4\ yr^{-1}$
			$EF_i = EF_c * SF_W * SF_p * SF_o * SF_{s,r}$	$CH_4Rice = A * t * EF_i * 10^{-6}$
		$SF_{s,r}$	EF_i	CH_4Rice
$({}_{cont}f)$		1	2,2	0,005
$({}_{sing}f)$		1	0.88	0.002

Reducing methane emissions through water-saving techniques

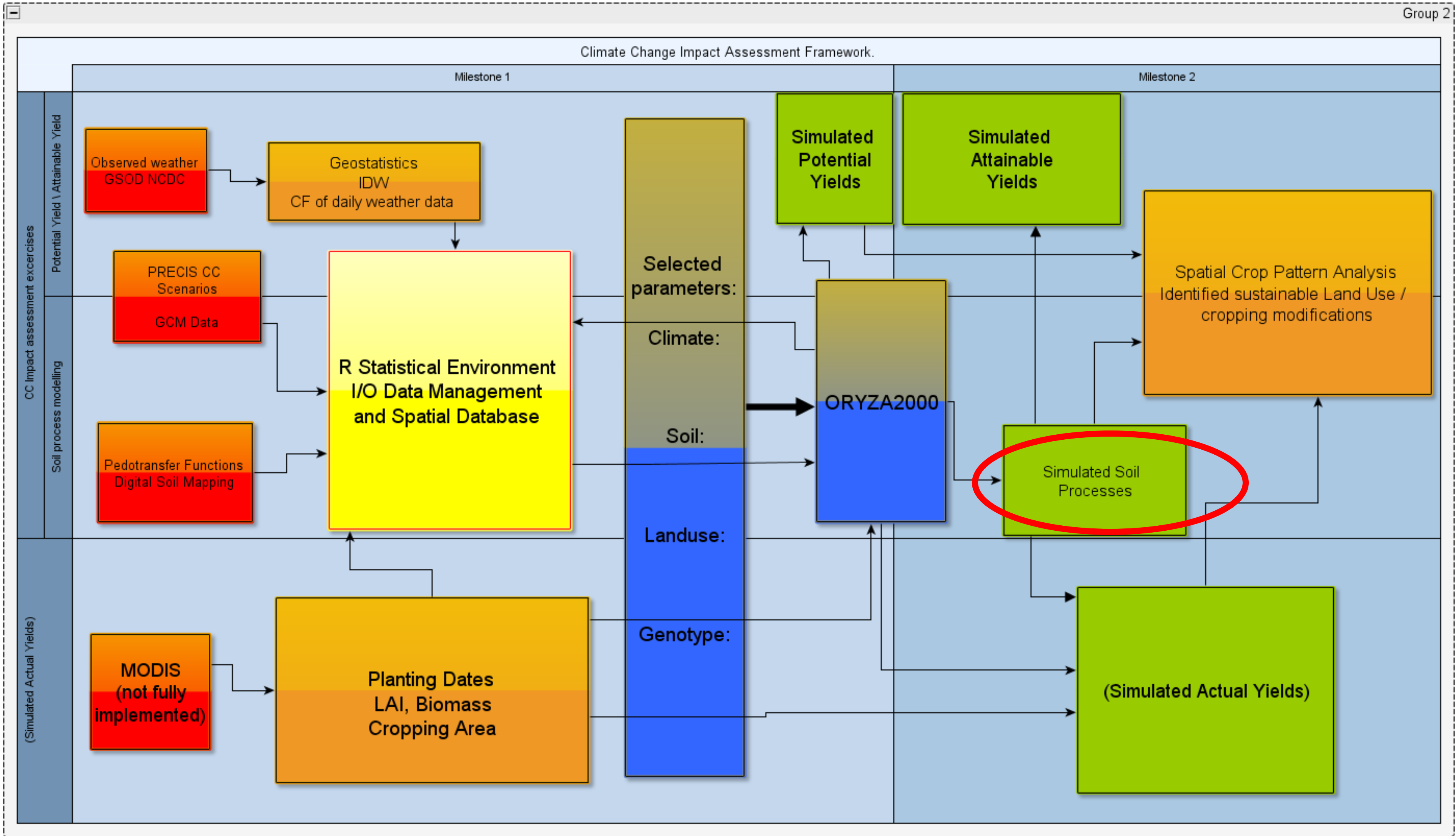
(!!! Sample watershed upscaled to 16000 ha !!!)

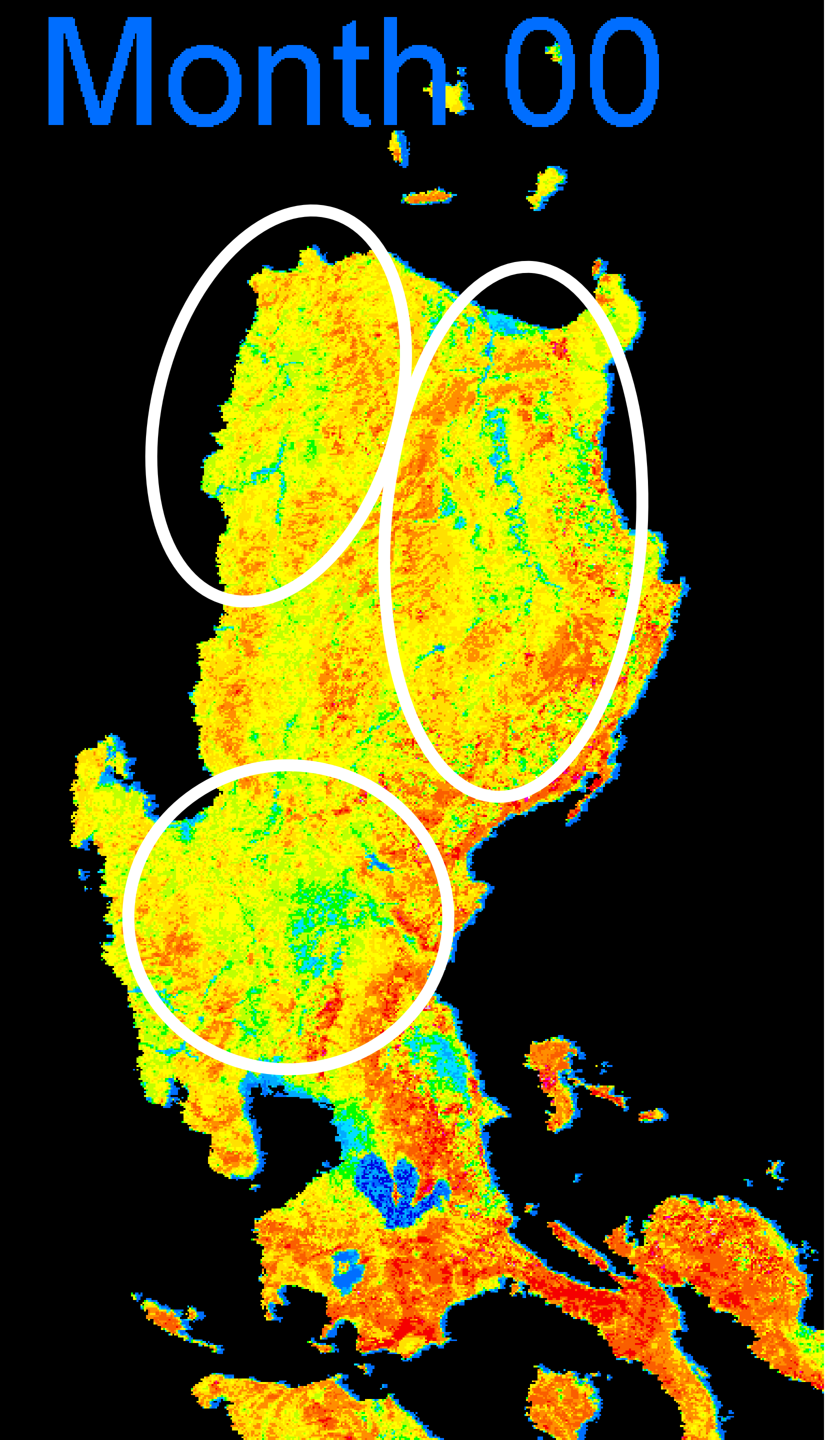
Using the UNFCCC GHG scheme



- Calculating carbon offsets in CO_2-equiv.
- Current carbon price

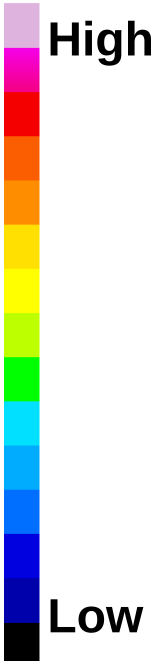
Developed spatially explicit modeling framework (regional scale)





Monitoring Agriculture through MODIS (EXAMPLES for the Philippines)

- Phenology (yield, biomass, LAI),
- Hydrology (water budget/ water regime)

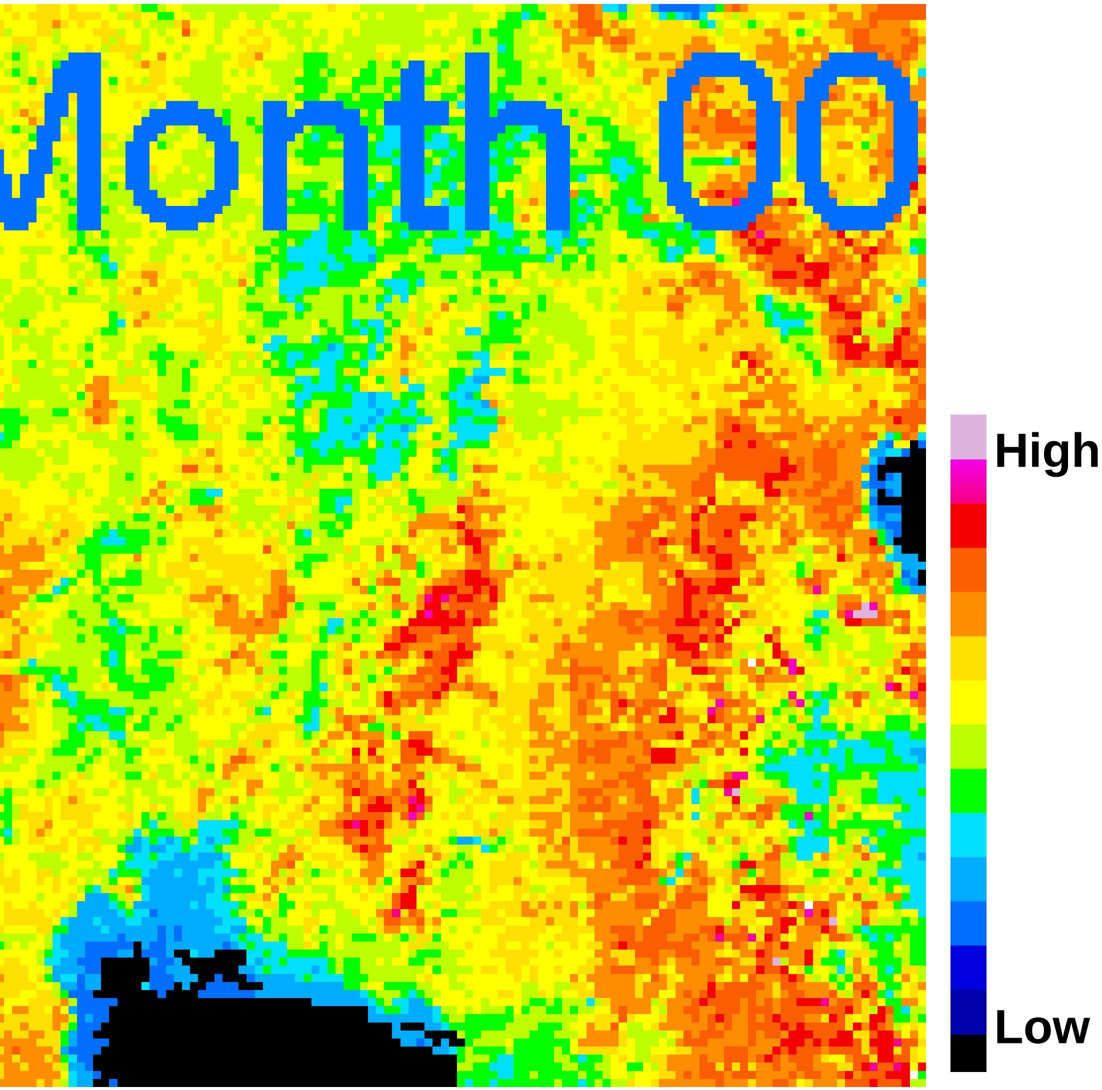


Jan. to Dec. 2007
Monit. aboveground Biomass

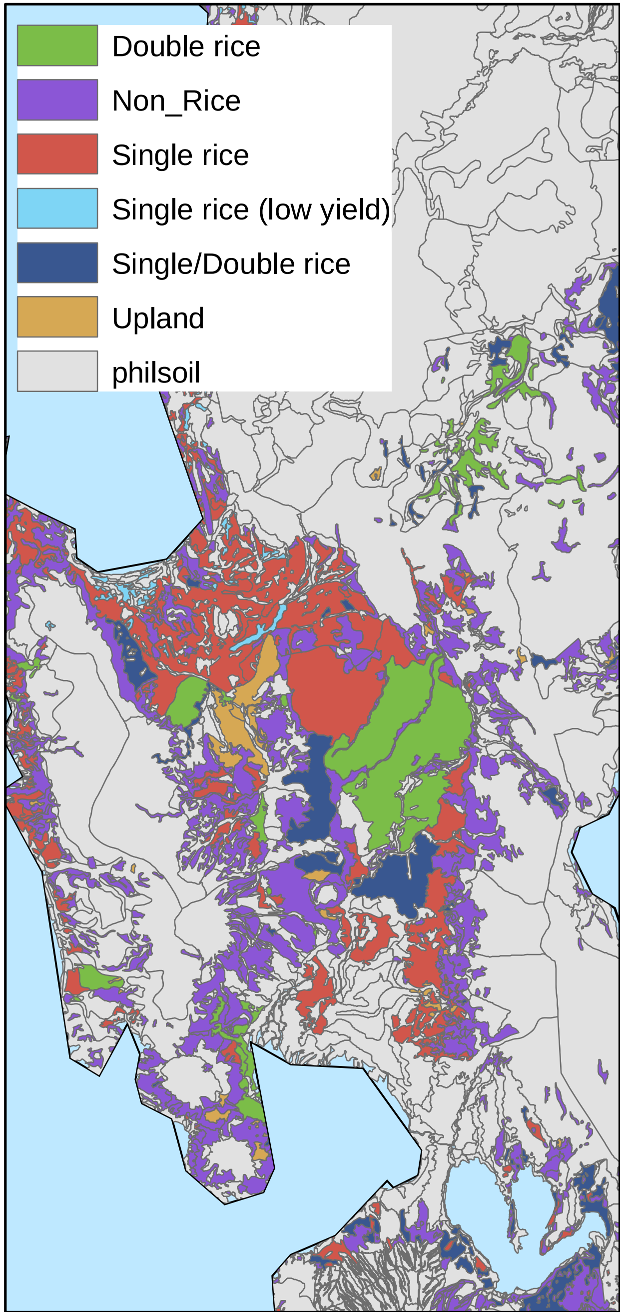
MODIS optical data
Repetition time: twice a day
500 m Resolution

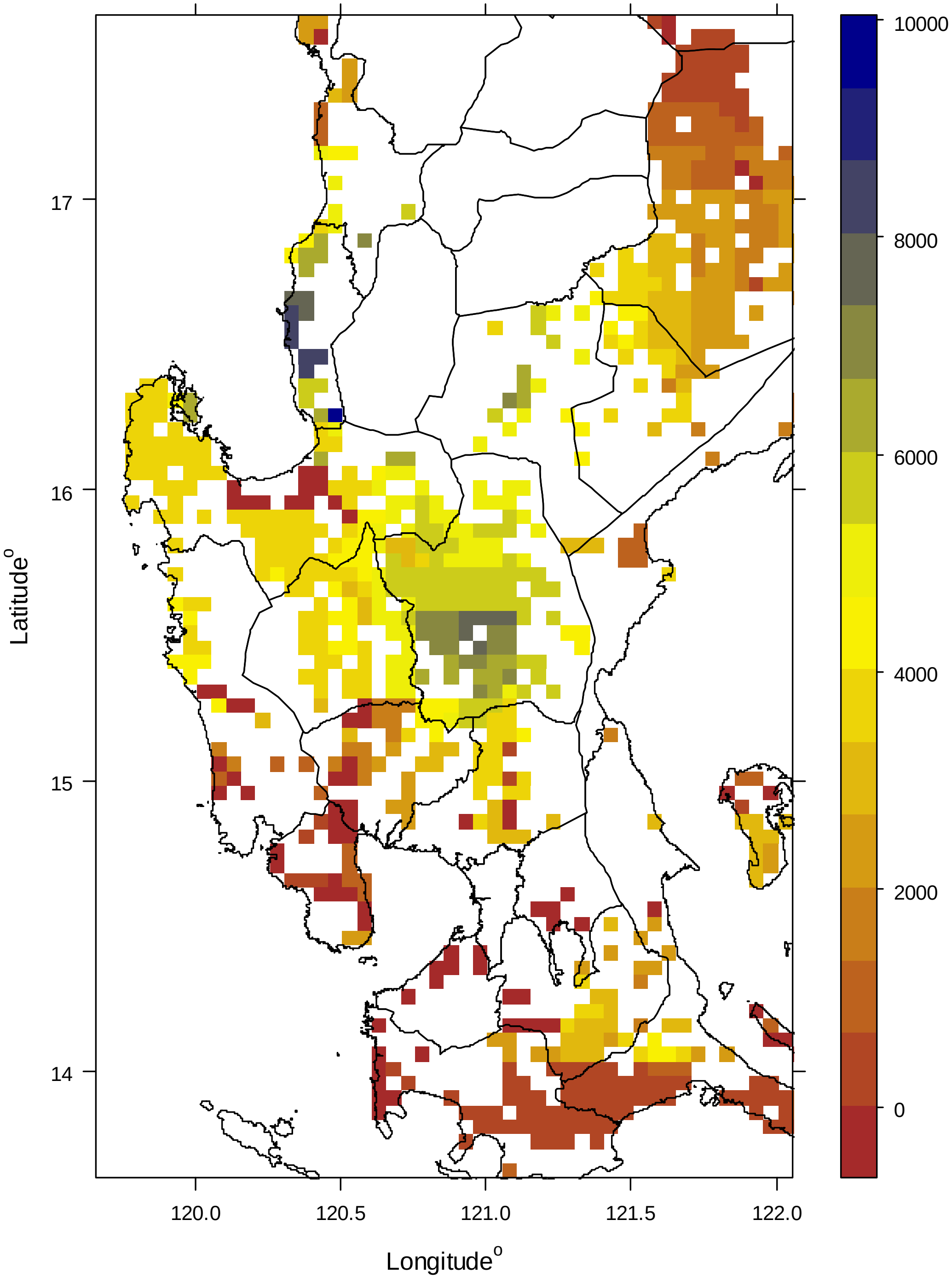
Focus is on all
Land cover types

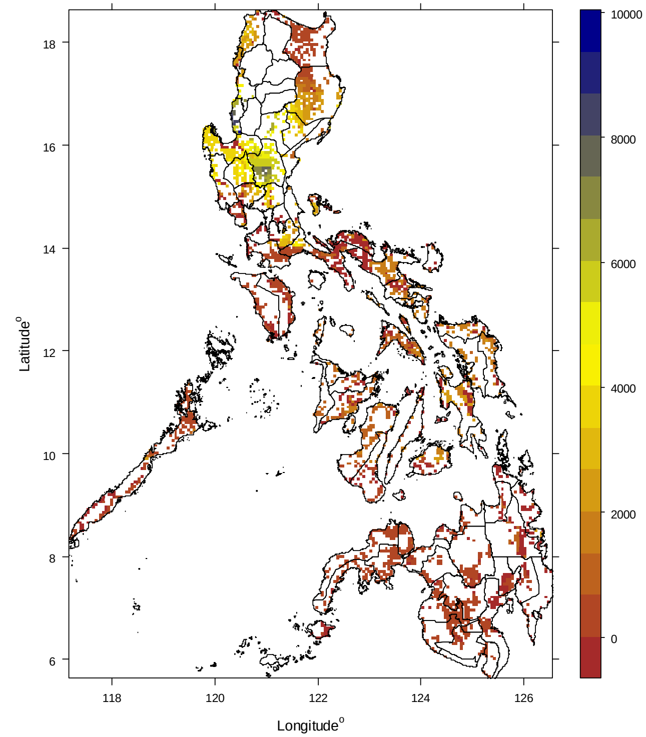
Aboveground Biomass



BSWM







Developed spatially explicit modeling framework for quantifying crop processes with ORYZA2000

- Rice yield [kg/ha]
- Wet season '97-98
- Cultivar IR72
- Water-limited

Next step: Integrating GHG (C & N dynamics) components into this framework

GHG emissions from Rice Cultivation

ongoing projects at IRRI
Project leader: Reiner Wassmann
Postdoctoral fellow: Björn Ole Sander
Start: 01/01/2010

The goals are:

- Development of a methodological framework for utilizing remote sensing data for regional upscaling of GHG emissions from rice cropping systems. **(75% completed)**
- Assessing temporal variability of CH_4 and N_2O emissions if farmers' fields practicing water saving techniques. **(ongoing) GHG measurements**
- Spatial variability of emissions as affected by distinct water saving practices of different farmers. **(ongoing) GHG measurements**
- Calibration and validation of a air-bio-geochemistry model to the specific conditions in two regions of the Philippines. **(ongoing)**

GHG emissions from Rice Cultivation

(conclusions)

- Measurements, remote sensing and modeling techniques are necessary to monitor and quantify GHG from agriculture
- TIER 3 approaches (combination of models such as DNDC and Remote Sensing) are possible even in data sparse regions through remote sensing monitoring techniques for CDM projects.
- **(Pre) - Feasibility studies are needed**