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

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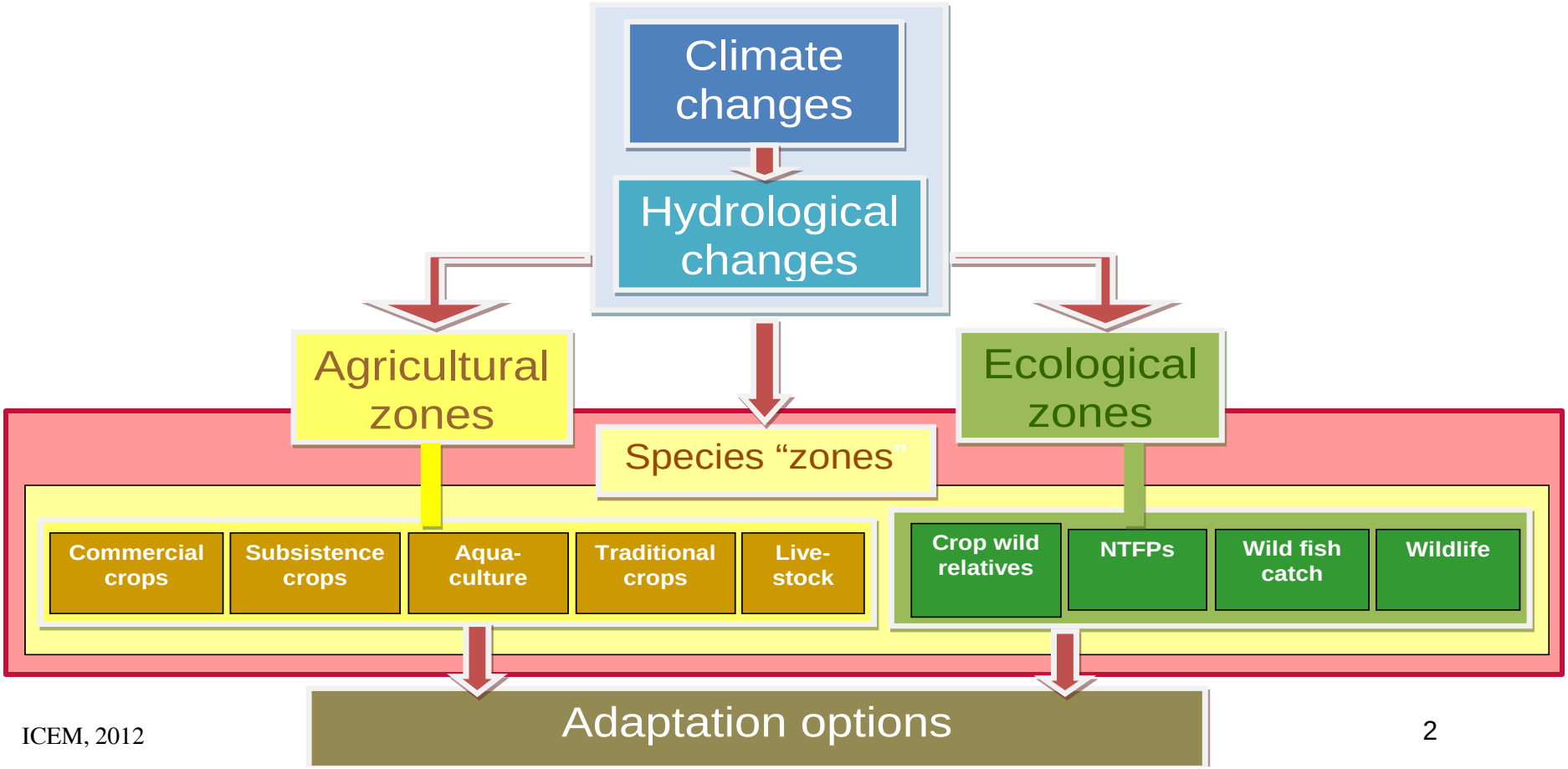
ICEM – International Centre for Environmental Management
www.icem.com.au

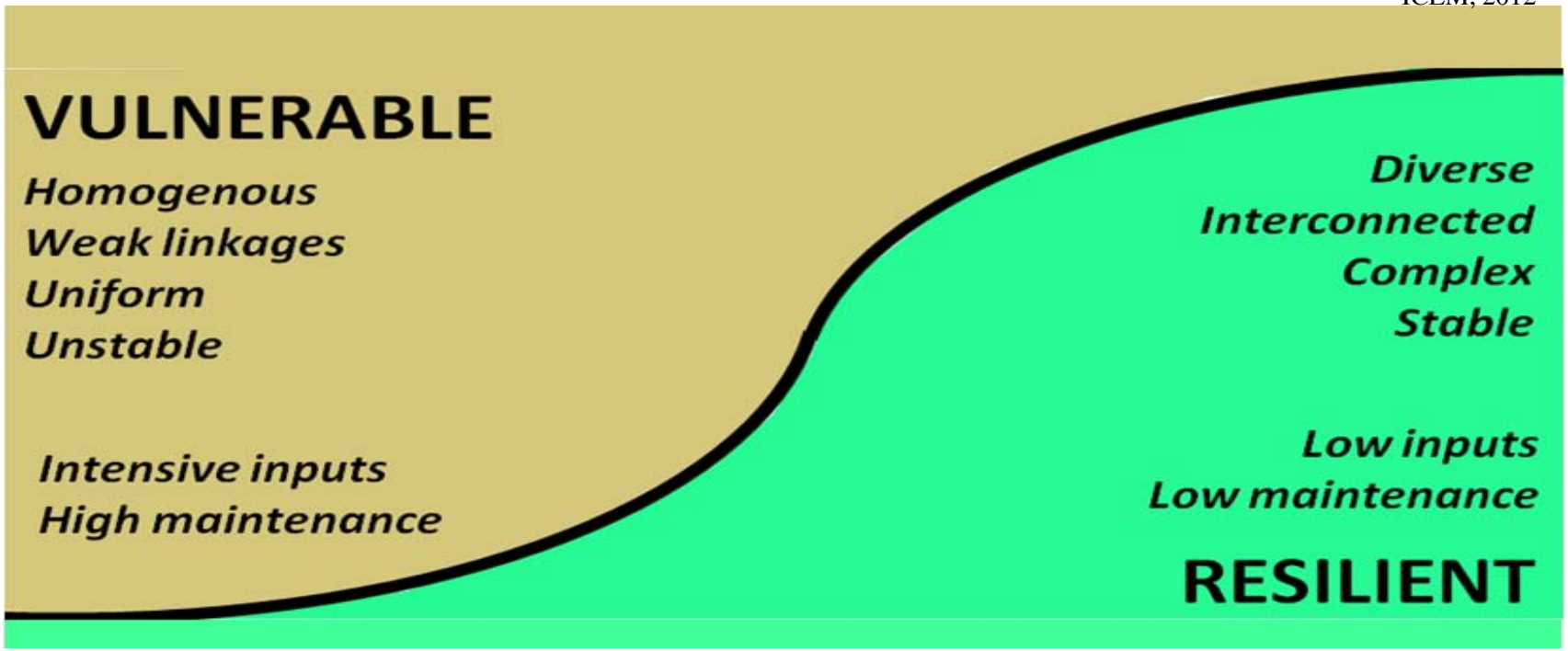
May 2012, Bangkok

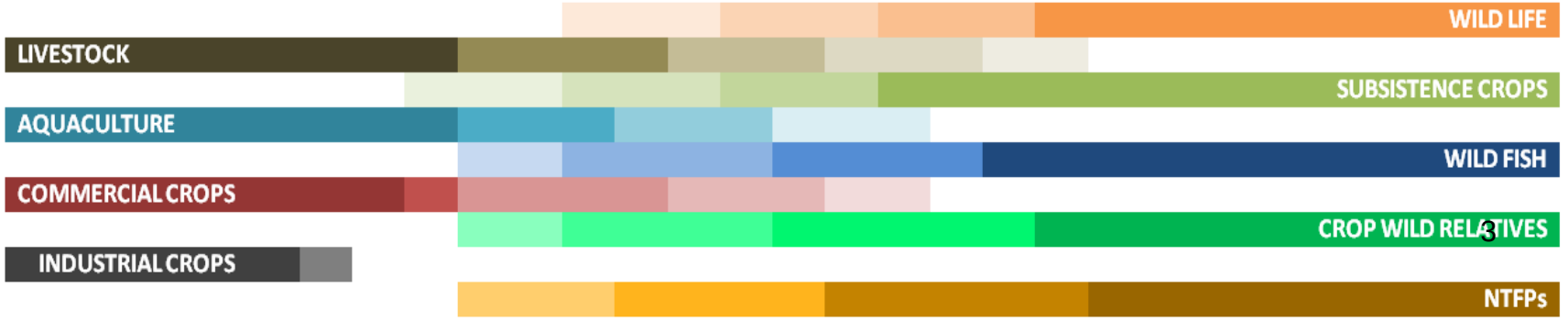
Assessing climate change threats to agriculture and subsistence livelihoods



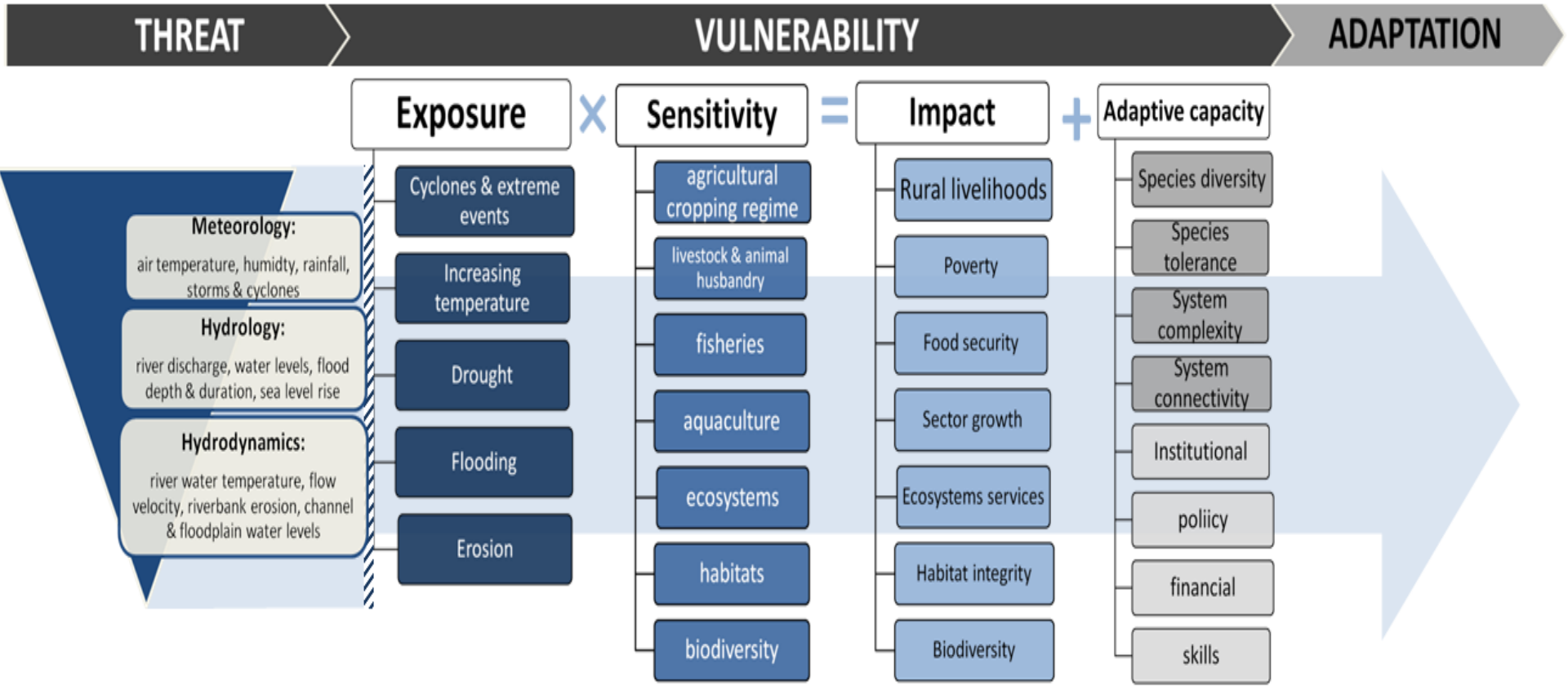
Agricultural systems and climate change continuum

ICEM, 2012





CAM method



Source: ICEM, 2012

Climate and hydrological changes

Climate changes

Regular (daily and seasonal)

- Increase in C02
- 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)

Centre of origin for: coconut palm, sugarcane, clove, nutmeg, black pepper, onion, cucumber

Key assessment concepts

Zones

- Climate change, Ecological, Agricultural

Shifts

- Geographic, Elevation, Seasonal

Hotspots

- Exposure, Sensitivity, Adaptive capacity

Climate change overlaid on "zones"

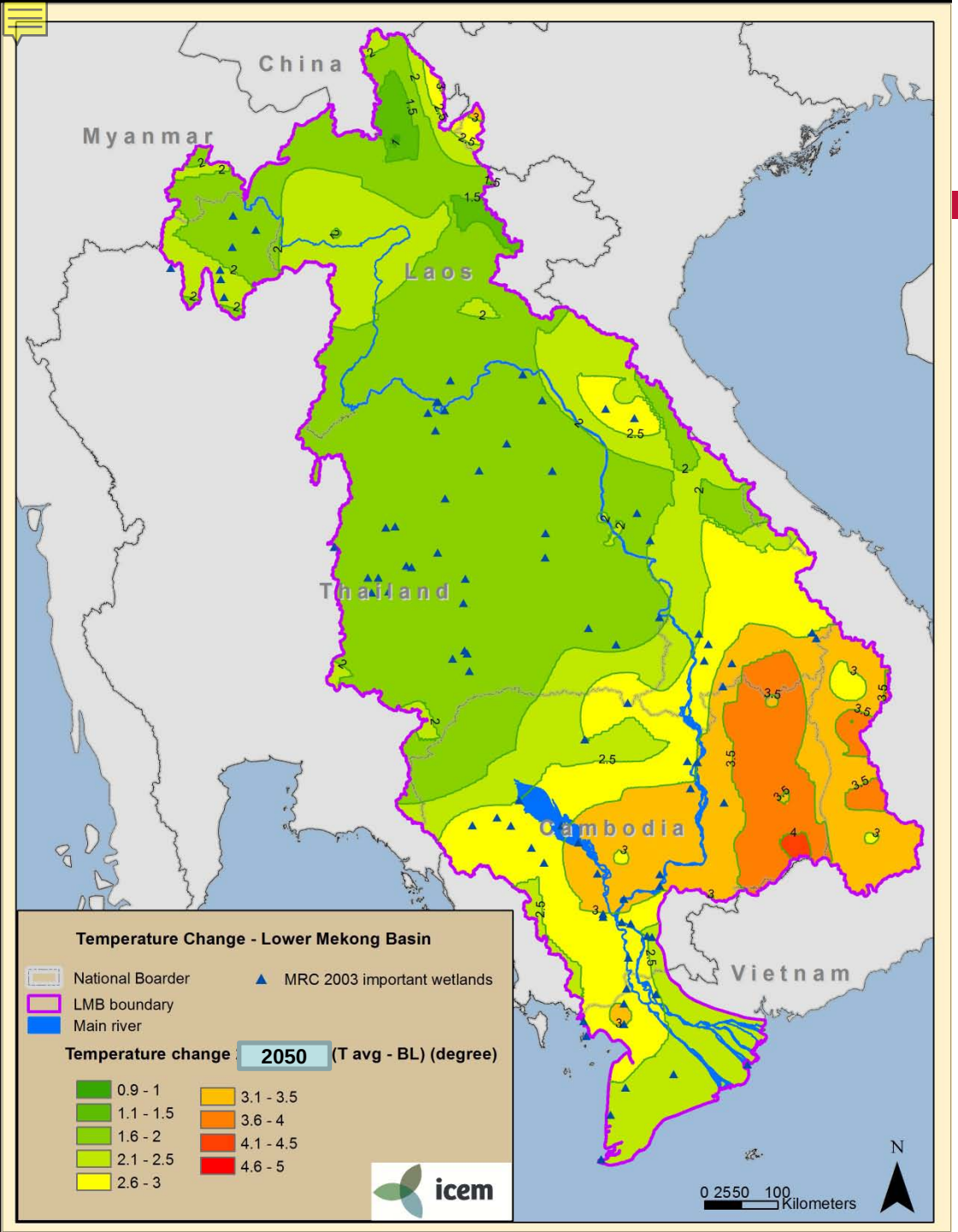
Zones provide the common analytical framework for the study team

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

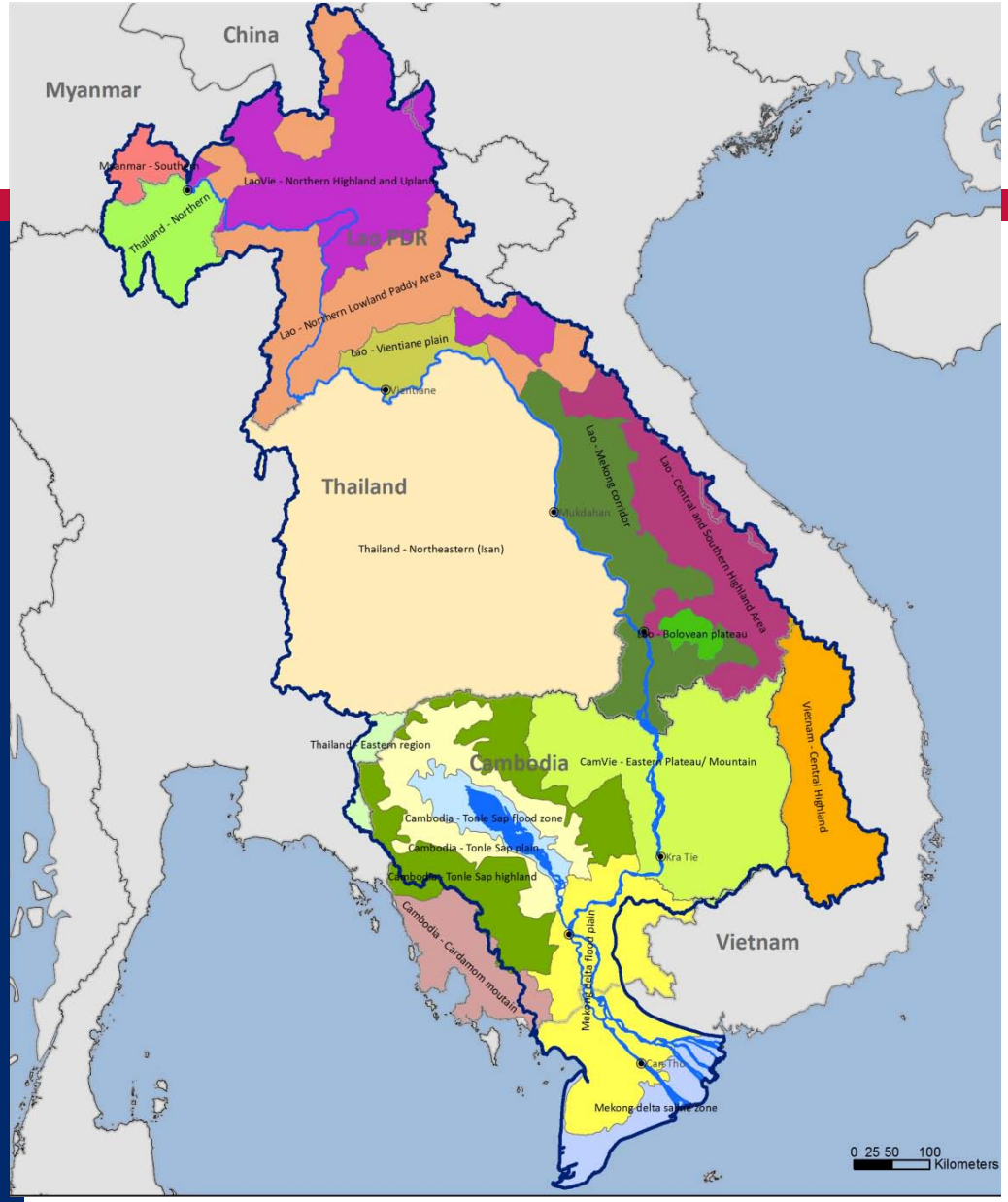


Climate change zones

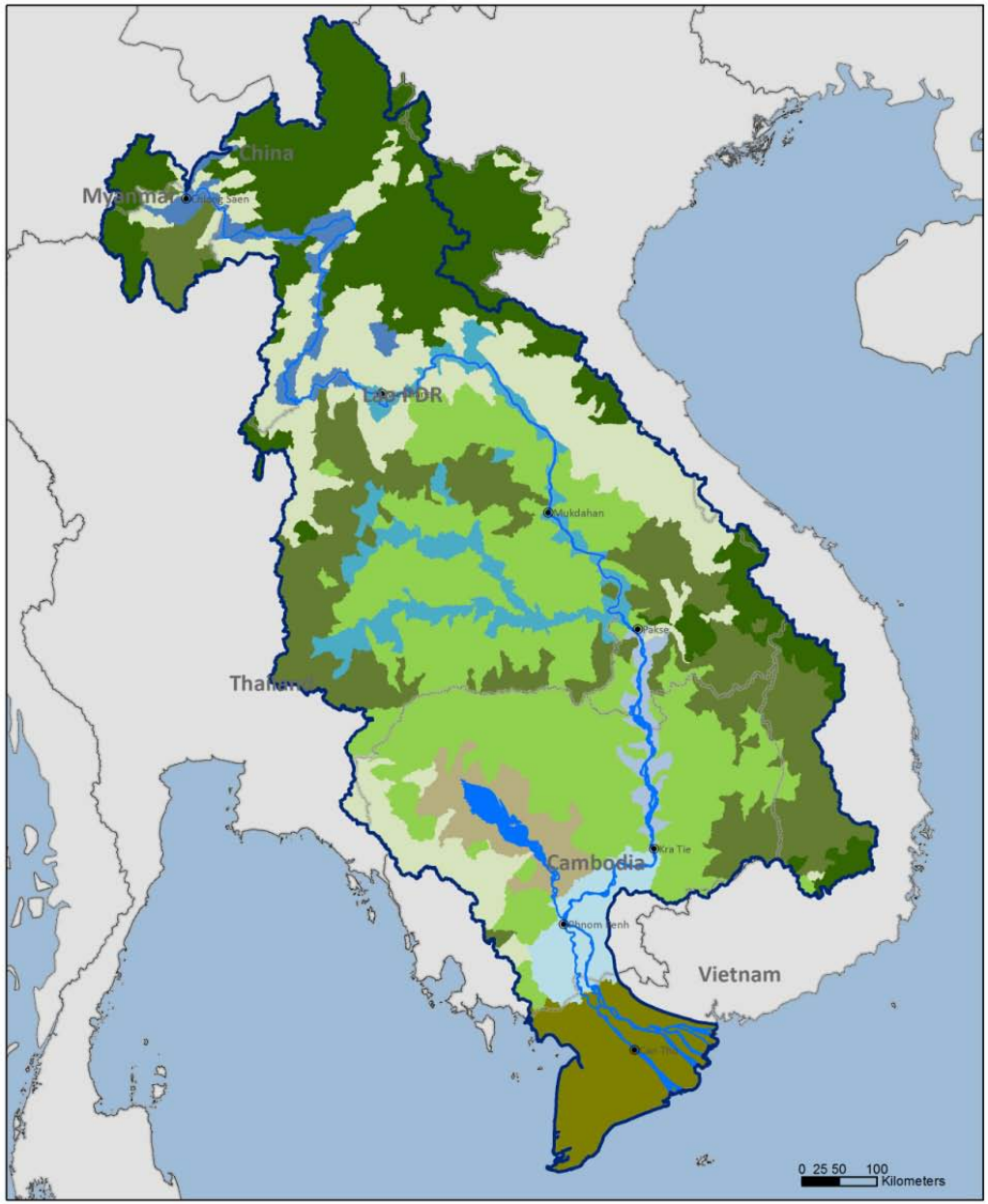
Areas experiencing similar climate change

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

- National Border
- LMB boundary

- High-elevation moist broadleaf forest
- Mid-elevation dry broadleaf forest
- Low-elevation dry broadleaf forest
- Low-elevation moist broadleaf forest
- Upper floodplain wetland, lake (Chiang Saen to Vientiane)
- Mid floodplain, wetland, lake (Vientiane to Pakse)
- Lower floodplain, wetland, lake (Pakse to Kratie)
- Lower floodplain, wetland, lake (Kratie to delta)
- Swamp forest – Tonle Sap
- Mekong delta zone

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Data Source:
ICEM 2012,
WWF 2005
MRC GIS Database

Climate change shifts

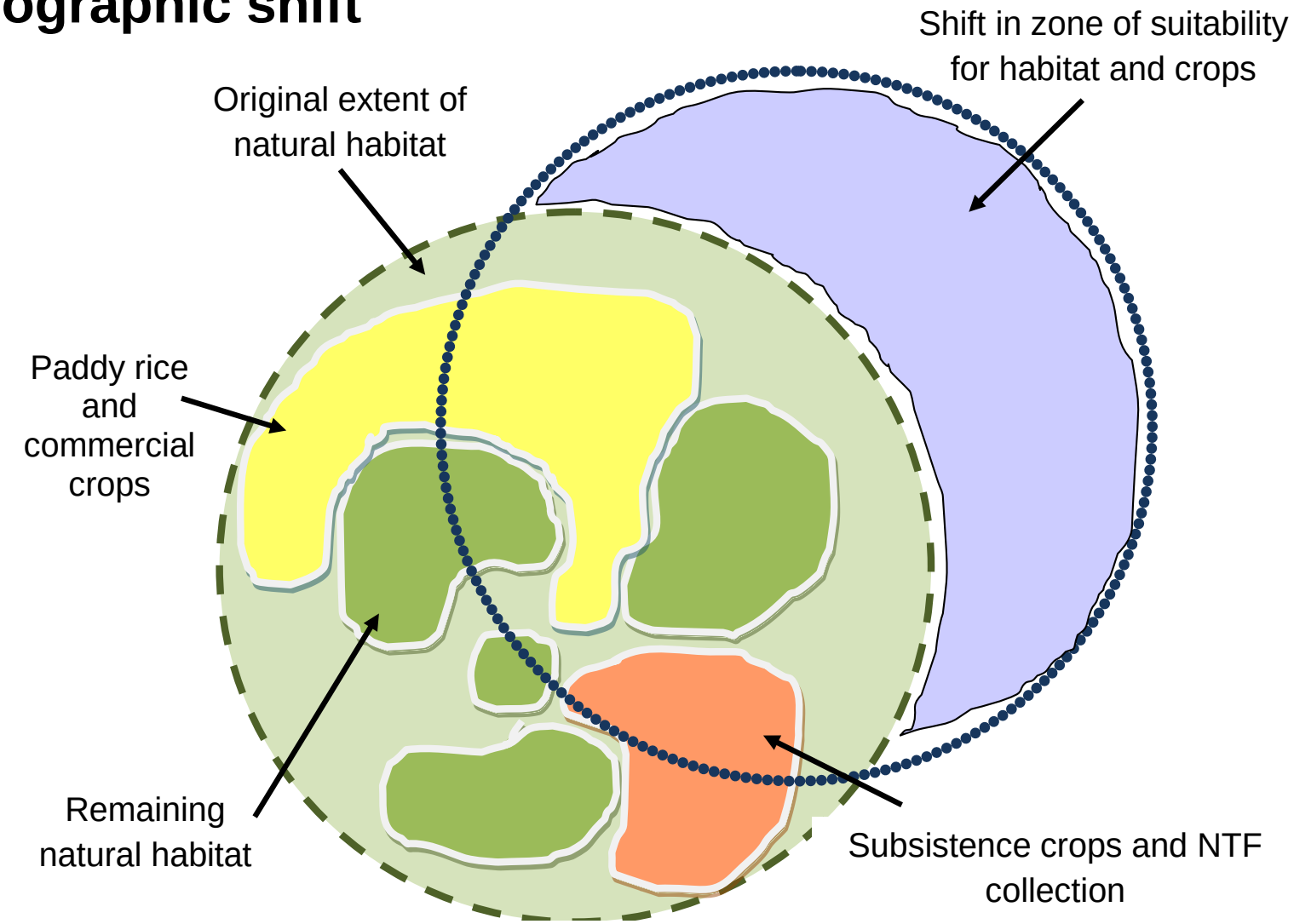
Regular climate

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

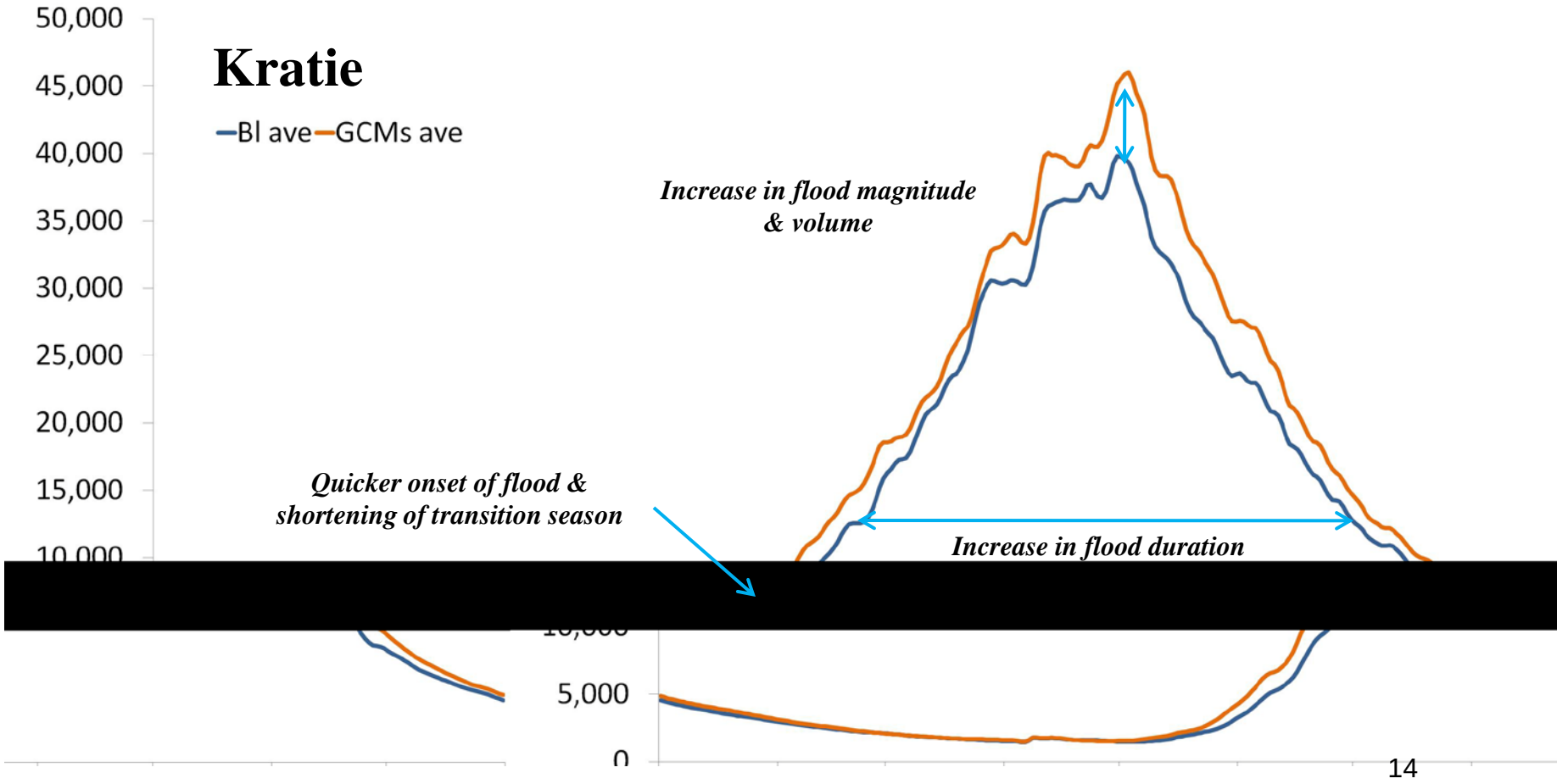
4. **Extreme event shifts**
   - Micro – eg flash flooding and soil loss in uplands
   - Macro – eg saline intrusion in Delta; cyclone landfall

Geographic shift



ICEM, 2012

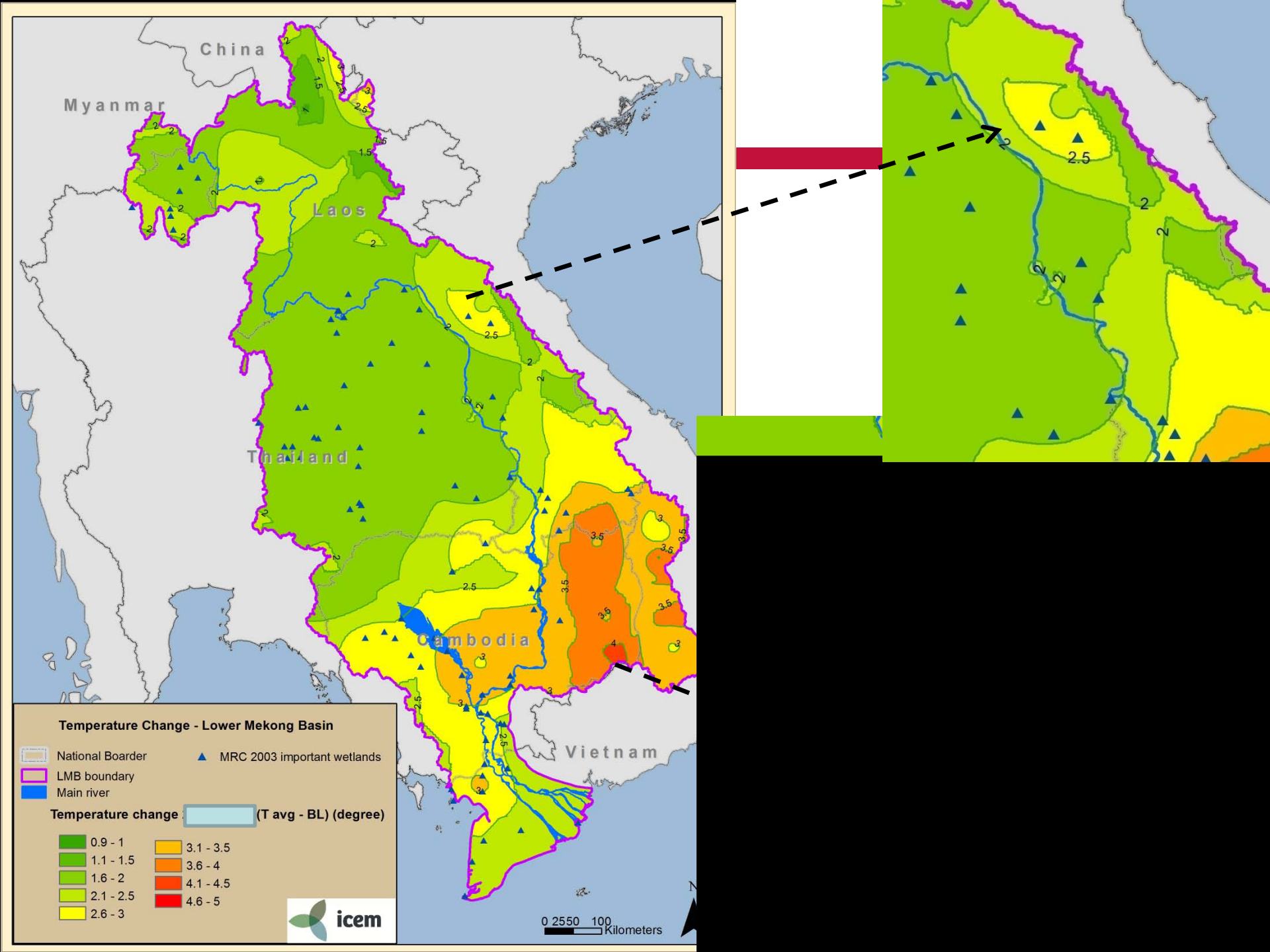
Seasonal shifts

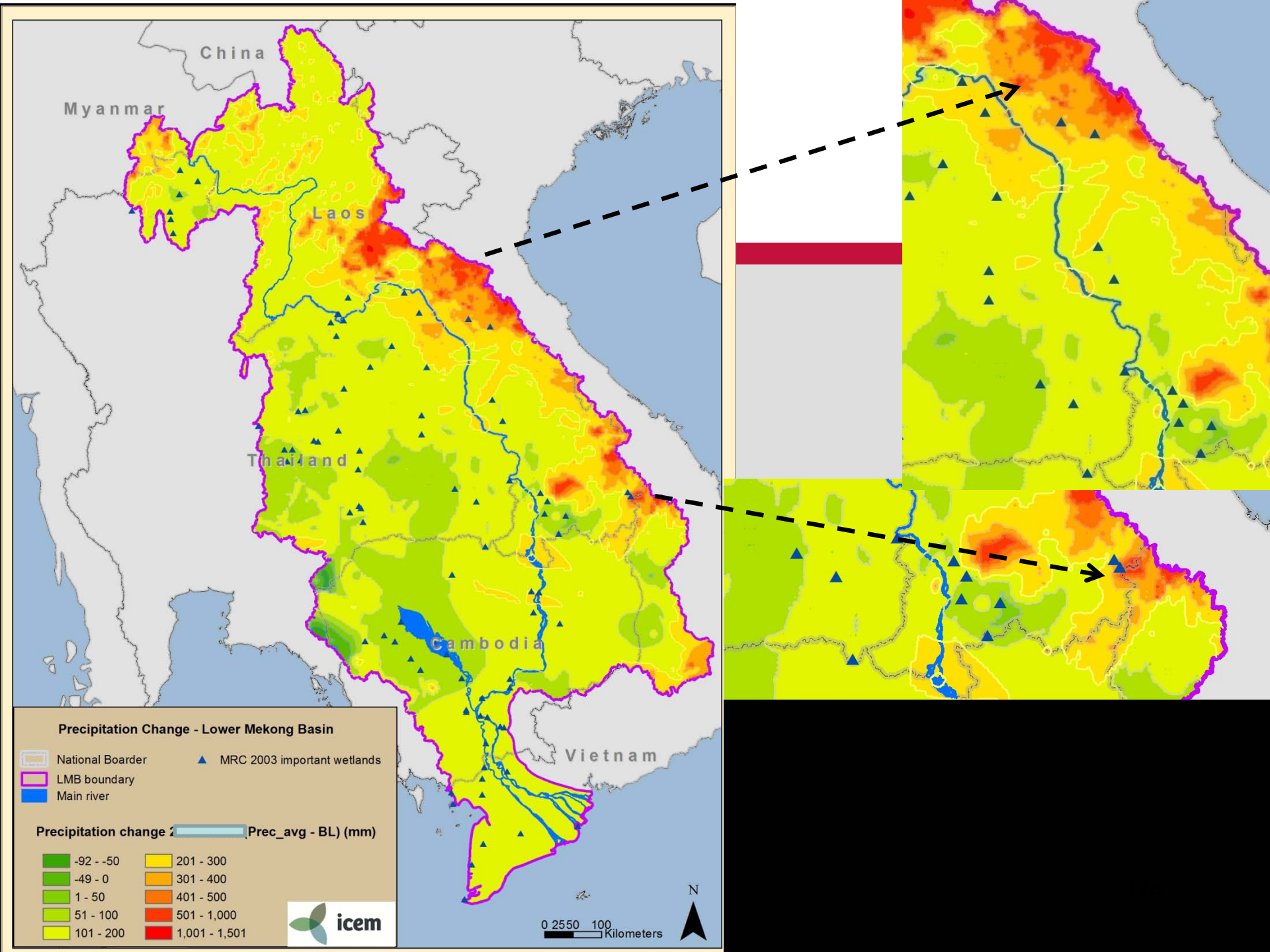


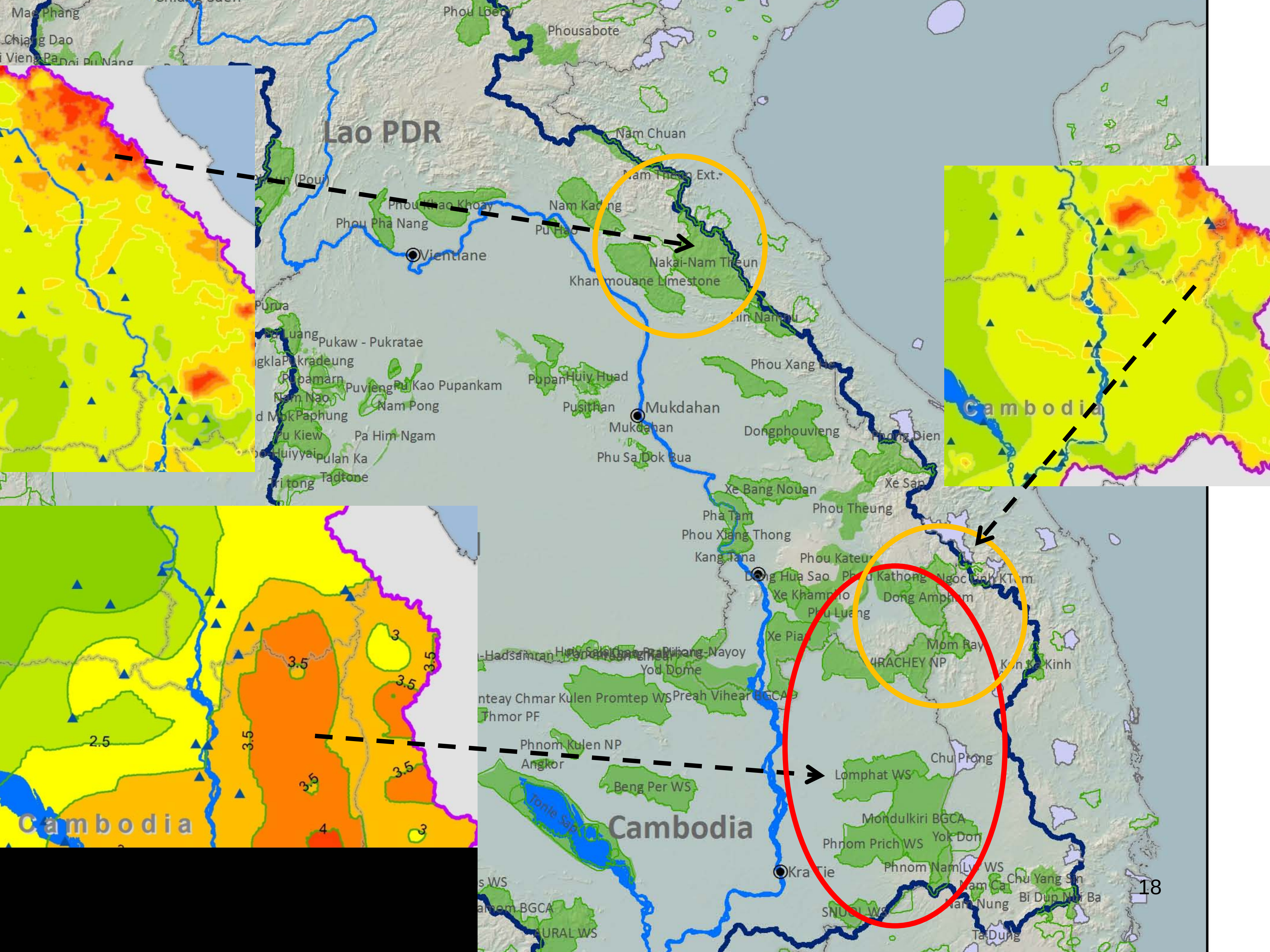
Source: ICEM, 2012

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


China
Myanmar
Laos
Thailand
Cambodia
Vietnam
Temperature Change - Lower Mekong Basin
National Boarder
LMB boundary
Main river
MRC 2003 important wetlands
Temperature change (T avg - BL) (degree)
0.9 - 1
1.1 - 1.5
1.6 - 2
2.1 - 2.5
2.6 - 3
3.1 - 3.5
3.6 - 4
4.1 - 4.5
4.6 - 5
icem
0 2550 100
Kilometers


China
Myanmar
Laos
Thailand
Cambodia
Vietnam
Precipitation Change - Lower Mekong Basin
National Boarder
LMB boundary
Main river
MRC 2003 important wetlands
Precipitation change 2 (Prec_avg - BL) (mm)
-92 - -50
-49 - 0
1 - 50
51 - 100
101 - 200
201 - 300
301 - 400
401 - 500
501 - 1,000
1,001 - 1,501
icem
0 2550 100
Kilometers
N



Lao PDR
Cambodia
Vientiane
Mukdahan
Kra Tie
Mae Phang
Chiang Dao
Phou Loeuy
Phousabote
Nam Chuan
Nam Theun Ext.
Phou Khao Khoay
Phou Pha Nang
Nam Kading
Nakai-Nam Theun
Khammouane Limestone
Pukaw - Pukratae
Pukradeung
Pupamarn
Puvieng
Pu Kao Pupankam
Nam Pong
Phupaphung
Pa Him Ngam
Pulan Ka
Tadtone
Pupan
Huiy Huad
Pusithan
Phu Sa Dok Bua
Phou Xang He
Dongphouvieng
Xe Bang Nouan
Phou Theung
Pha Tam
Phou Xiang Thong
Kang Tana
Dong Hua Sao
Phou Kateu
Xe Khampho
Phou Luang
Xe Pian
Dong Amphan
VIRACHEY NP
Mom Ray
Xe Sap
Yod Dome
Thmor PF
Preah Vihear BGCA
Phnom Kulen NP
Angkor
Beng Per WS
Tonle Sap
Chu Prong
Lomphat WS
Mondulkiri BGCA
Yok Don
Phnom Prich WS
Phnom Nam Lyr WS
Chu Yang Sin
Bi Dup Nui Ba
Nam Nung
Ta Dung
SNUOL WS
2.5
3
3.5
4
Cambodia

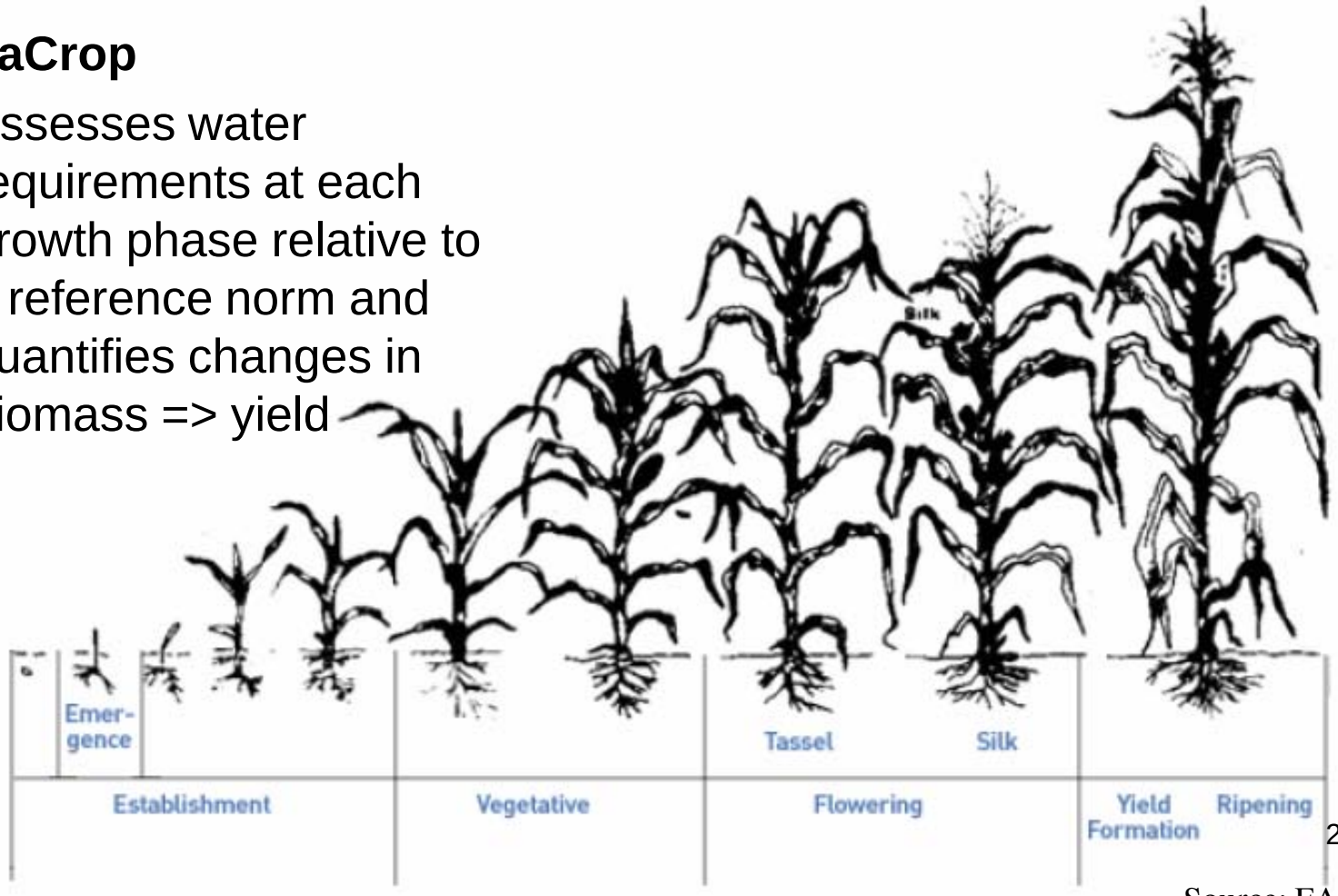
Sensitivity assessments: climate tolerances

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



Source: FAO, 2010

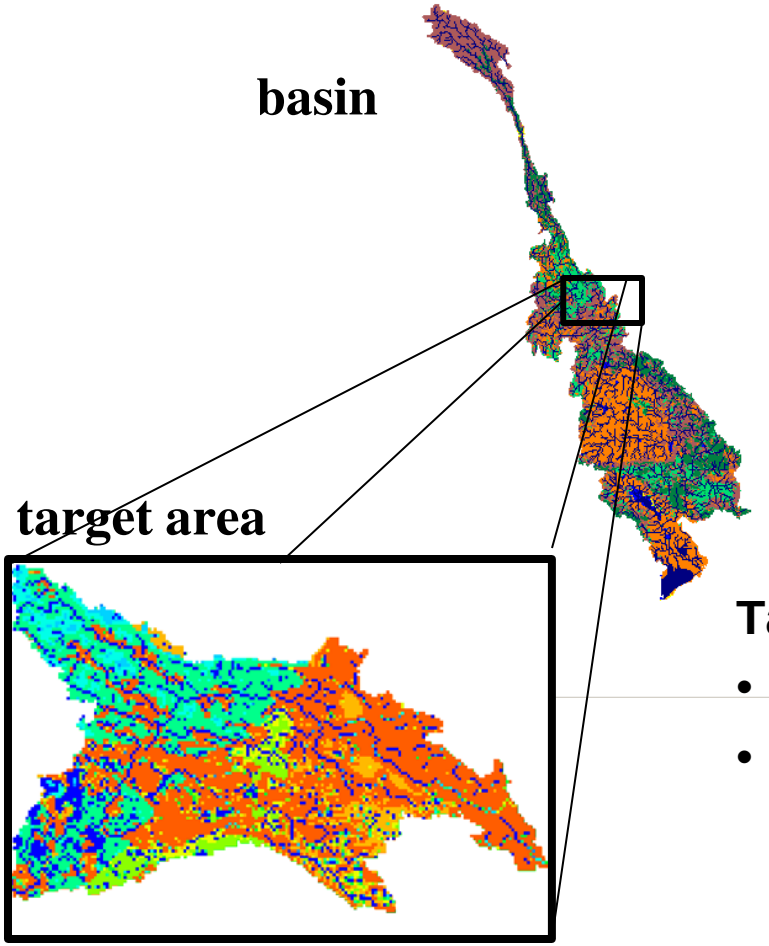
Models

- 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

Predicting future changes in land suitability

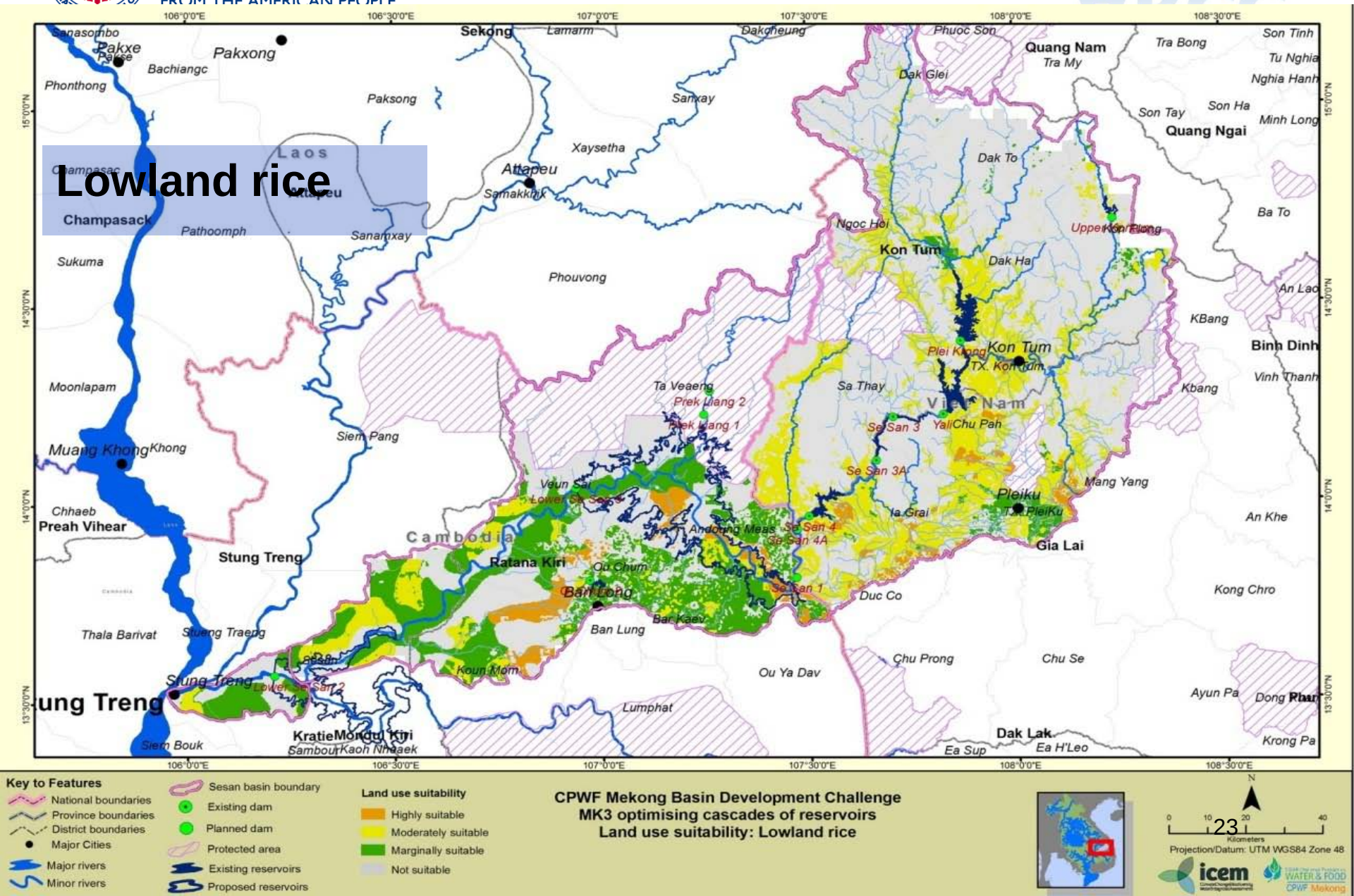


Basin – crop suitability

- 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


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
Kilometers
Projection/Datum: UTM WGS84 Zone 48
Laos
Cambodia
Champasack
Attapeu
Sekong
Pakxe
Pakxong
Paksong
Samakkhixay
Xaysetha
Phouvong
Sanamxay
Pathoomph
Sukuma
Phonthong
Bachiangc
Sanasombo
Lamarm
Dakcheung
Moonlapam
Muang Khong
Khong
Siem Pang
Chhaeb
Preah Vihear
Stung Treng
Thala Barivat
Stueng Traeng
Siem Bouk
Kratie
Sambour
Kaoh Nheaek
Mondul Kiri
Ratana Kiri
Ou Chum
Ban Long
Bar Kaev
Ban Lung
Koun Mom
Lumphat
Ou Ya Dav
Chu Prong
Chu Se
Duc Co
Gia Lai
Pleiku
TX. PleiKu
Ia Grai
Mang Yang
An Khe
Kong Chro
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Ea Sup
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Dong Phu
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Dak Glei
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Son Tinh
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Nghia Hanh
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Quang Ngai
Dak To
Ba To
Kon Tum
Ngoc Hoi
Upper Kon Plong
Dak Ha
Plei Kong
TX. Kon Tum
An Lao
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Binh Dinh
Vinh Thanh
Kbang
Sa Thay
Se San 3
YaliChu Pah
Se San 3A
Se San 4
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Se San 1
Lower Se San 2
Veun Sai
Lower Se San 2
Prek Liang 2
Prek Liang 1
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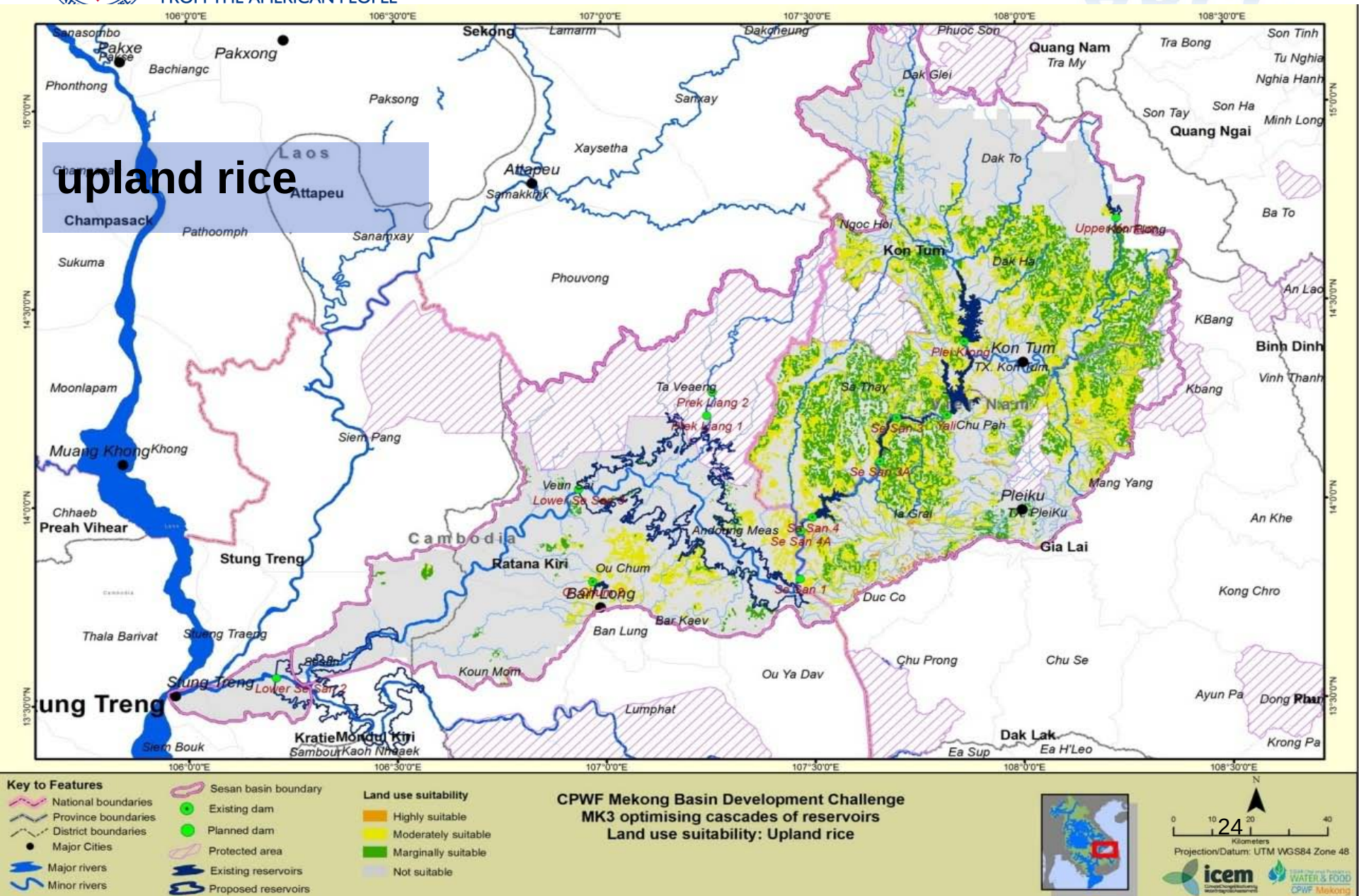
upland rice
Key to Features
National boundaries
Province boundaries
District boundaries
Major Cities
Major rivers
Minor rivers
Sesan basin boundary
Existing dam
Planned dam
Protected area
Existing reservoirs
Proposed reservoirs
Land use suitability
Highly suitable
Moderately suitable
Marginally suitable
Not suitable
CPWF Mekong Basin Development Challenge
MK3 optimising cascades of reservoirs
Land use suitability: Upland rice
Projection/Datum: UTM WGS84 Zone 48
Kilometers
Laos
Cambodia
Vietnam
Attapeu
Champasack
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Xaysetha
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Sanamxay
Pathoomph
Sukuma
Phonthong
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15°0'0"N
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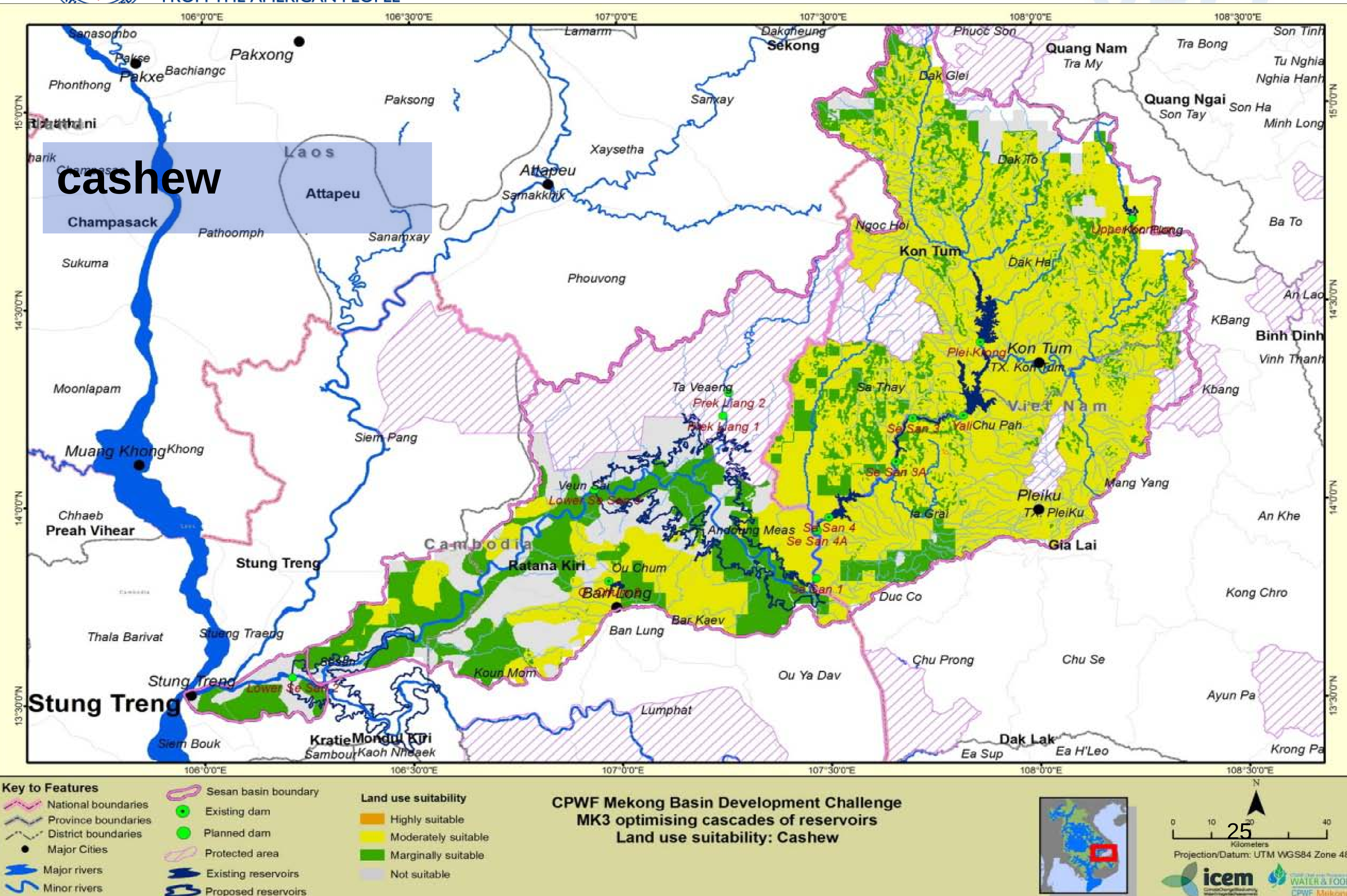
14°0'0"N
13°30'0"N

cashew

USAID
FROM THE AMERICAN PEOPLE

Mekong ARCC
Adaptation & Resilience to Climate Change



CPWF Mekong Basin Development Challenge
MK3 optimising cascades of reservoirs
Land use suitability: Cashew
Key to Features
National boundaries
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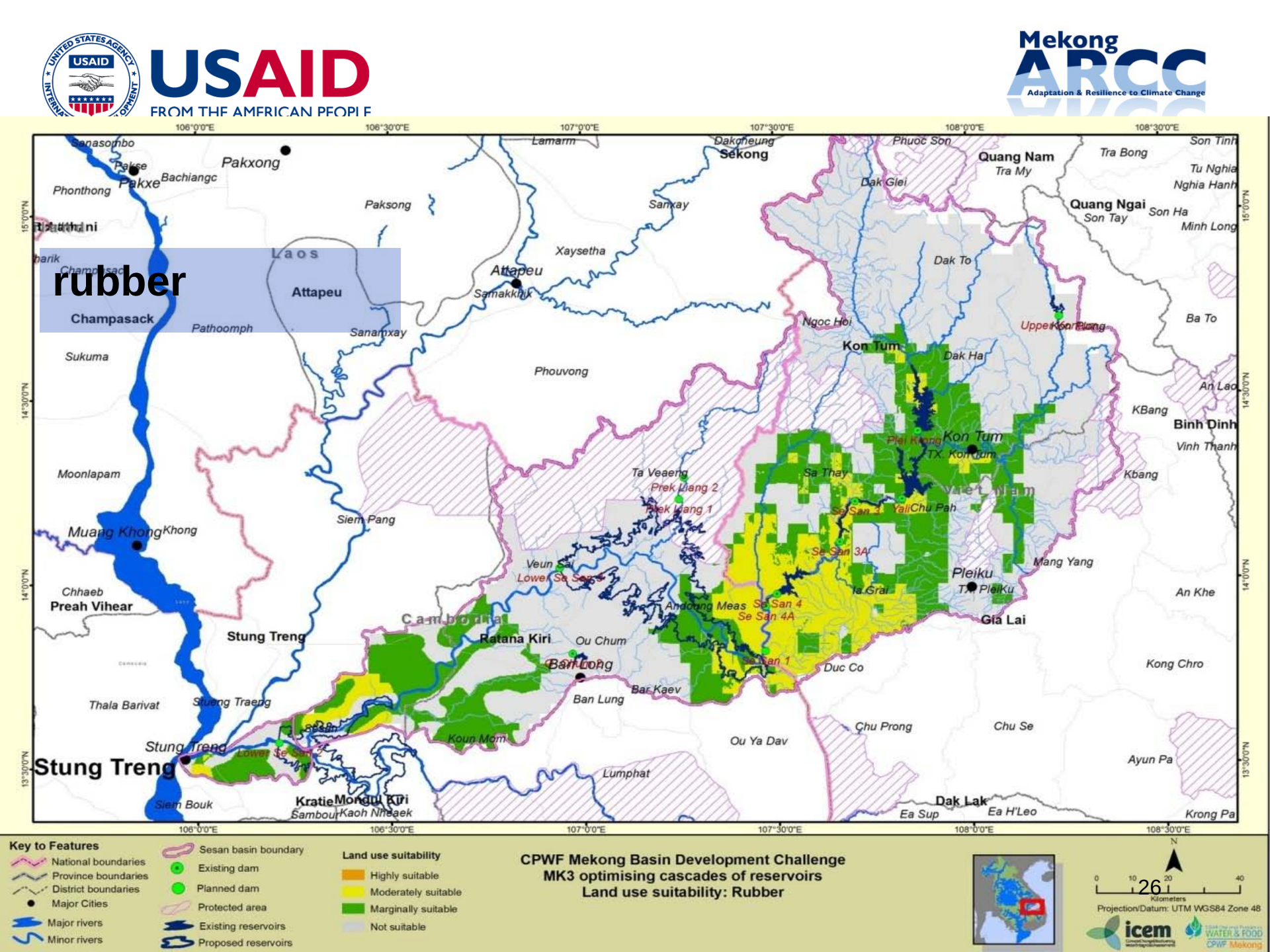
rubber
Laos
Champasack
Attapeu
Pakxong
Pakse
Paksong
Xaysetha
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Sanamxay
Pathoomph
Phouvong
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13°30'0"N
Key to Features
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Minor rivers
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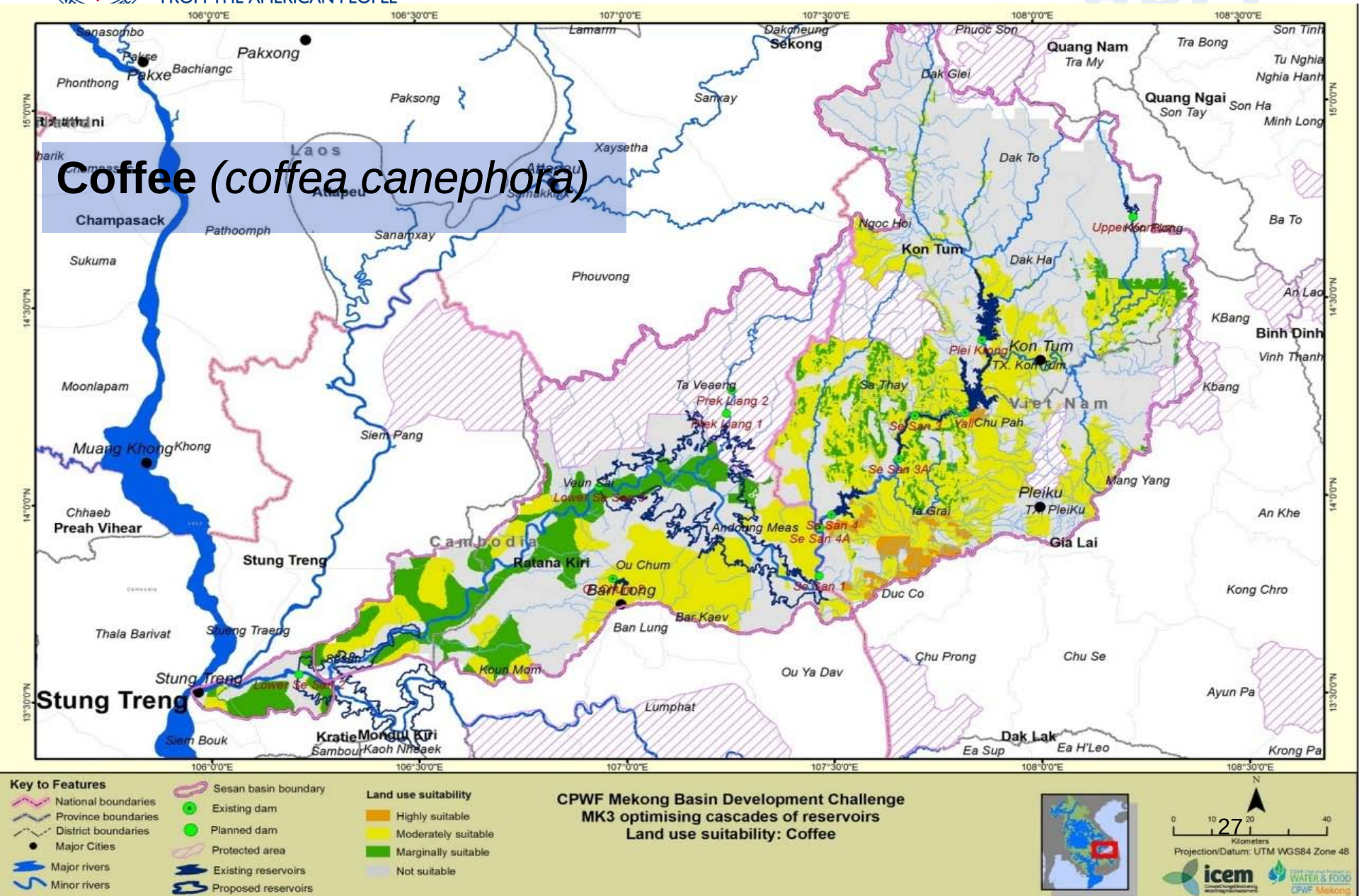
Planned dam
Protected area
Existing reservoirs
Proposed reservoirs
Land use suitability
Highly suitable
Moderately suitable
Marginally suitable
Not suitable
CPWF Mekong Basin Development Challenge
MK3 optimising cascades of reservoirs
Land use suitability: Rubber
N
0 10 20 40
Kilometers
Projection/Datum: UTM WGS84 Zone 48
icem
WATER & FOOD
CPWF Mekong


Coffee (coffea canephora)
Key to Features
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Minor rivers
Sesan basin boundary
Existing dam
Planned dam
Protected area
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Land use suitability
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MK3 optimising cascades of reservoirs
Land use suitability: Coffee
Projection/Datum: UTM WGS84 Zone 48
Laos
Cambodia
Viet Nam
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Paksong
Attapeu
Sekong
Kon Tum
Pleiku
Gia Lai
Quang Nam
Quang Ngai
Binh Dinh
Stung Treng
Ratana Kiri
Kratie
Mondul Kiri
Dak Lak
Muang Khong
Preah Vihear
Siem Bouk
Thala Barivat
Lumphat
Ou Ya Dav
Chu Prong
Chu Se
Kong Chro
Ayun Pa
Krong Pa
Mang Yang
An Khe
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Tra Bong
Tra My
Son Tay
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Minh Long
Nghia Hanh
Tu Nghia
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Yali Chu Pah
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Ia Grai
TX. PleiKu
Se San 4
Se San 4A
Se San 1
Duc Co
Ou Chum
Ban Lung
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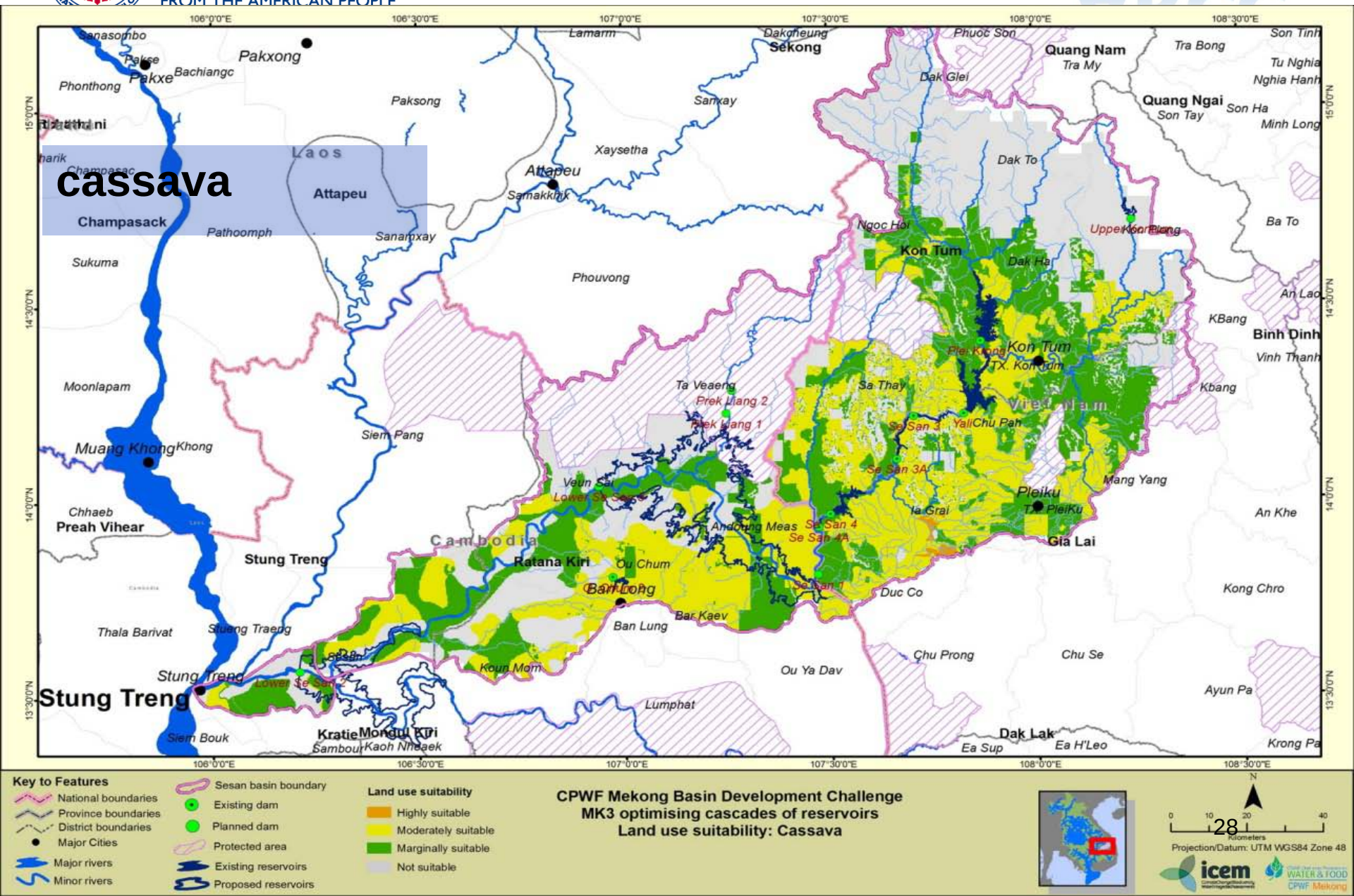
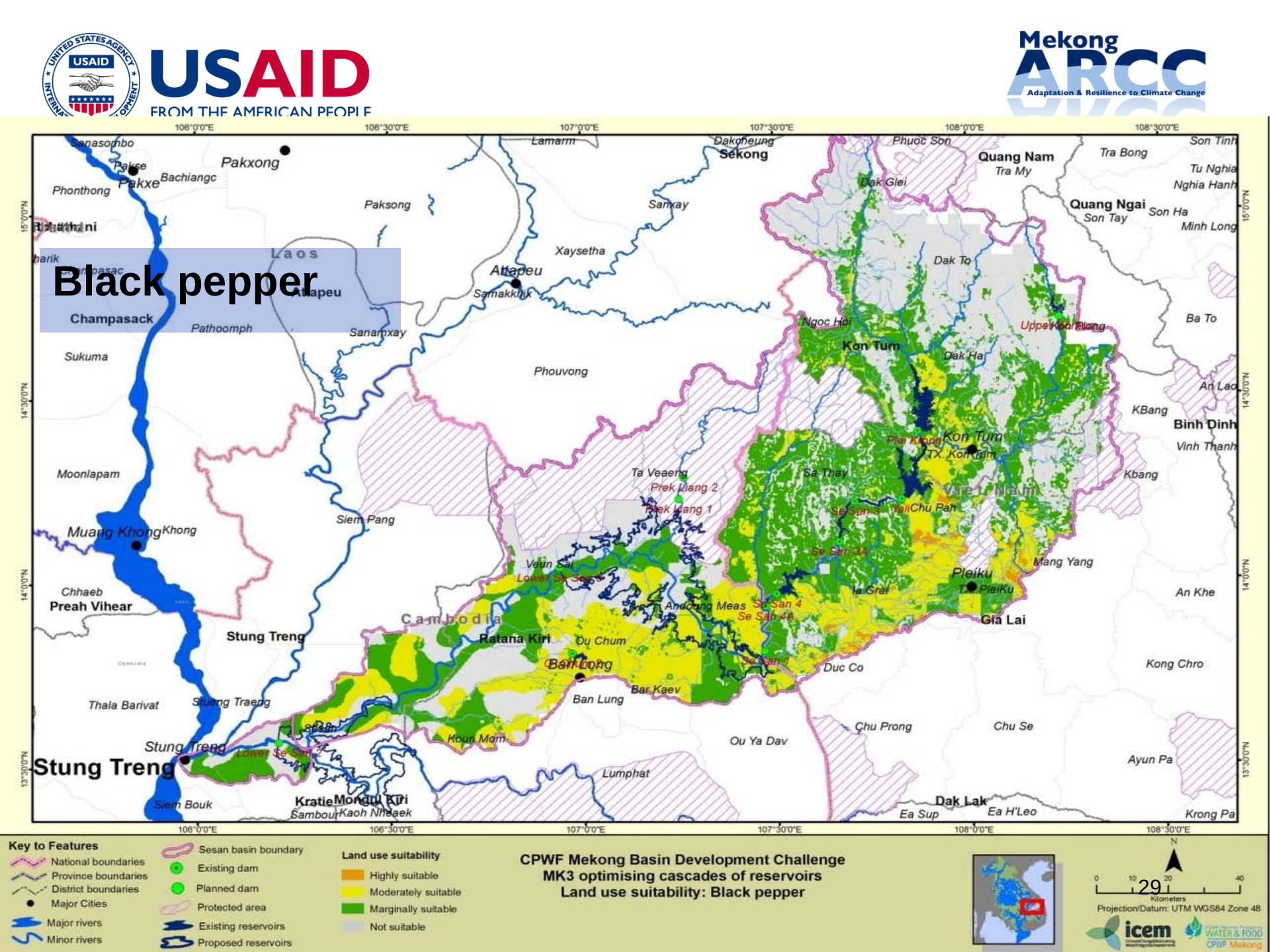
Koun Mom
Lower Se San
Prek Liang 2
Prek Liang 1
Ta Veaeng
Siem Pang
Phouvong
Xaysetha
Samkkhi
Sanamxay
Pathoomph
Champasack
Sukuma
Moonlapam
Chhaeb
Khong
Samakkhi
Lamarm
Dakcheung
Samkay
Phuoc Son
An Lao
KBang
Kbang
Vinh Thanh
An Khe
Kong Chro
Ea Sup
Ea H'Leo
Sambour
Kaoh Nheaek
Stung Treng
Phonthong
Bachiangc
Sanasomboo
106°0'0"E
106°30'0"E
107°0'0"E
107°30'0"E
108°0'0"E
108°30'0"E
15°0'0"N
14°30'0"N
14°0'0"N
13°30'0"N
0
10
20
40
Kilometers
N
27


cassava
Laos
Cambodia
Champasack
Attapeu
Pakxong
Pakxe
Paksong
Sekong
Quang Nam
Quang Ngai
Kon Tum
Pleiku
Gia Lai
Binh Dinh
Stung Treng
Ratana Kiri
Preah Vihear
Muang Khong
Siem Pang
Phouvong
Xaysetha
Samakkhix
Sanamxay
Pathoomph
Moonlapam
Sukuma
Thala Barivat
Ban Lung
Bar Kaev
Duc Co
Mang Yang
An Khe
Kong Chro
Chu Prong
Chu Se
Ou Ya Dav
Ayun Pa
Dak Lak
Ea Sup
Ea H'Leo
Krong Pa
Lumphat
Siem Bouk
Kratie
Mondul Kiri
Sambour
Kaoh Nheaek
Koun Mom
Ou Chum
Veun Sai
Andoung Meas
Ta Veaeng
Prek Liang 2
Prek Liang 1
Se San 4
Se San 4A
Se San 3
Se San 3A
Se San 2
Lower Se San 2
Yali
Chu Pah
Ia Grai
Dak To
Dak Glei
Dak Ha
Ngoc Hoi
Upper Kon Plong
Tra My
Tra Bong
Son Tay
Son Ha
Minh Long
Nghia Hanh
Tu Nghia
Son Tinh
Ba To
An Lao
KBang
Kbang
Vinh Thanh
Phuoc Son
Samxay
Lamarm
Dakcheung
Phonthong
Bachiangc
Champasac
Sanasombo
Pakse
Khong
Chhaeb
Stung Treng
Stueng Traeng
Koh Preah
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: Cassava
N
0 10 20 40
Kilometers
Projection/Datum: UTM WGS84 Zone 48
106°0'0"E
106°30'0"E
107°0'0"E
107°30'0"E
108°0'0"E
108°30'0"E
15°0'0"N
14°30'0"N
14°0'0"N
13°30'0"N


Black pepper
Laos
Cambodia
Champasack
Attapeu
Pakxong
Pakxe
Paksong
Sekong
Quang Nam
Quang Ngai
Kon Tum
Gia Lai
Pleiku
Binh Dinh
Dak Lak
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Phouvong
Dak Ha
An Lao
KBang
Vinh Thanh
Kbang
Moonlapam
Ta Veaeng
Prek Liang 2
Prek Liang 1
Sa Thay
Kon Tum
TX. Kon Tum
Plei Kong
Siem Pang
Se San 3
Yali
Chu Pah
Se San 3A
Mang Yang
Chhaeb
Veun Sai
Lower Se Kong
Andoung Meas
Se San 4
Se San 4A
Ia Grai
TX. PleiKu
An Khe
Ou Chum
Ban Long
Duc Co
Kong Chro
Bar Kaev
Ban Lung
Thala Barivat
Stueng Traeng
Koun Mom
Chu Prong
Chu Se
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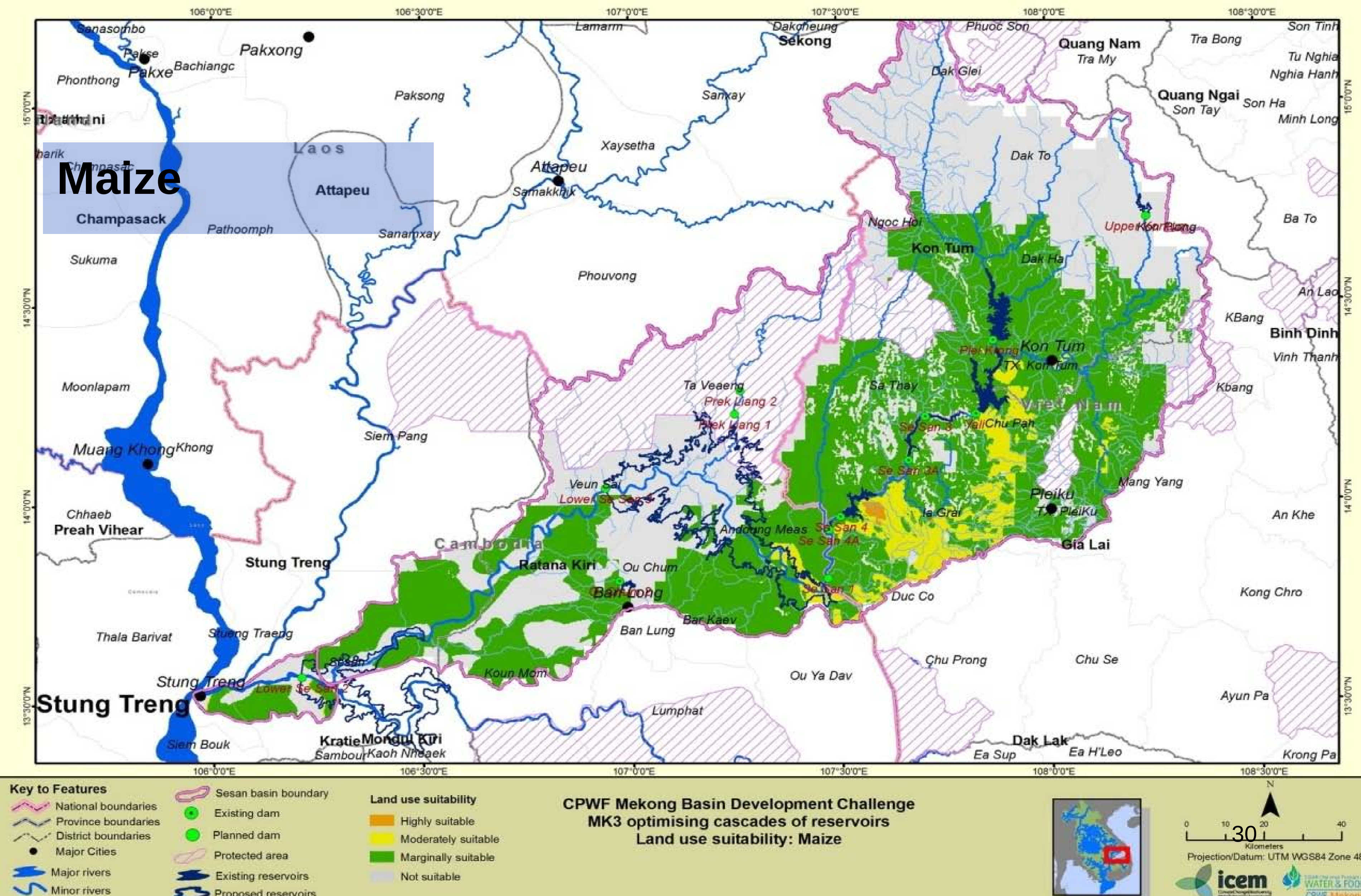
Marginally suitable
Not suitable
CPWF Mekong Basin Development Challenge
MK3 optimising cascades of reservoirs
Land use suitability: Black pepper
N
0 10 20 40
Kilometers
Projection/Datum: UTM WGS84 Zone 48

Maize



Laos
Champasack
Attapeu
Cambodia
Stung Treng
Ratana Kiri
Kon Tum
Gia Lai
Quang Nam
Quang Ngai
Binh Dinh
Dak Lak
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Kilometers
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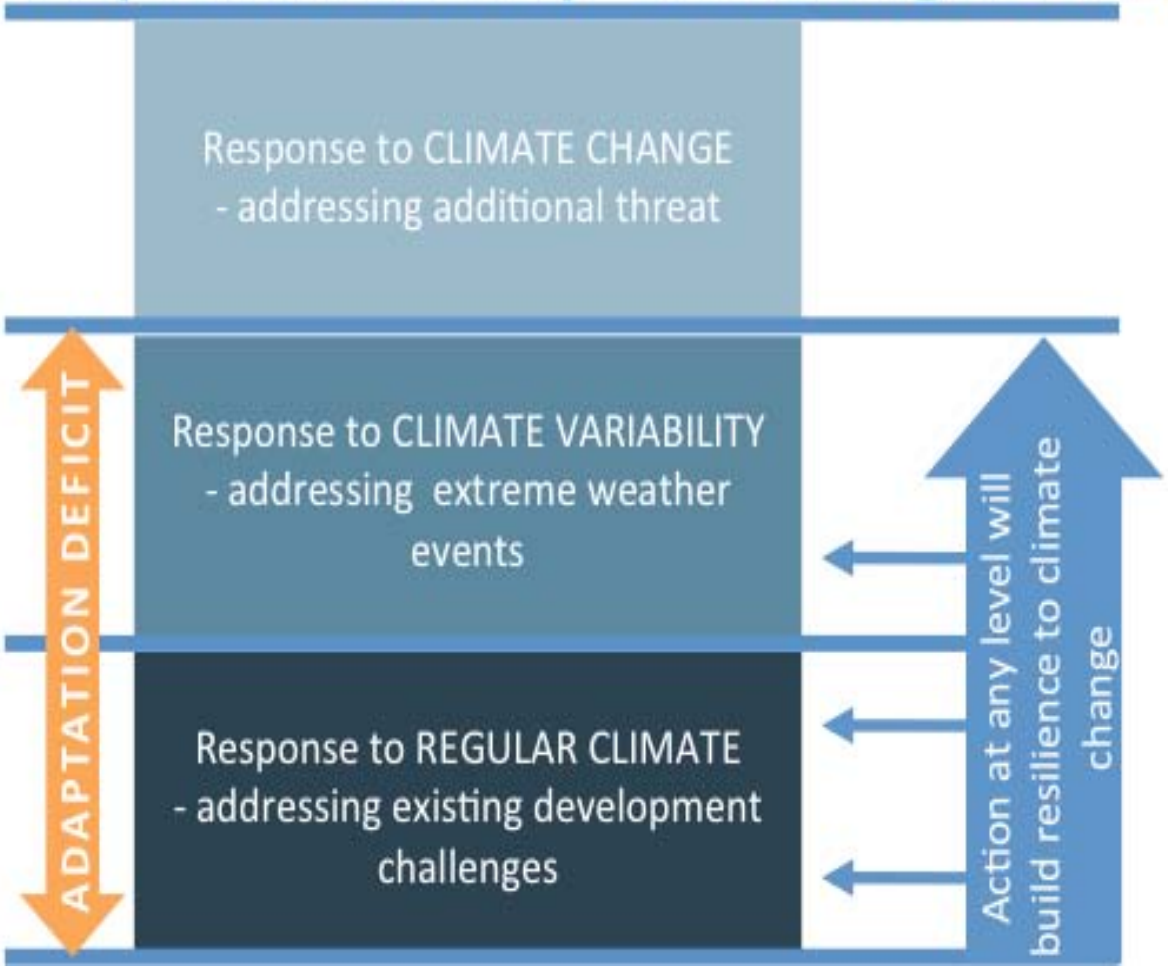
Adaptation Pathway - addressing the adaptation deficit



ADAPTATION PATHWAY

1. Addressing the adaptation deficit
2. Reinforcing successful coping mechanisms
3. Taking new high priority adaptation action

ICEM, 2011