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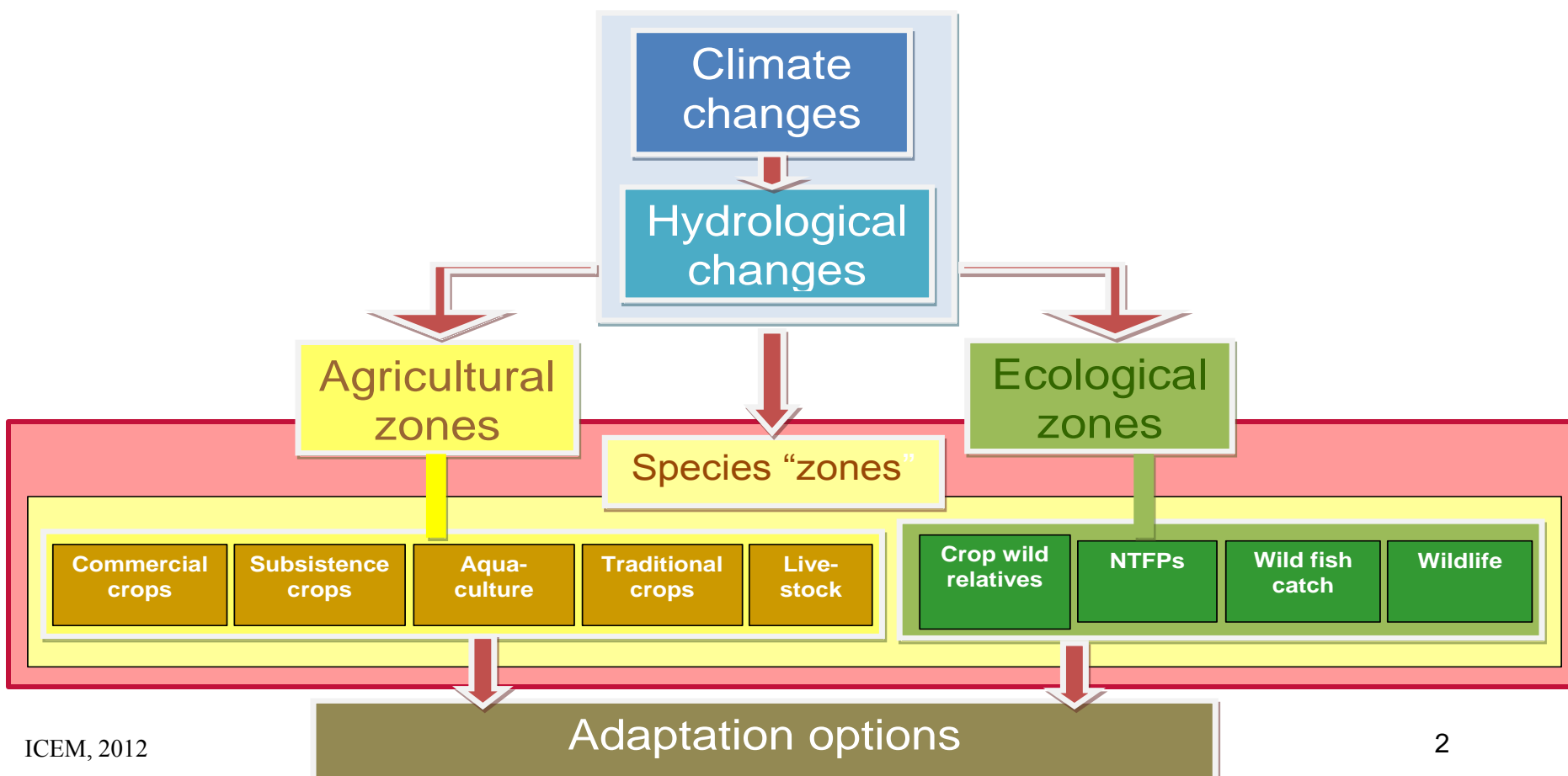
# Mekong ARCC Climate Change Impact and Adaptation Study for natural and agricultural systems

Jeremy Carew-Reid,  
ICEM – International Centre for Environmental Management  
[www.icem.com.au](http://www.icem.com.au)

May 2012, Bangkok

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# Assessing climate change threats to agriculture and subsistence livelihoods



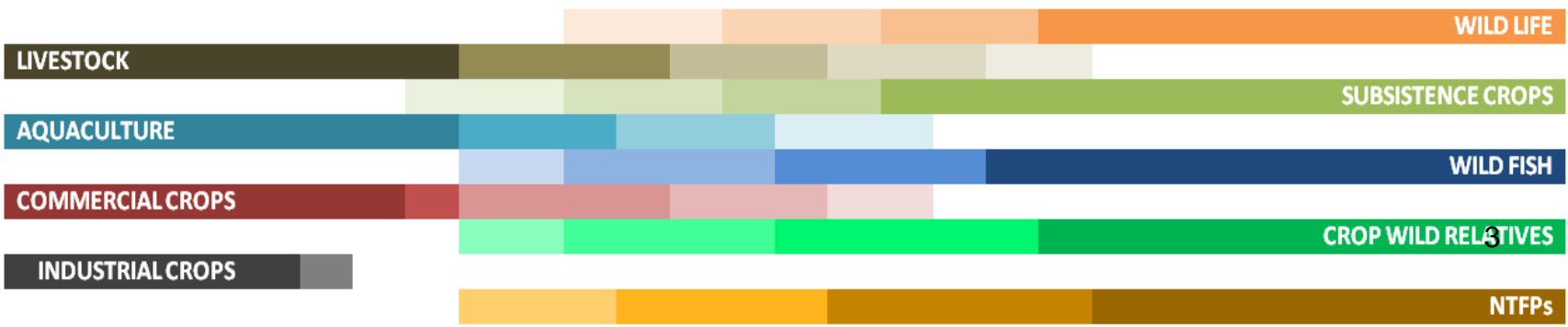
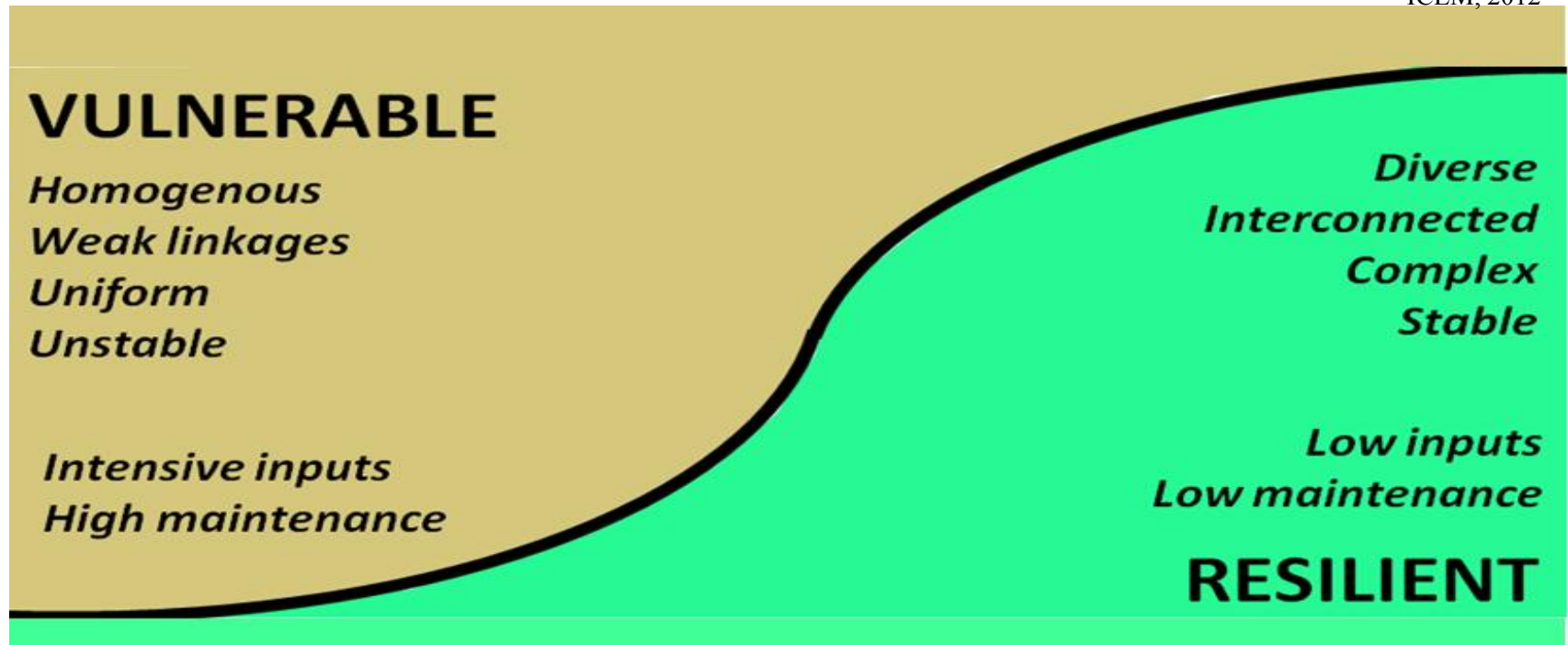


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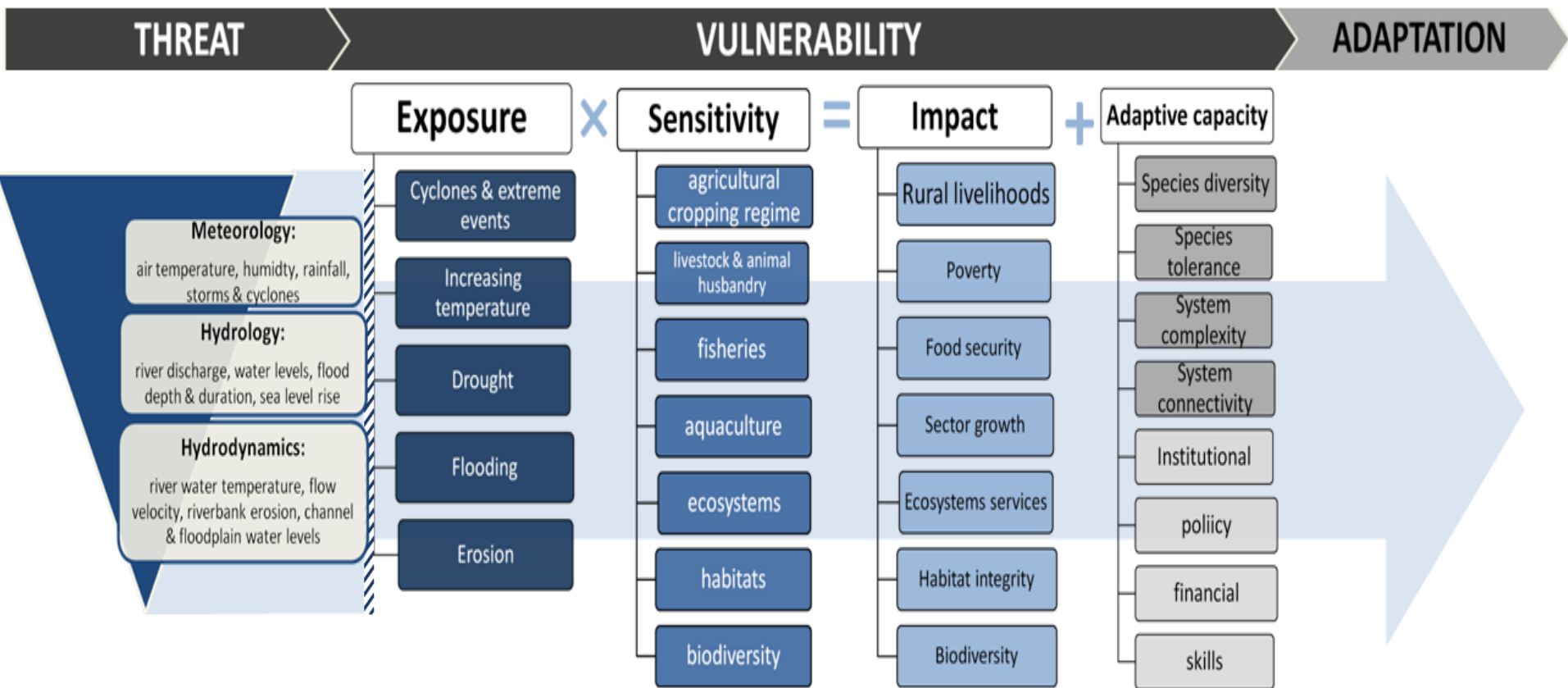


# Agricultural systems and climate change continuum

ICEM, 2012



# CAM method





## Climate and hydrological changes

### Climate changes

#### **Regular** (daily and seasonal)

- Increase in CO<sub>2</sub>
- Change in temperature
- Change in rainfall

#### **Extreme events**

- Storms
  - Rainfall
  - Wind
  - Low pressure

### Hydrological changes

#### **Regular** (daily and seasonal)

- Water availability
- Runoff and flow
- Regular flooding
- Evapotranspiration
- Saline intrusion
- Sea level rise

#### **Extreme events**

- Flooding (fresh and salt water)
- Flash flooding
- Drought
- Storm surge



# System assets

## Top commercial crops

Vietnam	Laos	Thailand	Cambodia
Rice, paddy	Rice, paddy	Rice, paddy	Rice, paddy
Coffee, green	Maize	Rubber	Cassava
Cashew nuts, with shell	Coffee, green	Cassava	Maize
Cassava	Tobacco,	Sugar cane	Bananas

**Fruit trees:** Bananas and mangoes

**Vegetables:** Sweet potatoes, tomatoes, beans, chilli

### Subsistence crops

- Lowland and upland rice
- Cassava
- Maize
- Peanuts

### Traditional crop varieties

- Rice (more than 13,000 identified in Lao)
- Eggplant (more than 3000 in Lao)
- Papaya
- Banana (centre of origin)
- Mango (centre of origin)
- Pineapple
- Water melon
- Passion fruits

### Wild plants

- Cardamom,
- Rattan and bamboo
- Orchids
- Mushrooms

### Crop wild relatives

- Glutinous rice (centre of origin)
- Eggplant (centre of origin)



## Key assessment concepts

### Zones

- Climate change, Ecological, Agricultural

### Shifts

- Geographic, Elevation, Seasonal

### Hotspots

- Exposure, Sensitivity, Adaptive capacity



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## Climate change overlaid on “zones”

**Zones provide the common analytical framework for the study team**

**Purpose of zoning** is to:

- Identify areas of the basin with common bio-physical and socio-economic characteristics
- Observe “shifts” in the zones with climate change

**Three types of zones:**

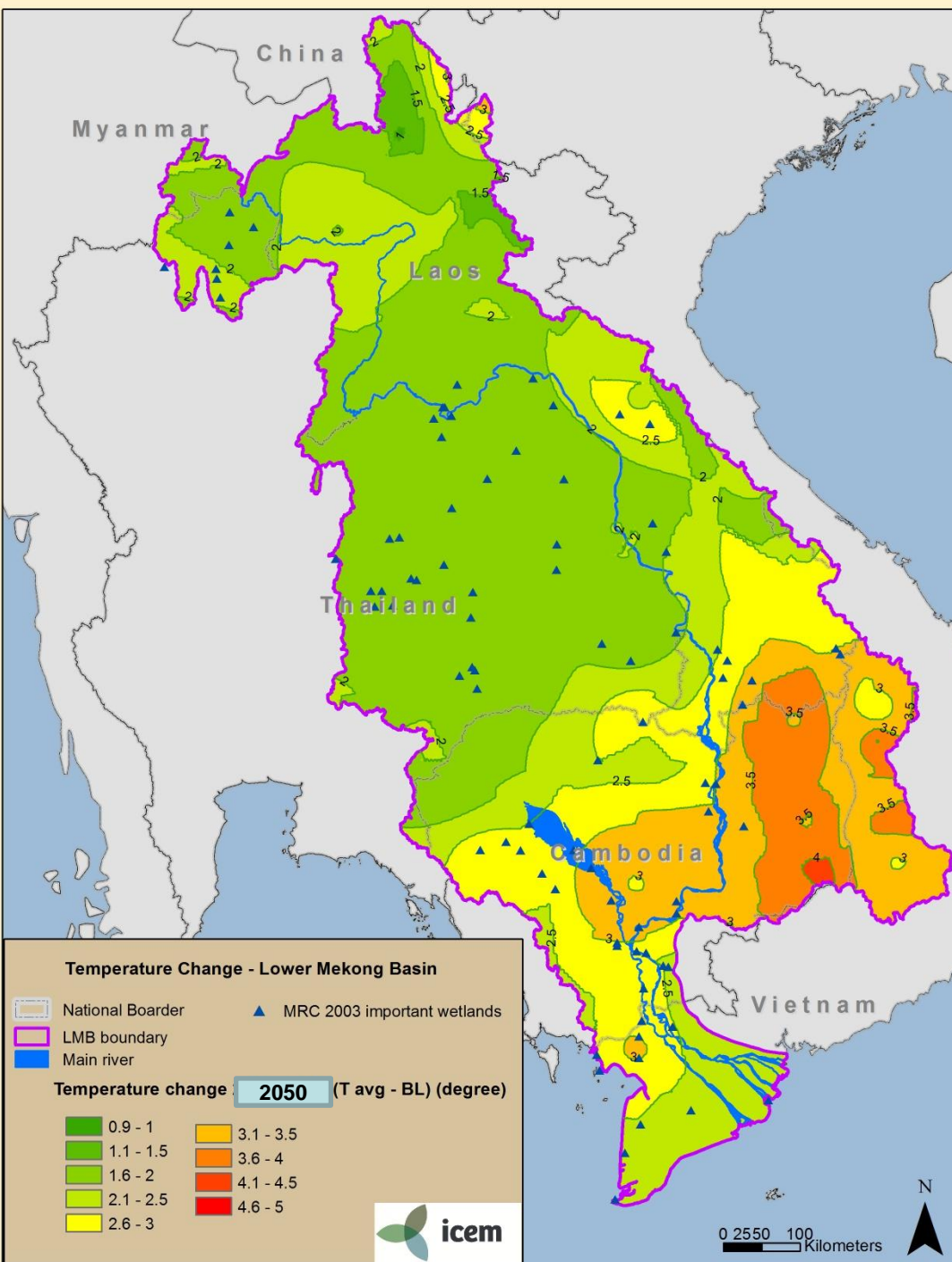
1. **Climate change zones** – temperature, rainfall and hydrology
2. **Agricultural zones** – agricultural land uses and natural conditions
3. **Ecological zones** – natural habitat, species and genetic resources



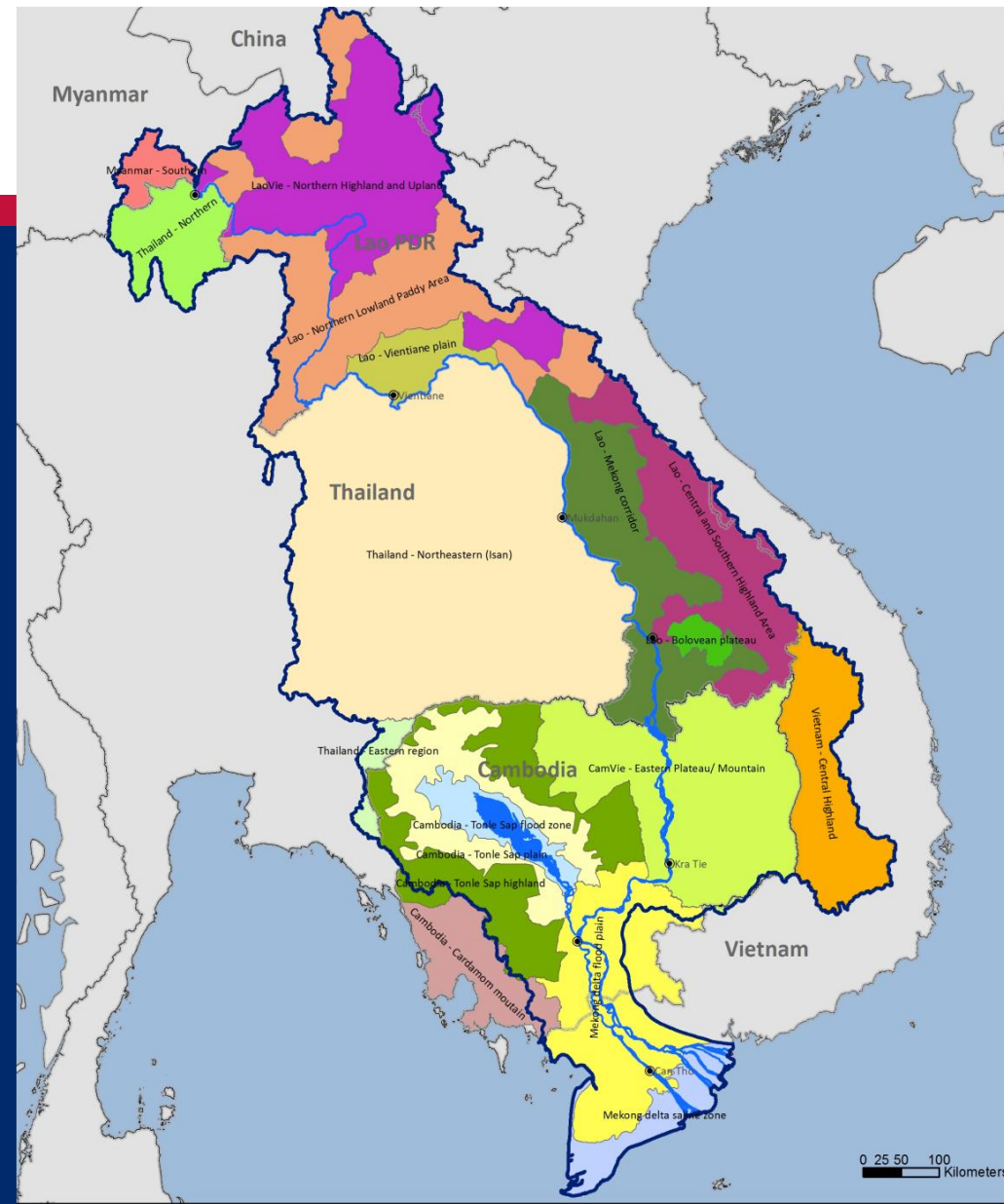
# Climate change zones

Areas experiencing similar climate change

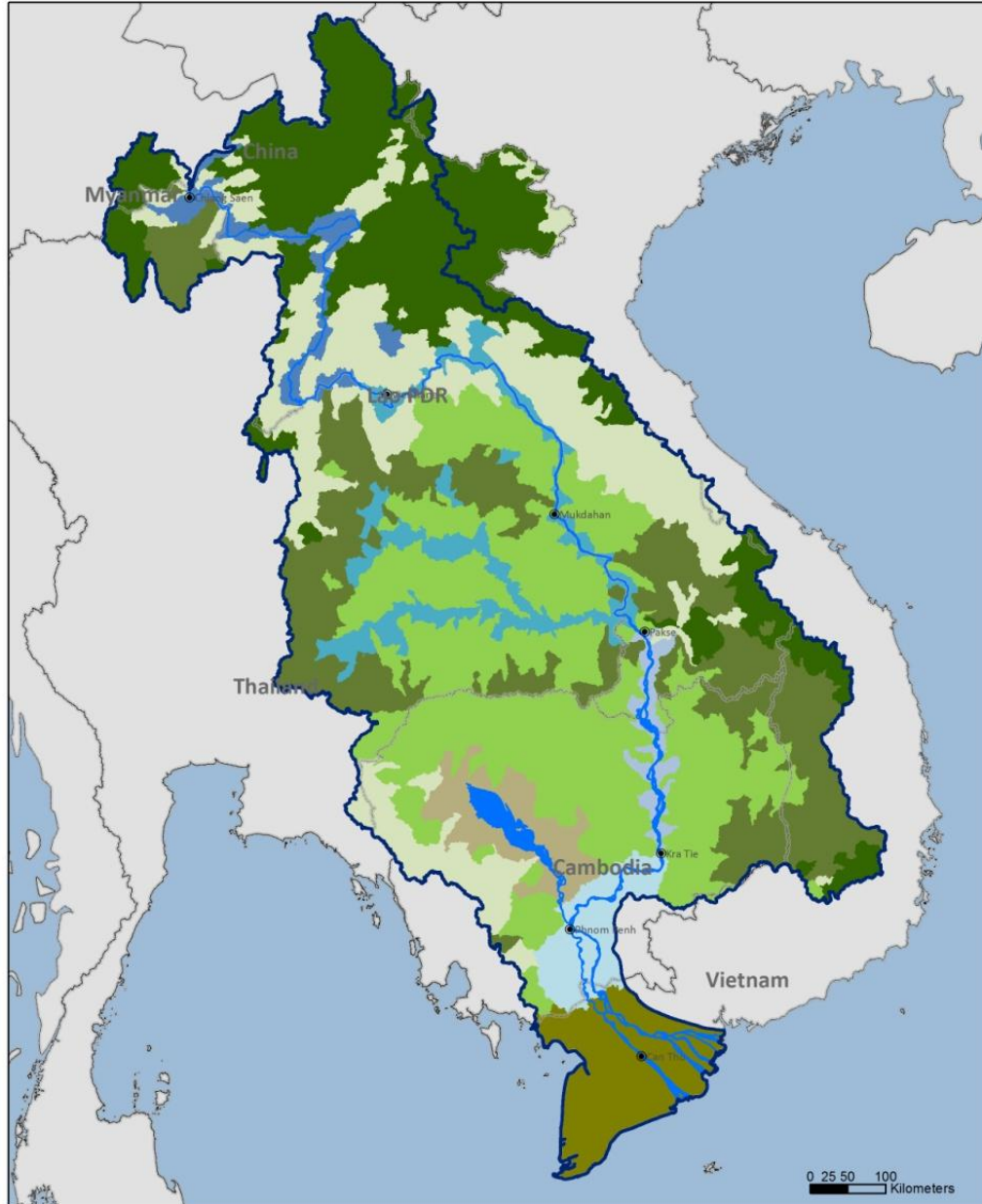
1. Annual + seasonal rainfall averages & extremes
2. Annual + seasonal temperature averages & extremes
3. Specific tolerance & threshold maps



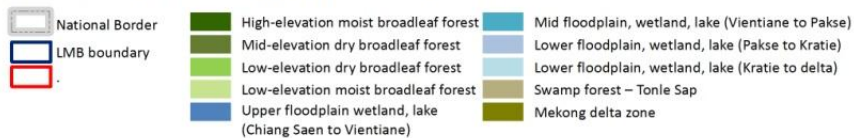
# Agriculture zones



# Ecozones



## ECOZONES IN THE LOWER MEKONG BASIN



icem

Data Source:  
ICEM 2012,  
WWF 2005  
MRC GIS Database



# Climate change **shifts**

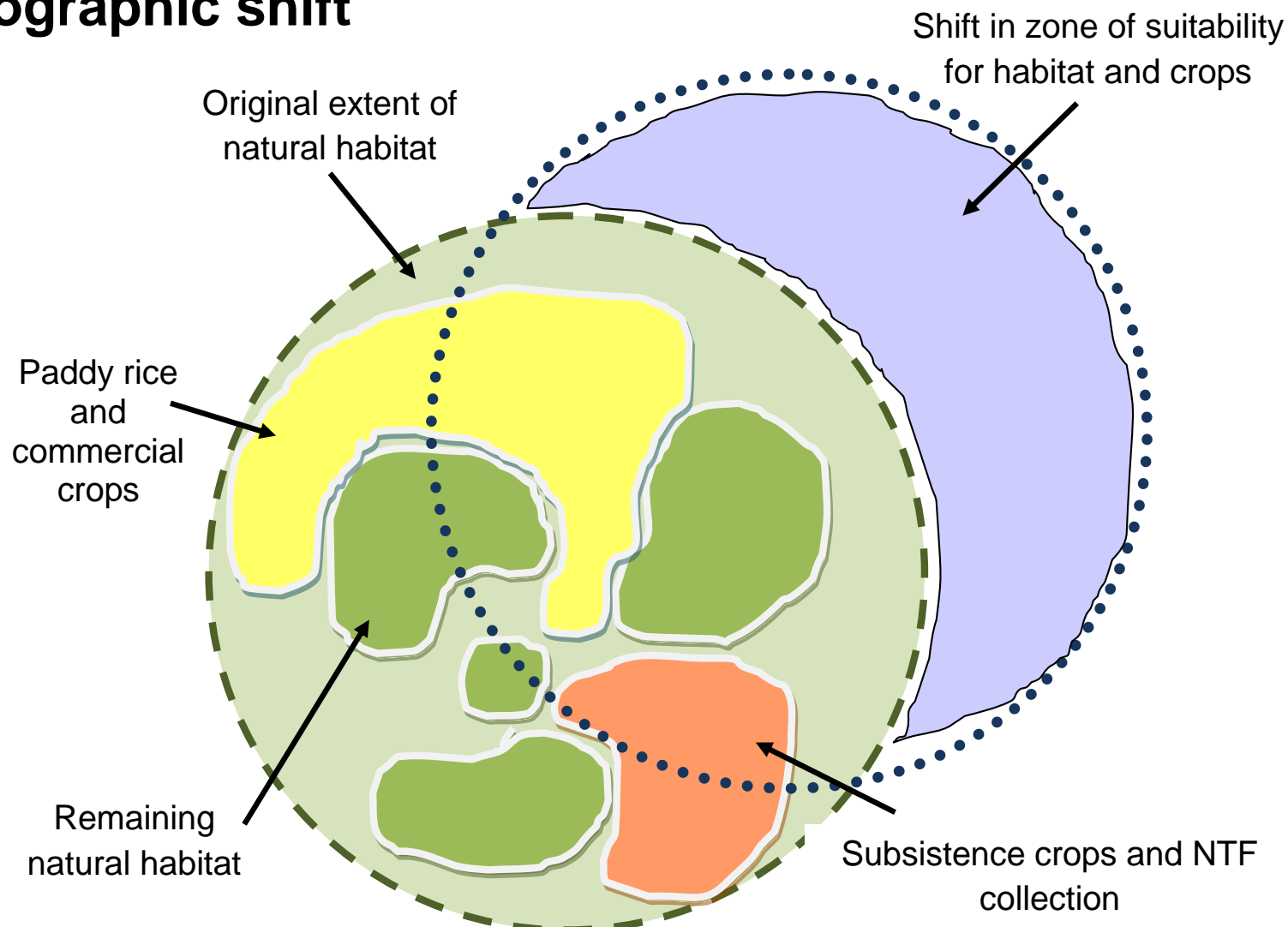
## Regular climate

1. **Geographic shifts** – change in area of suitability
2. **Elevation shifts** (for highly restricted habitats and species) – change in (i) location and (ii) elevation
3. **Seasonal shifts** – change in (i) yields, (ii) cropping patterns

## Extreme events

4. **Extreme event shifts**
  - Micro – eg flash flooding and soil loss in uplands
  - Macro – eg saline intrusion in Delta; cyclone landfall

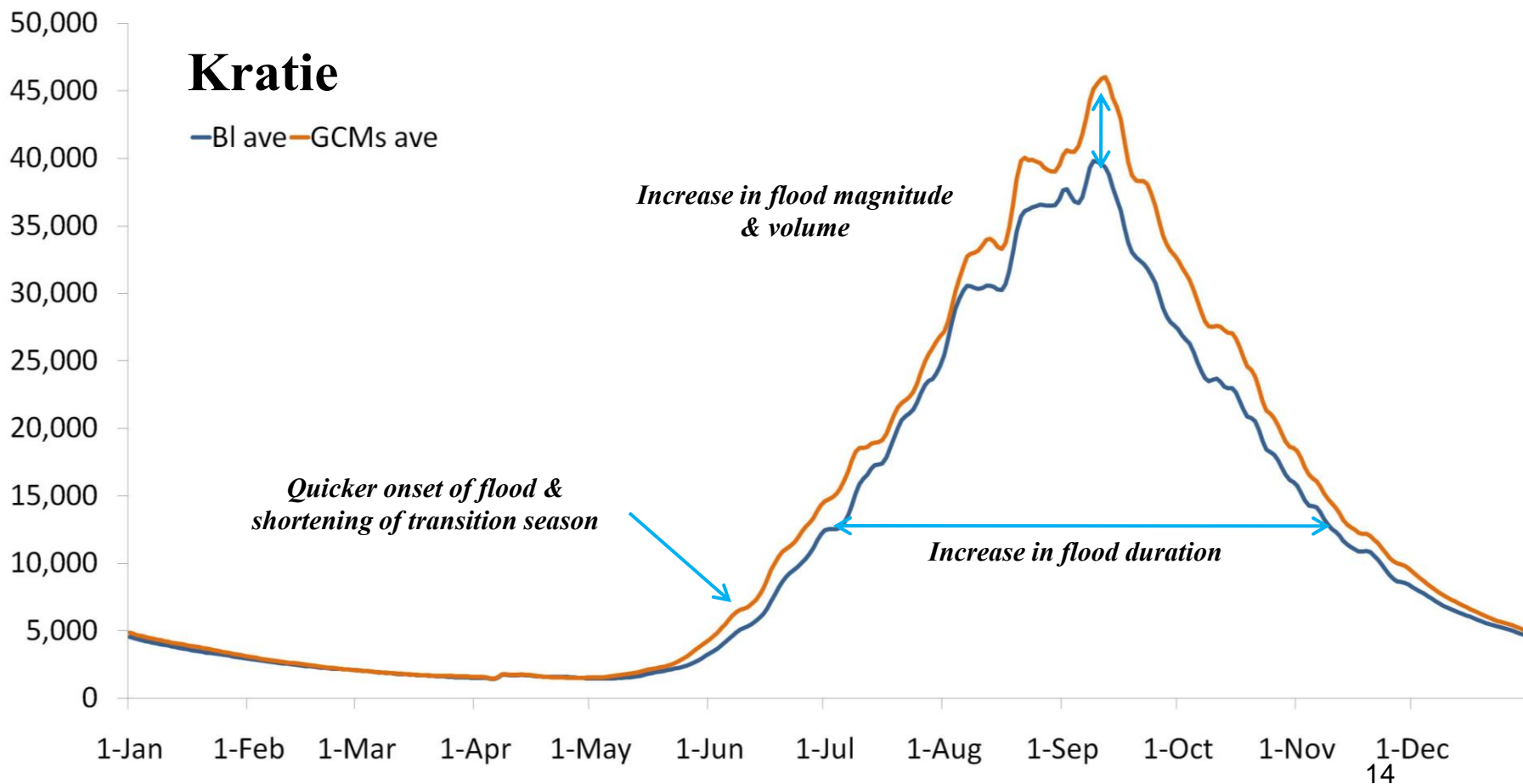
## Geographic shift







## Seasonal shifts



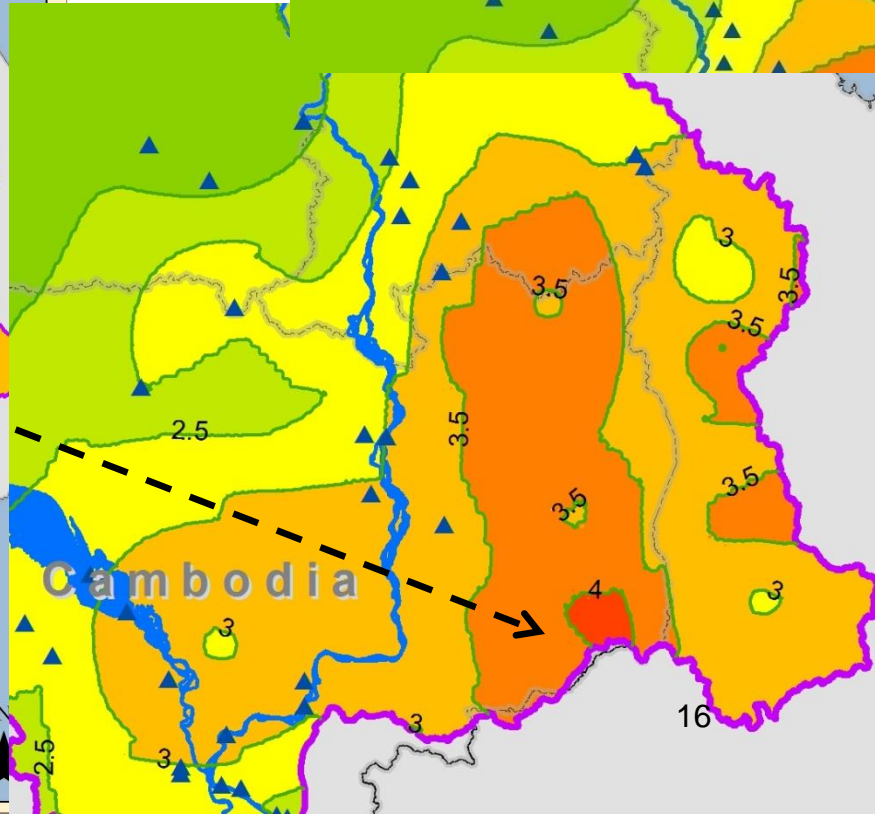
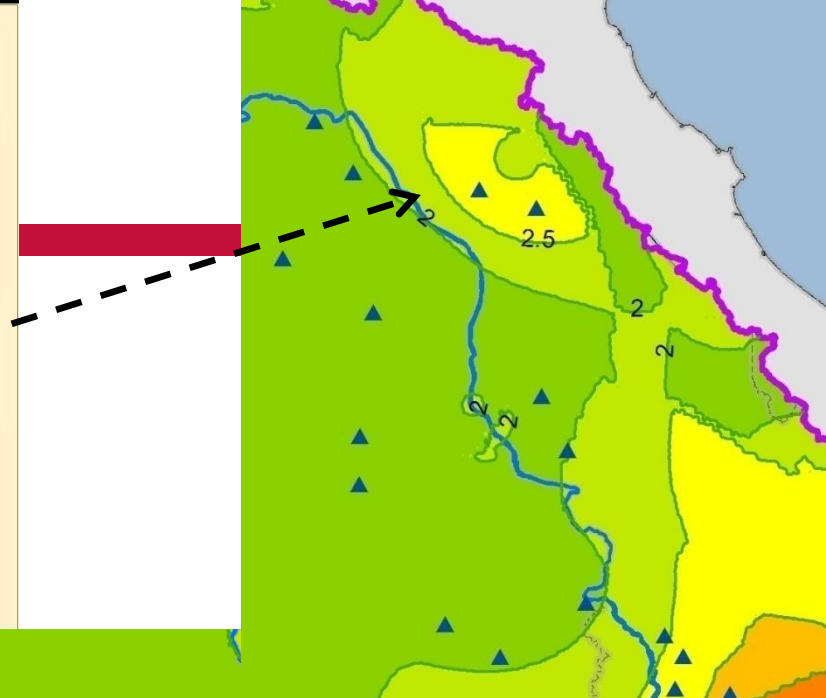
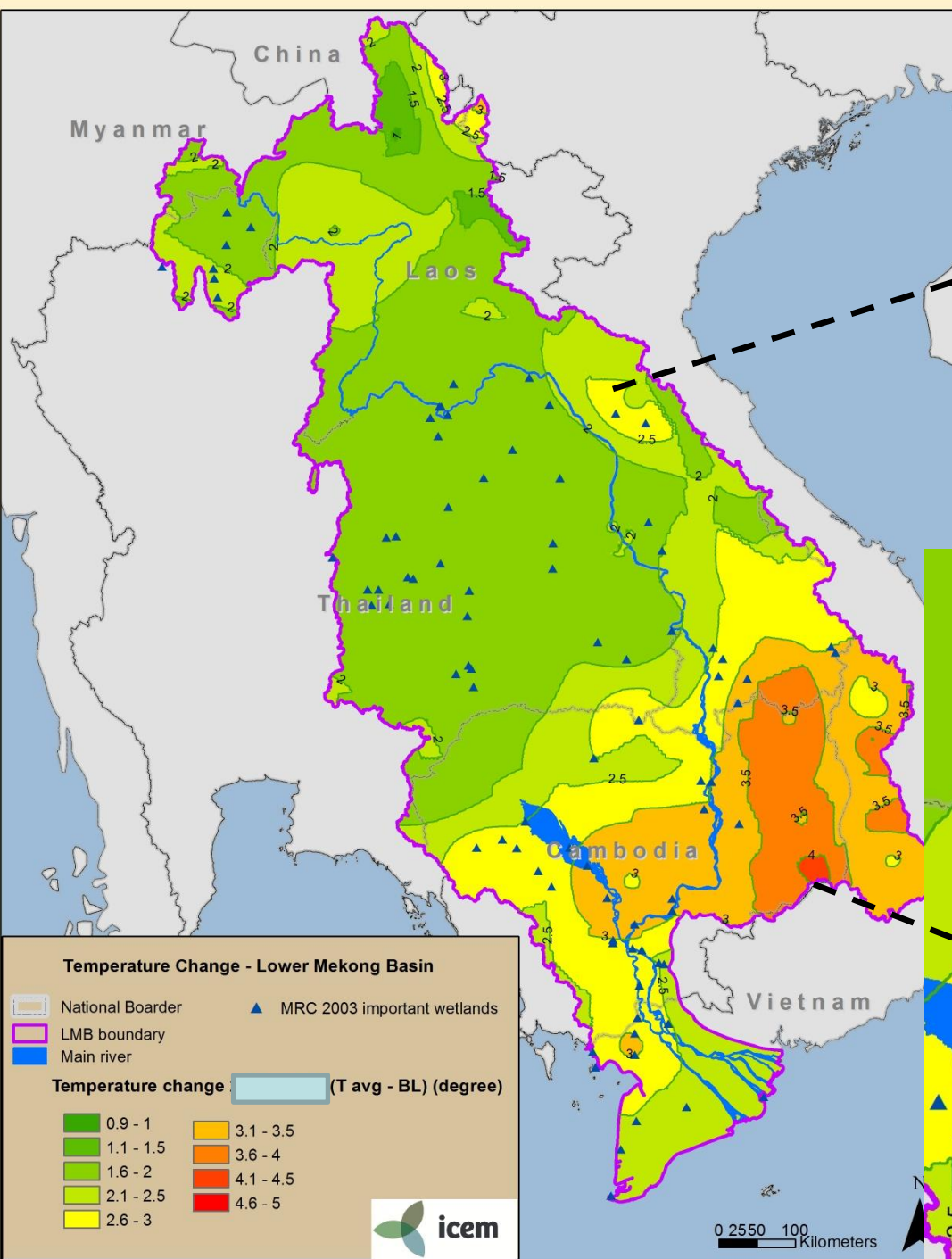


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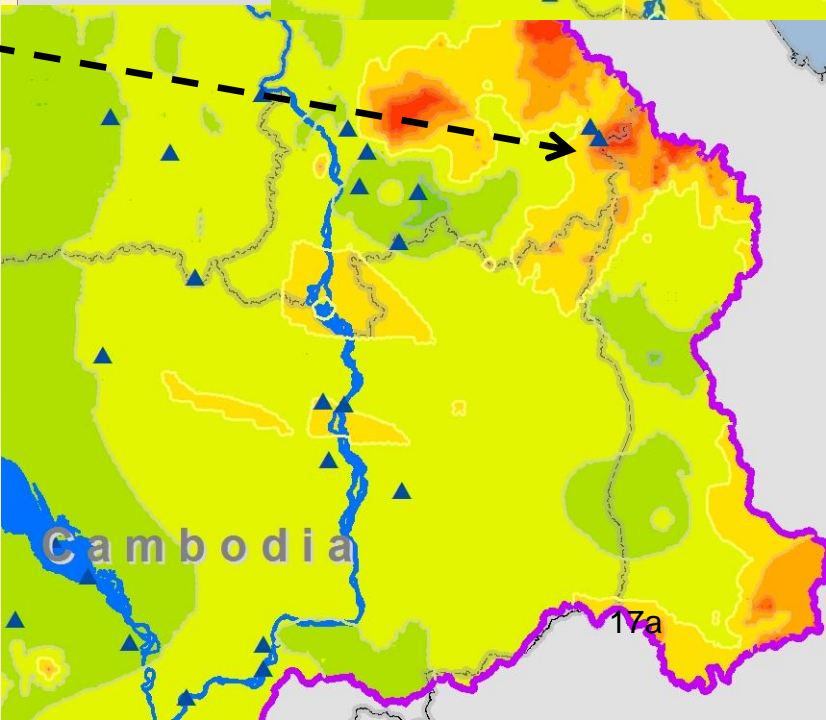
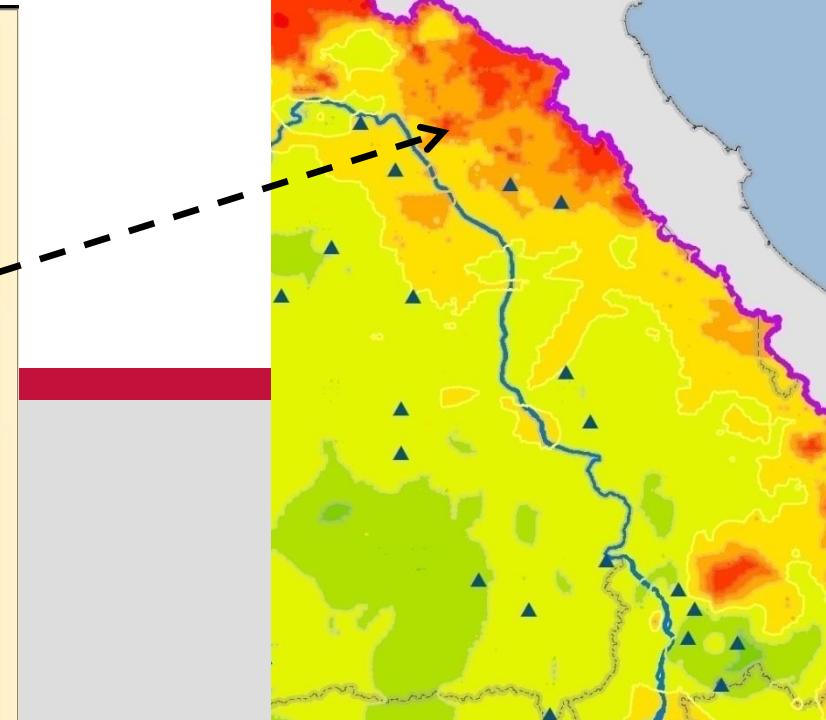
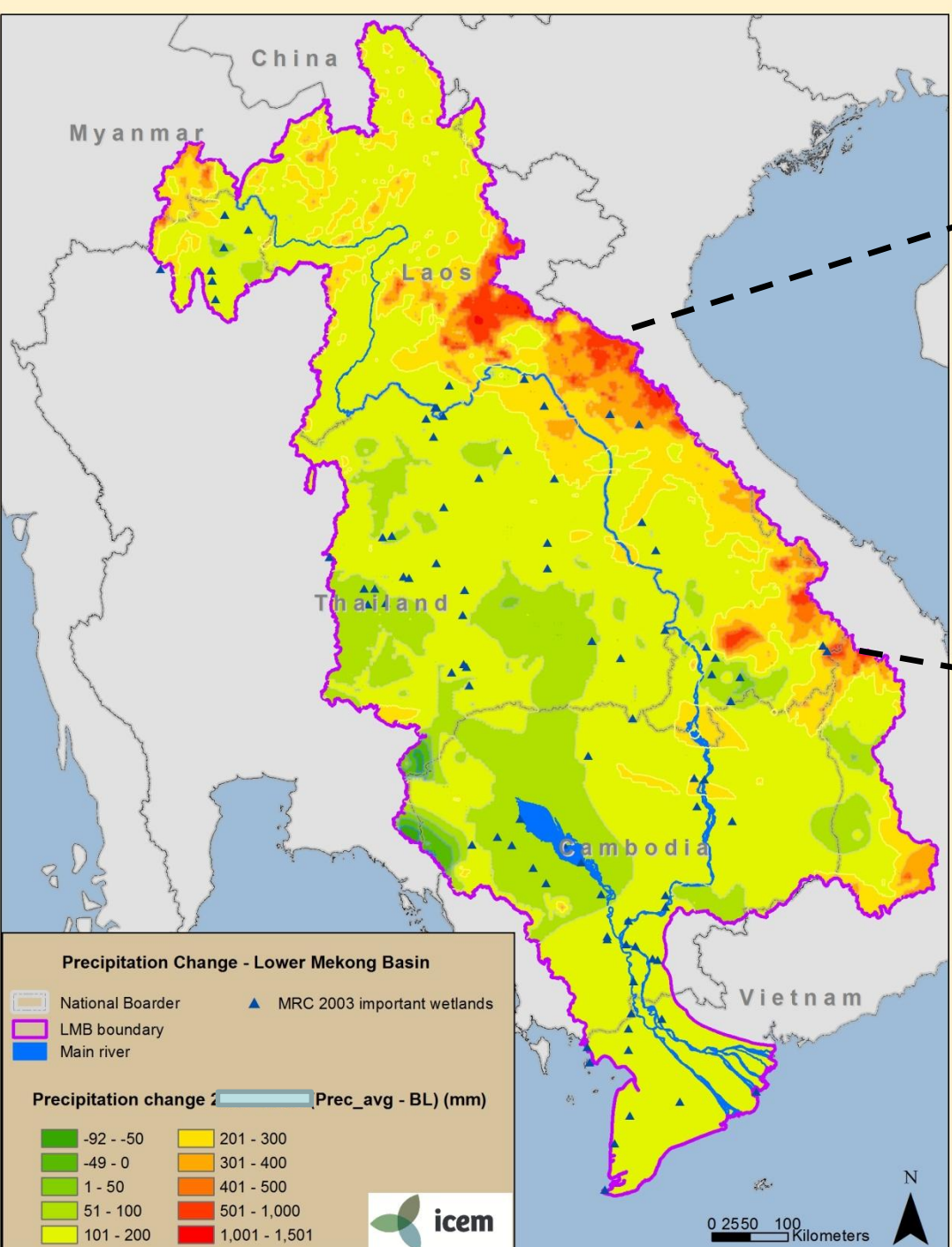


## Identifying climate change “hot spots” – i.e. highly vulnerable areas

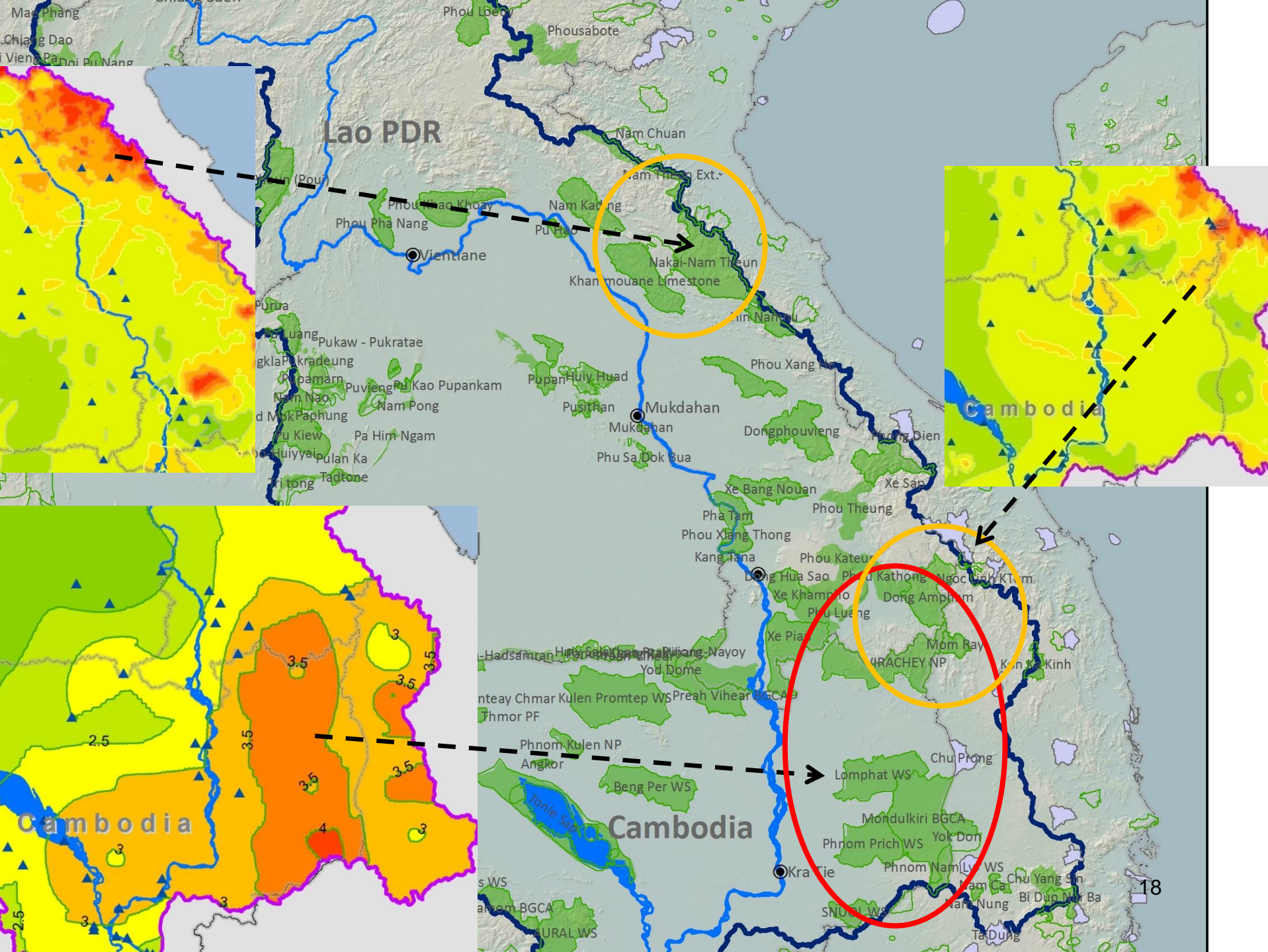
- High **exposure**:
  - significant climate change relative to base conditions
  - exposure to new climate/hydrological conditions
- High **sensitivity**:
  - limited temperature and moisture tolerance range
  - degraded and/or under acute pressure
  - severely restricted geographic range
  - rare or threatened
- Low **adaptive capacity**
  - Poor connectivity
  - Low diversity and tolerances
  - Homogenous systems













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# Sensitivity assessments: climate tolerances



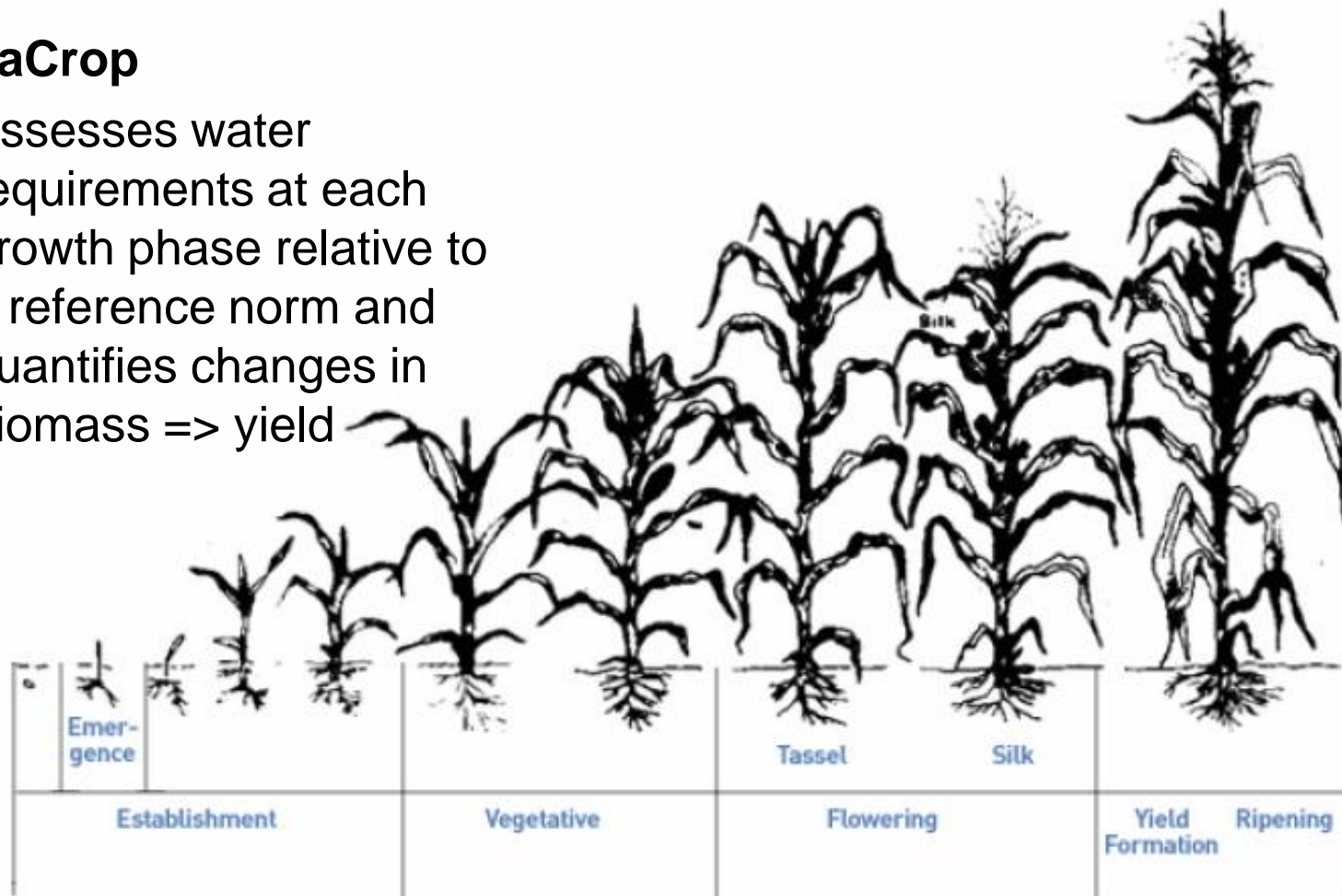
## Optimal growing conditions: mean annual precipitation



## Maize growth cycle

### AquaCrop

- Assesses water requirements at each growth phase relative to a reference norm and quantifies changes in biomass => yield







# Models

CC downscaling (6GCMs, A1B)

Hydrological & flood modeling  
(VMod, MIKE 11)

LUSET – Land Use Suitability  
Evaluation Tool (IRRI)

AQUACROP (FAO)

# Outputs

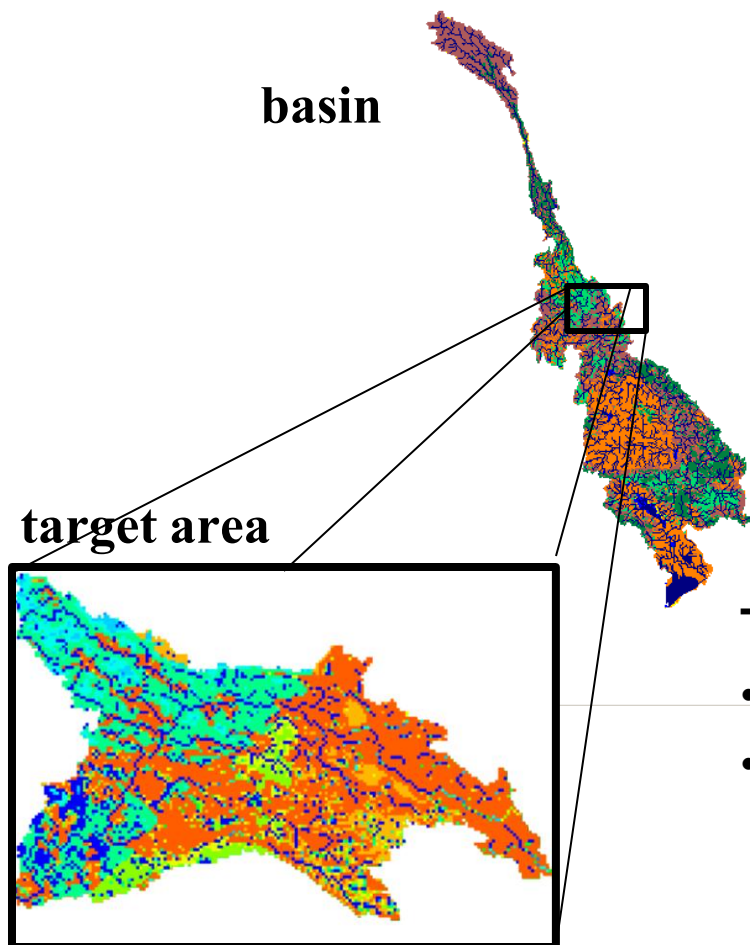
Geographical shifts in climate (CC  
zones)

Geographical shifts in natural  
systems (ecozones)

Geographical shifts in crop  
suitability

CC exposure for natural systems,  
agricultural, fisheries and socio-  
economic systems 21

## Predicting future changes in land suitability



### Basin – crop suitability

- Agro & eco zoning of basin characteristics
- Historic suitability of basin for a range of commercial and subsistence crops
- Suitability with climate change
- Assessment of transitions and shifts in geographical and seasonal suitability

### Target areas – crop yields

- Losses in crop yields within transition zones
- Yield potential for new crops in transition zones

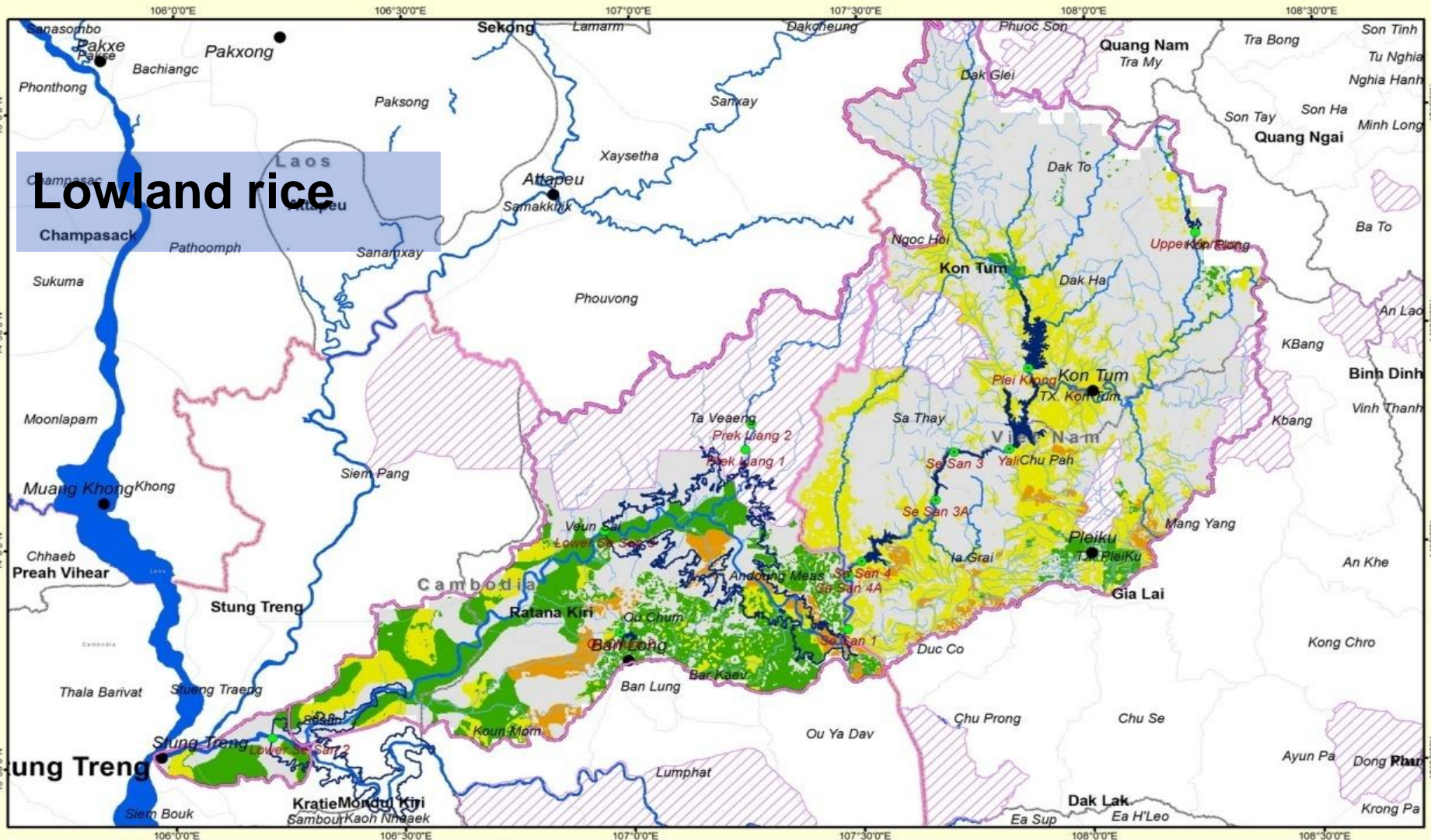


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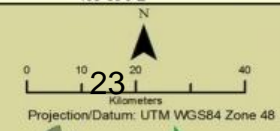
## Lowland rice



- Key to Features**
- National boundaries
  - Province boundaries
  - District boundaries
  - Major Cities
  - Major rivers
  - Minor rivers
  - Sesan basin boundary
  - Existing dam
  - Planned dam
  - Protected area
  - Existing reservoirs
  - Proposed reservoirs

- Land use suitability**
- Highly suitable
  - Moderately suitable
  - Marginally suitable
  - Not suitable

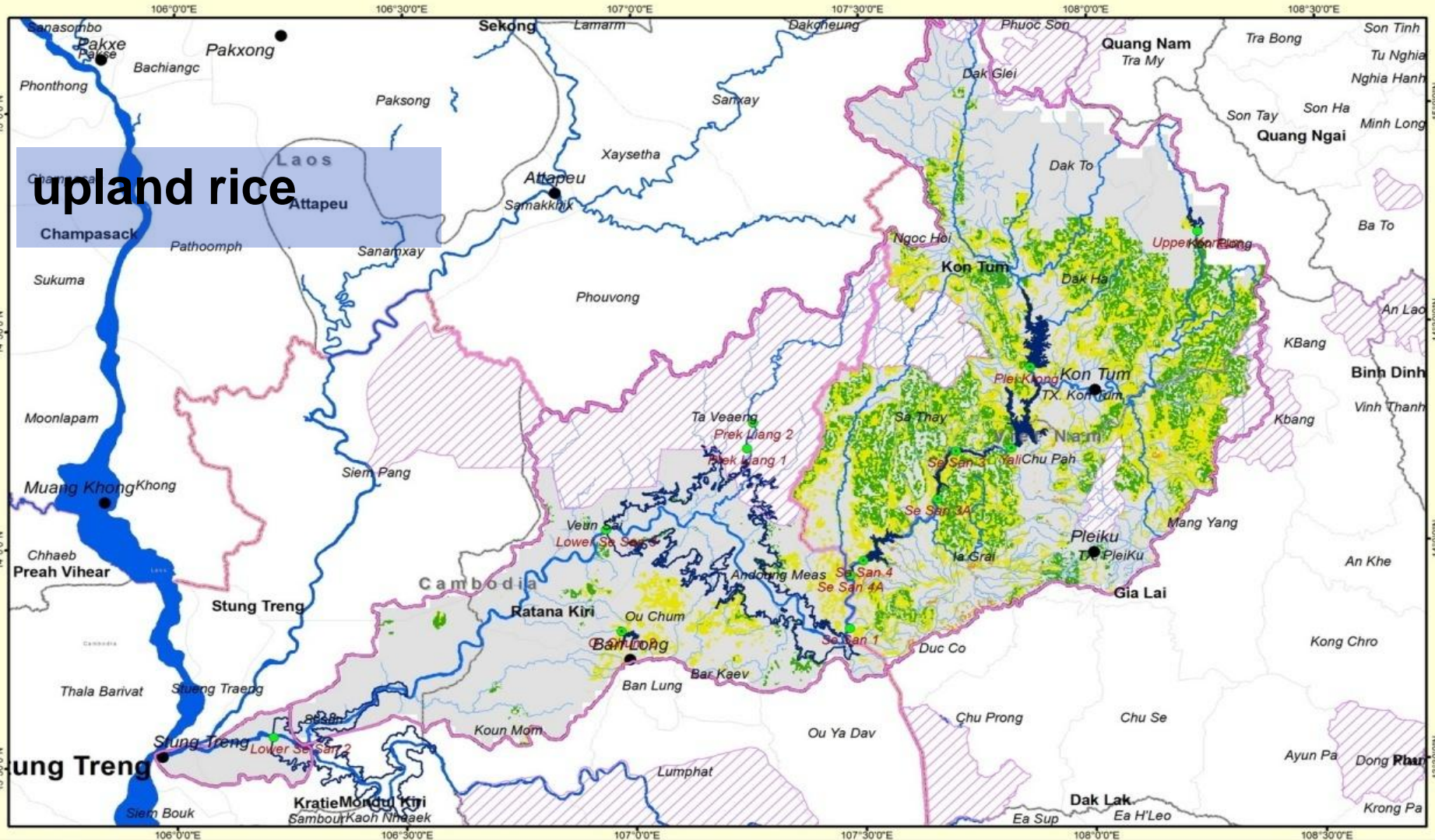
**CPWF Mekong Basin Development Challenge  
MK3 optimising cascades of reservoirs  
Land use suitability: Lowland rice**







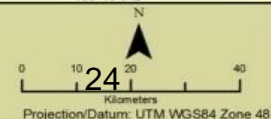
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  - Existing dam
  - Planned dam
  - Protected area
  - Existing reservoirs
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- Land use suitability**
- Highly suitable
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  - Marginally suitable
  - Not suitable

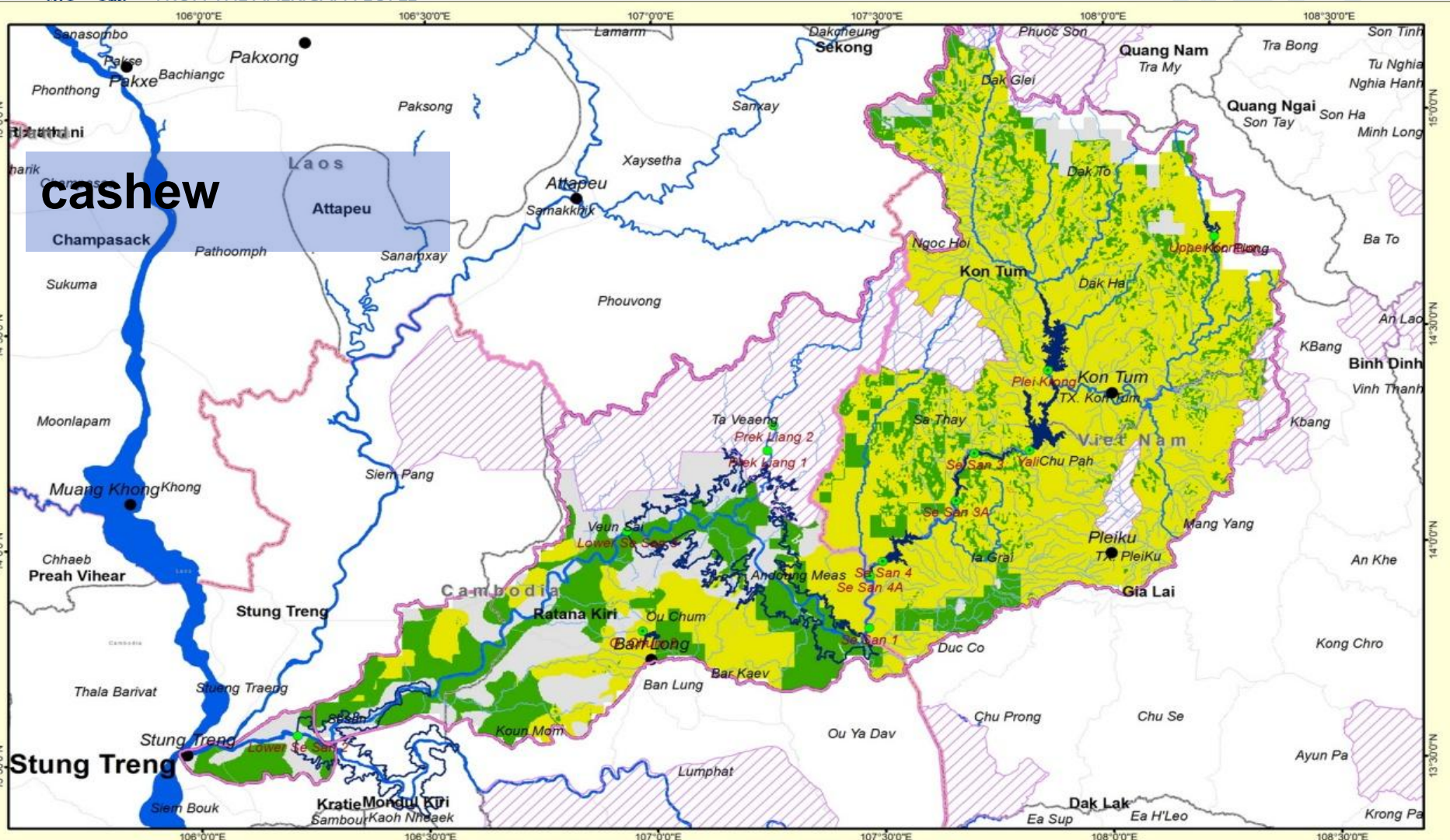
**CPWF Mekong Basin Development Challenge  
MK3 optimising cascades of reservoirs  
Land use suitability: Upland rice**







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- Key to Features**
- National boundaries
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  - Major Cities
  - Major rivers
  - Minor rivers
  - Sesan basin boundary
  - Existing dam
  - Planned dam
  - Protected area
  - Existing reservoirs
  - Proposed reservoirs

- Land use suitability**
- Highly suitable
  - Moderately suitable
  - Marginally suitable
  - Not suitable

**CPWF Mekong Basin Development Challenge  
MK3 optimising cascades of reservoirs  
Land use suitability: Cashew**



0 10 25 40  
Kilometers

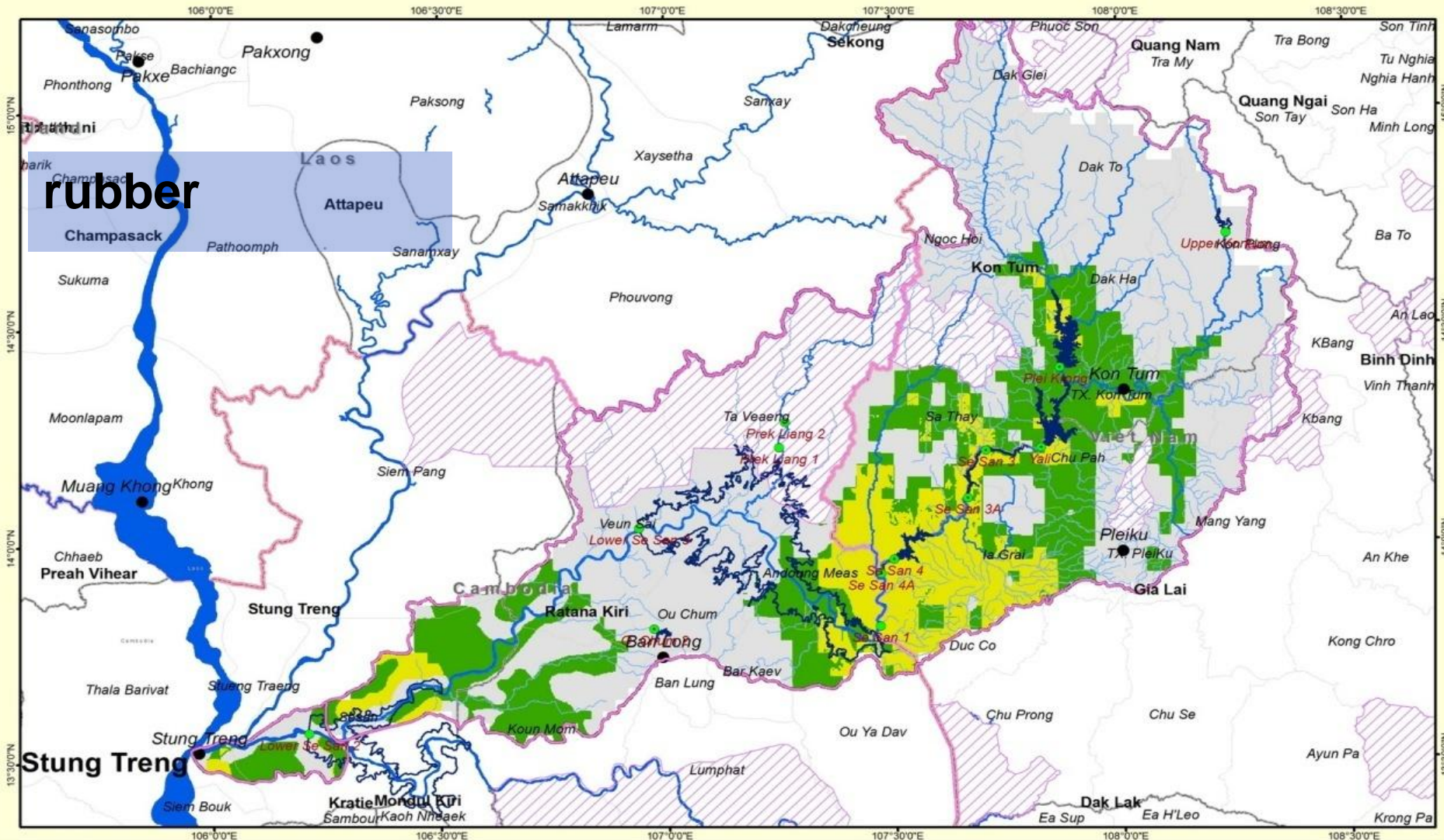
Projection/Datum: UTM WGS84 Zone 48





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- Key to Features**
- National boundaries
  - Province boundaries
  - District boundaries
  - Major Cities
  - Major rivers
  - Minor rivers
  - Sesan basin boundary
  - Existing dam
  - Planned dam
  - Protected area
  - Existing reservoirs
  - Proposed reservoirs

- Land use suitability**
- Highly suitable
  - Moderately suitable
  - Marginally suitable
  - Not suitable

**CPWF Mekong Basin Development Challenge  
MK3 optimising cascades of reservoirs  
Land use suitability: Rubber**



0 10 20 40  
Kilometers

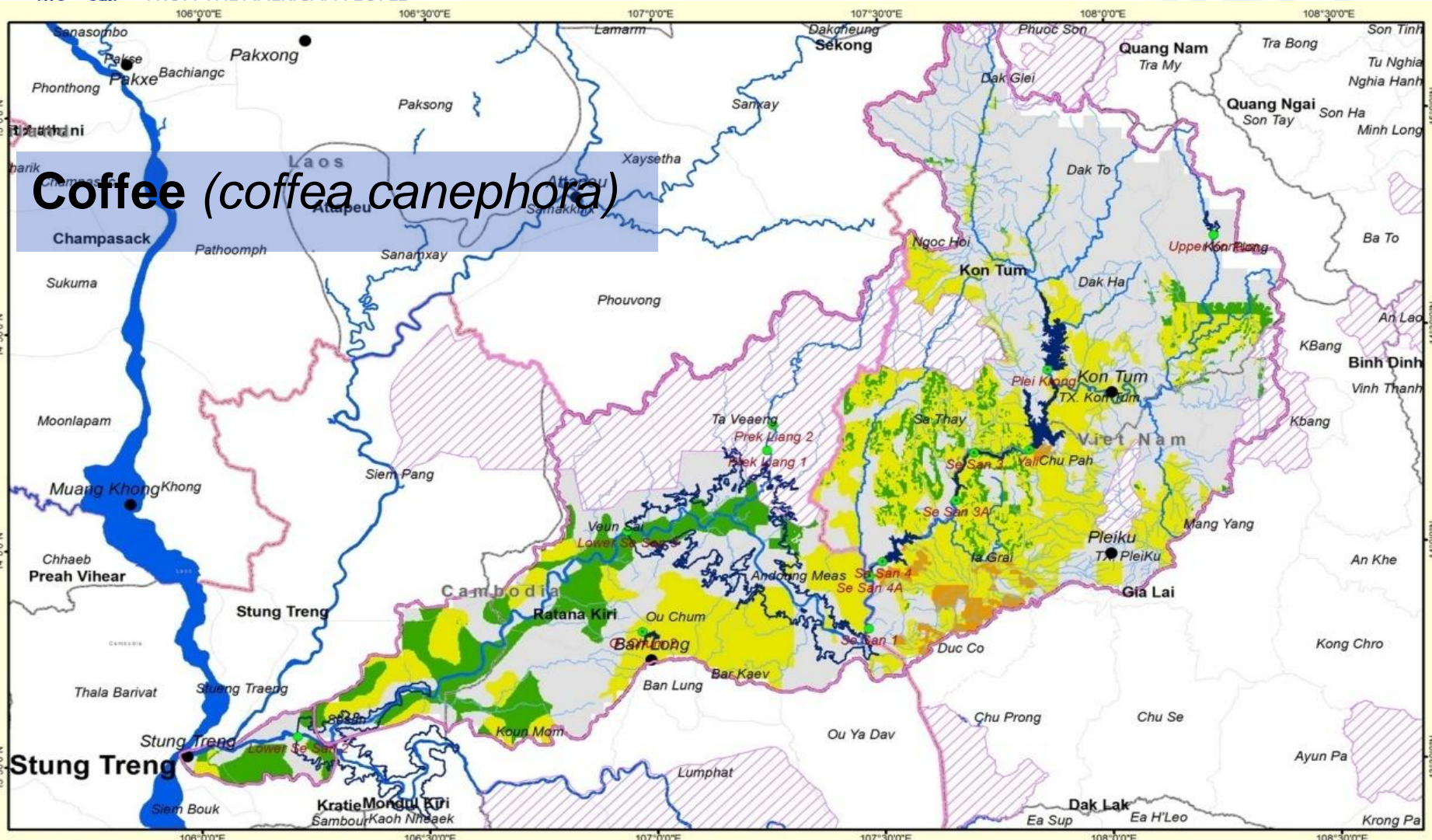
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Projection/Datum: UTM WGS84 Zone 48





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Coffee (*Coffea canephora*)

- Key to Features**
- National boundaries
  - Province boundaries
  - District boundaries
  - Major Cities
  - Major rivers
  - Minor rivers
  - Sesan basin boundary
  - Existing dam
  - Planned dam
  - Protected area
  - Existing reservoirs
  - Proposed reservoirs

- Land use suitability**
- Highly suitable
  - Moderately suitable
  - Marginally suitable
  - Not suitable

**CPWF Mekong Basin Development Challenge  
MK3 optimising cascades of reservoirs  
Land use suitability: Coffee**



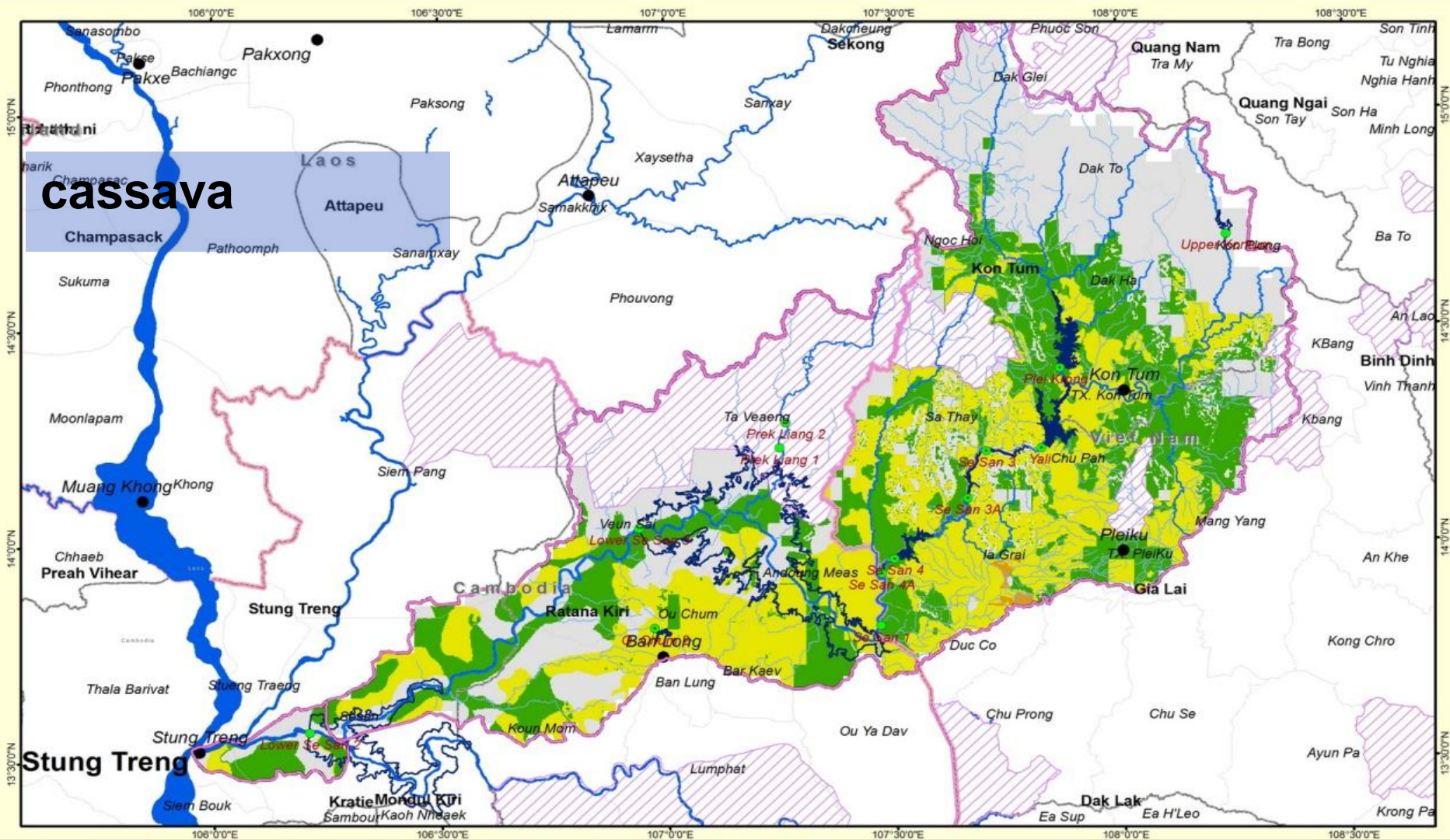
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Kilometers

Projection/Datum: UTM WGS84 Zone 48





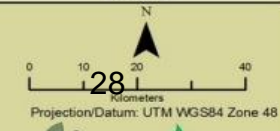
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**cassava**

Key to Features		Land use suitability	
	National boundaries		Highly suitable
	Province boundaries		Moderately suitable
	District boundaries		Marginally suitable
	Major Cities		Not suitable
	Major rivers		Existing dam
	Minor rivers		Planned dam
	Existing reservoirs		Protected area
	Proposed reservoirs		Existing reservoirs
	Sesan basin boundary		Proposed reservoirs

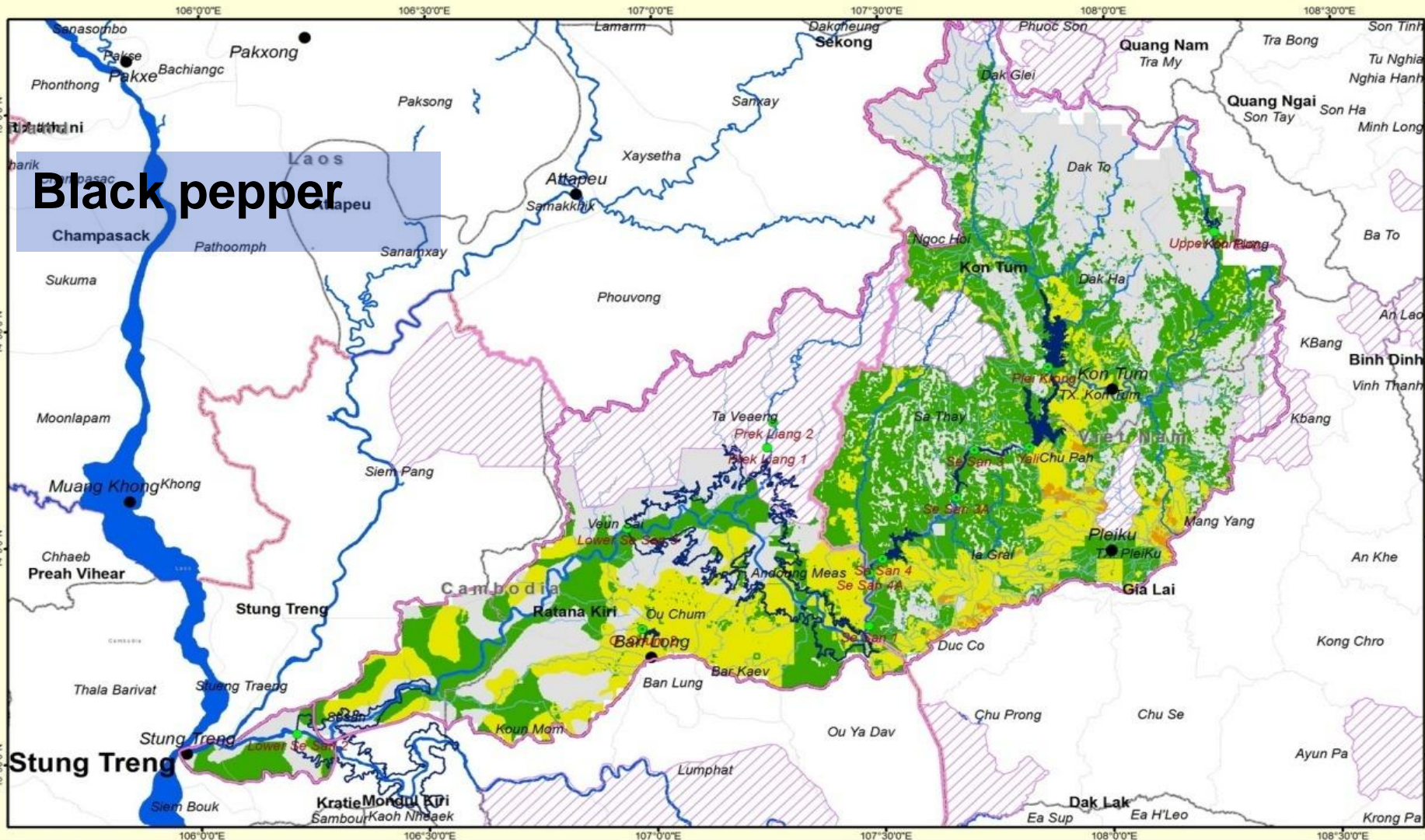
**CPWF Mekong Basin Development Challenge  
MK3 optimising cascades of reservoirs  
Land use suitability: Cassava**







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- Key to Features**
- National boundaries
  - Province boundaries
  - District boundaries
  - Major Cities
  - Major rivers
  - Minor rivers
  - Sesan basin boundary
  - Existing dam
  - Planned dam
  - Protected area
  - Existing reservoirs
  - Proposed reservoirs

- Land use suitability**
- Highly suitable
  - Moderately suitable
  - Marginally suitable
  - Not suitable

**CPWF Mekong Basin Development Challenge  
MK3 optimising cascades of reservoirs  
Land use suitability: Black pepper**



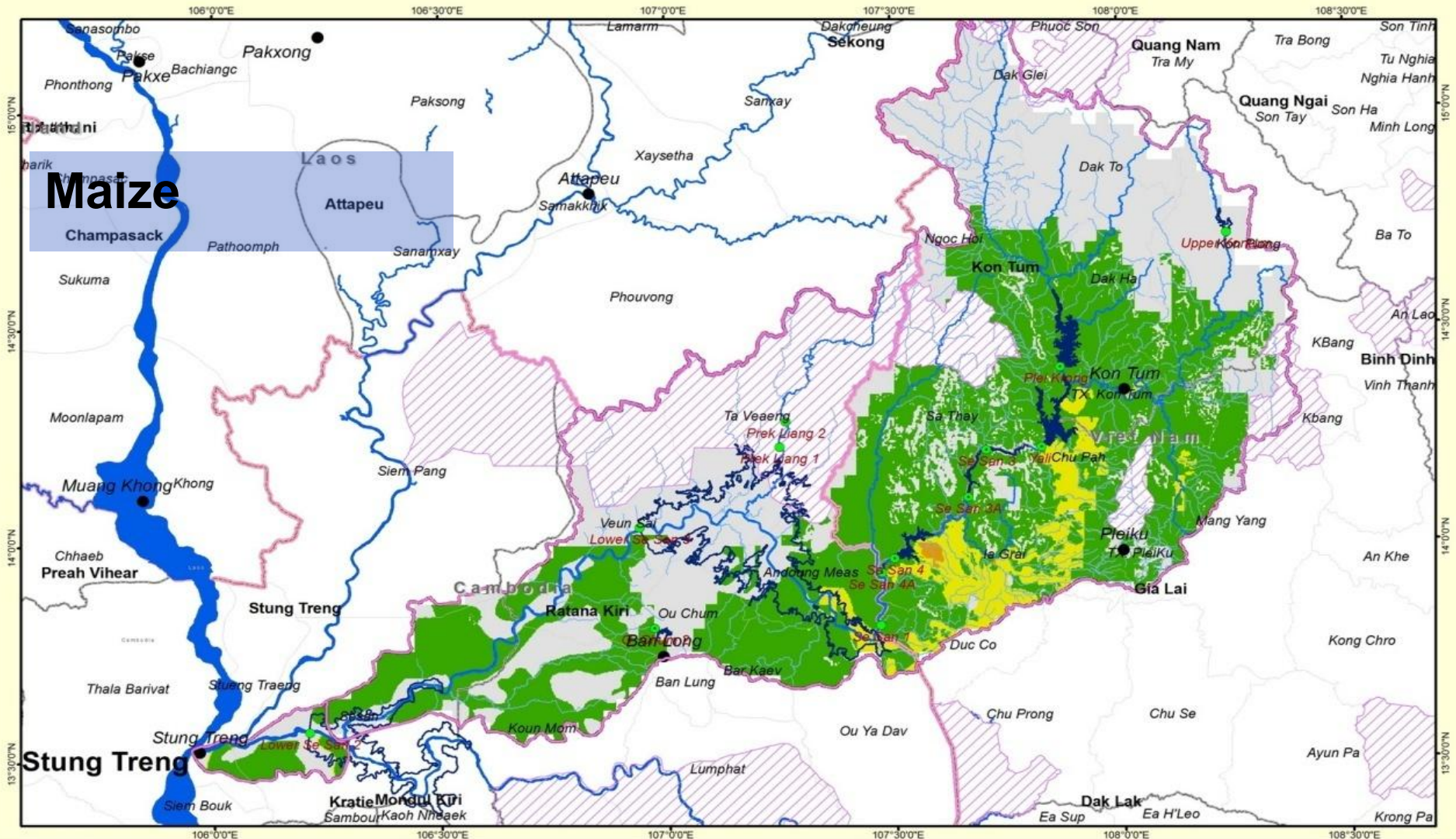
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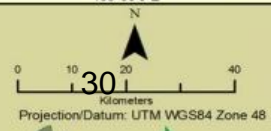


**Maize**

**CPWF Mekong Basin Development Challenge  
MK3 optimising cascades of reservoirs  
Land use suitability: Maize**

- Key to Features**
- National boundaries
  - Province boundaries
  - District boundaries
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  - Sesan basin boundary
  - Existing dam
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- Land use suitability**
- Highly suitable
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  - Marginally suitable
  - Not suitable





## Adaptation Pathway - addressing the **adaptation deficit**

