“Developing China’s Carbon Accounting Capacity Project”

- Pilot study to test methods in China (Guangxi)

  February 2008 – early 2011

- Institutions with involvement:
  - Australian Government Department of Climate Change and Energy Efficiency
  - Chinese Academy of Forestry
  - CSIRO
  - Chinese Academy of Surveying and Mapping

Modelling for the Guangxi province

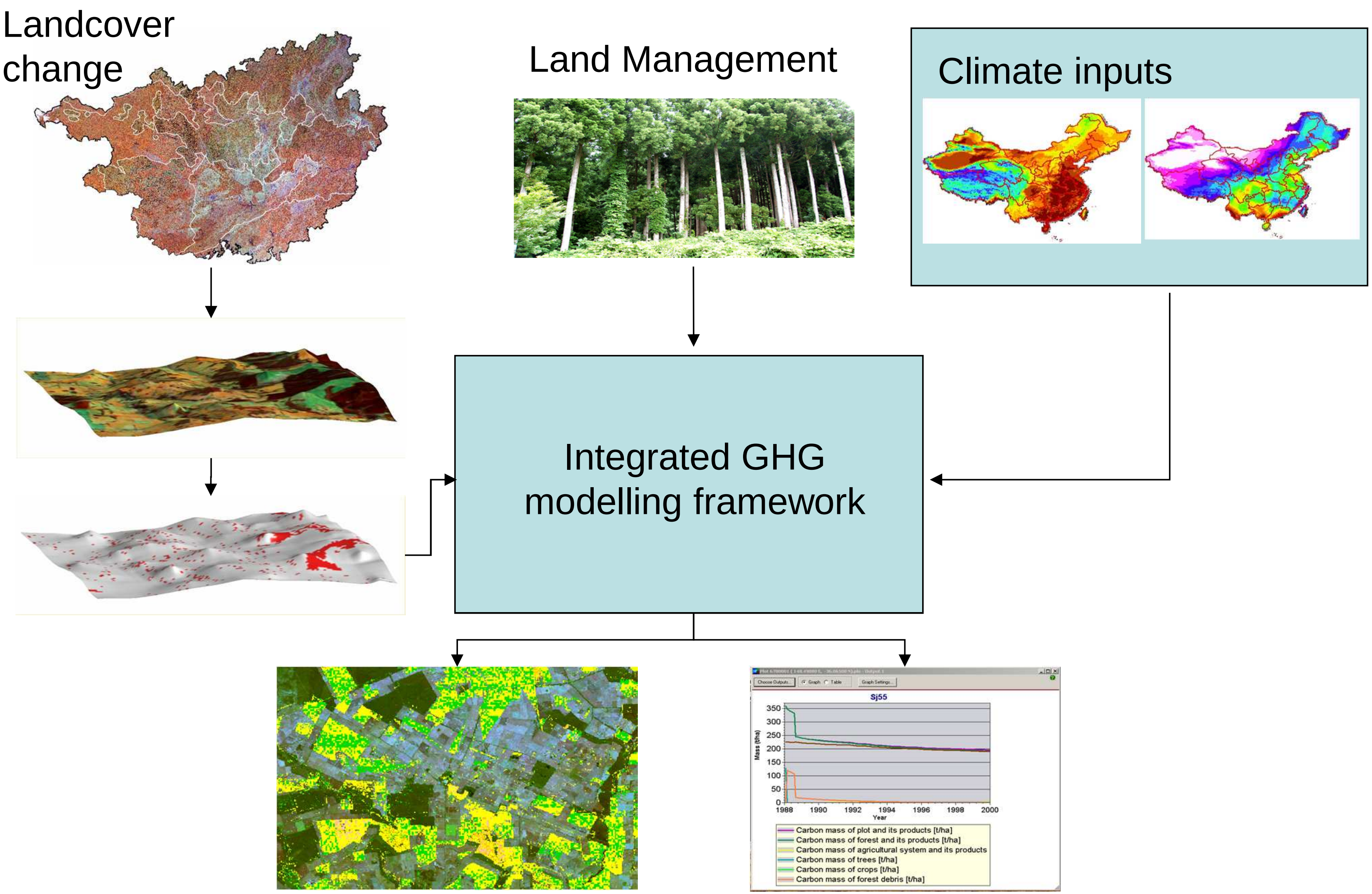
- The project consists of three stages:
  - **Stage 1**: Produce a series of FullCAM models using IPCC defaults (Tier 1 methods) or, where available, existing China specific data (Tier 2), allowing China able to report under 2006 IPCC guidelines for the second national communication.
  - **Stage 2**: Conduct a case study in a test province (Guangxi) using advanced, Tier 2/3 modelling methods with activity data obtained from satellite remote sensing.
  - **Stage 3**: Scope the application of a Chinese variant of Australia's NCAS at the continental scale, using spatially explicit modelling systems, and to outline a future development pathway.

Beijing
Tianjin
Qinghai
China
Xi'an
Huainan
Hefei
Nanjing
Wuxi
Sichuan
Chengdu
UNEP
Fulin
Chongqing
Wuhan
Changsha
Nanchang
Hunan
Guiyang
Yunnan
Kunming
Guangxi
China广西壮族自治区(Canton)
Shenzhen
Shantou
Taichung
(Hanoi) Hà Noi
Macau
Central Hong Kong
Kaohsiung
Laos

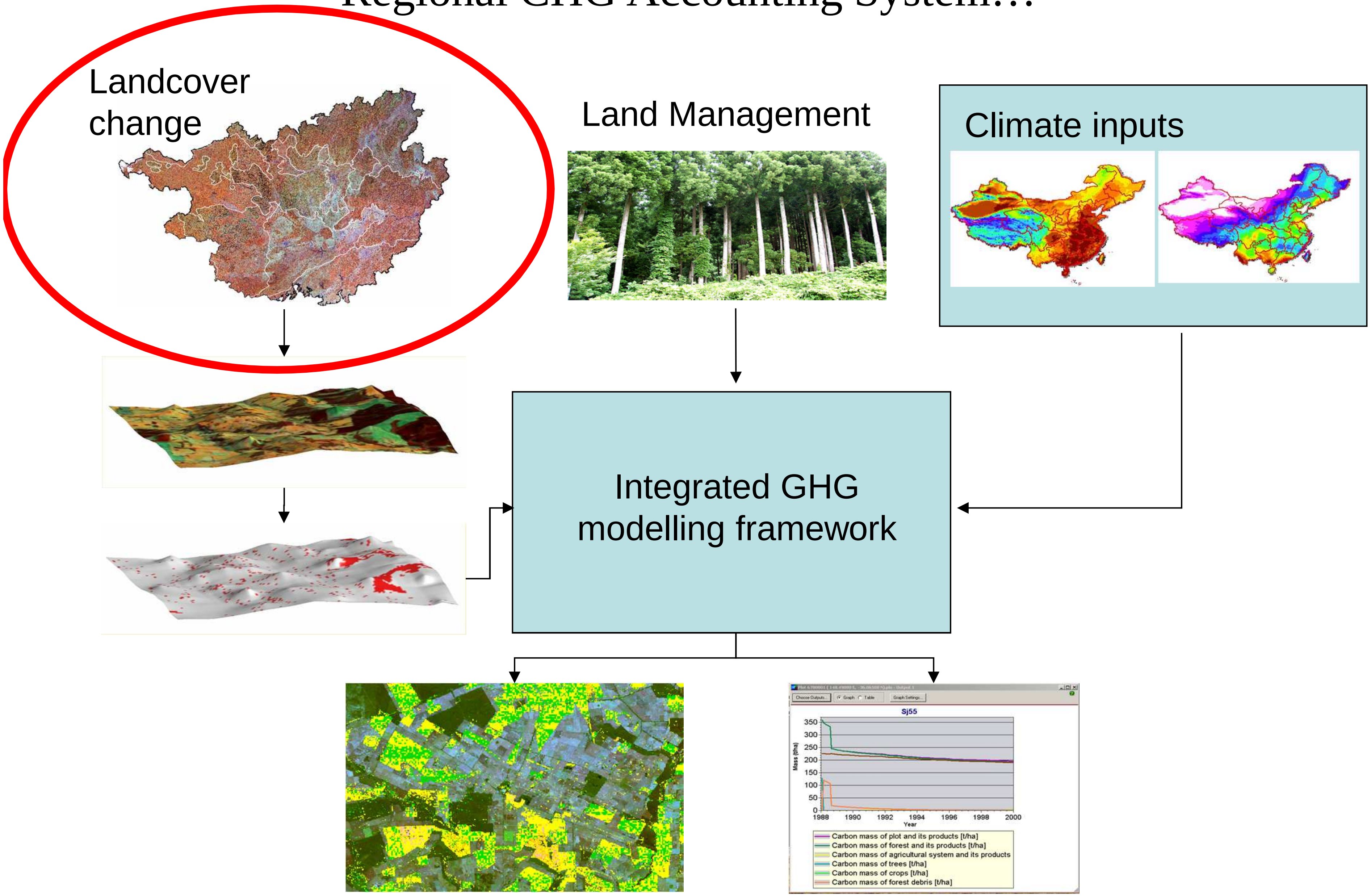
A mountainous region and terraced valley in the north of Guangxi Province.

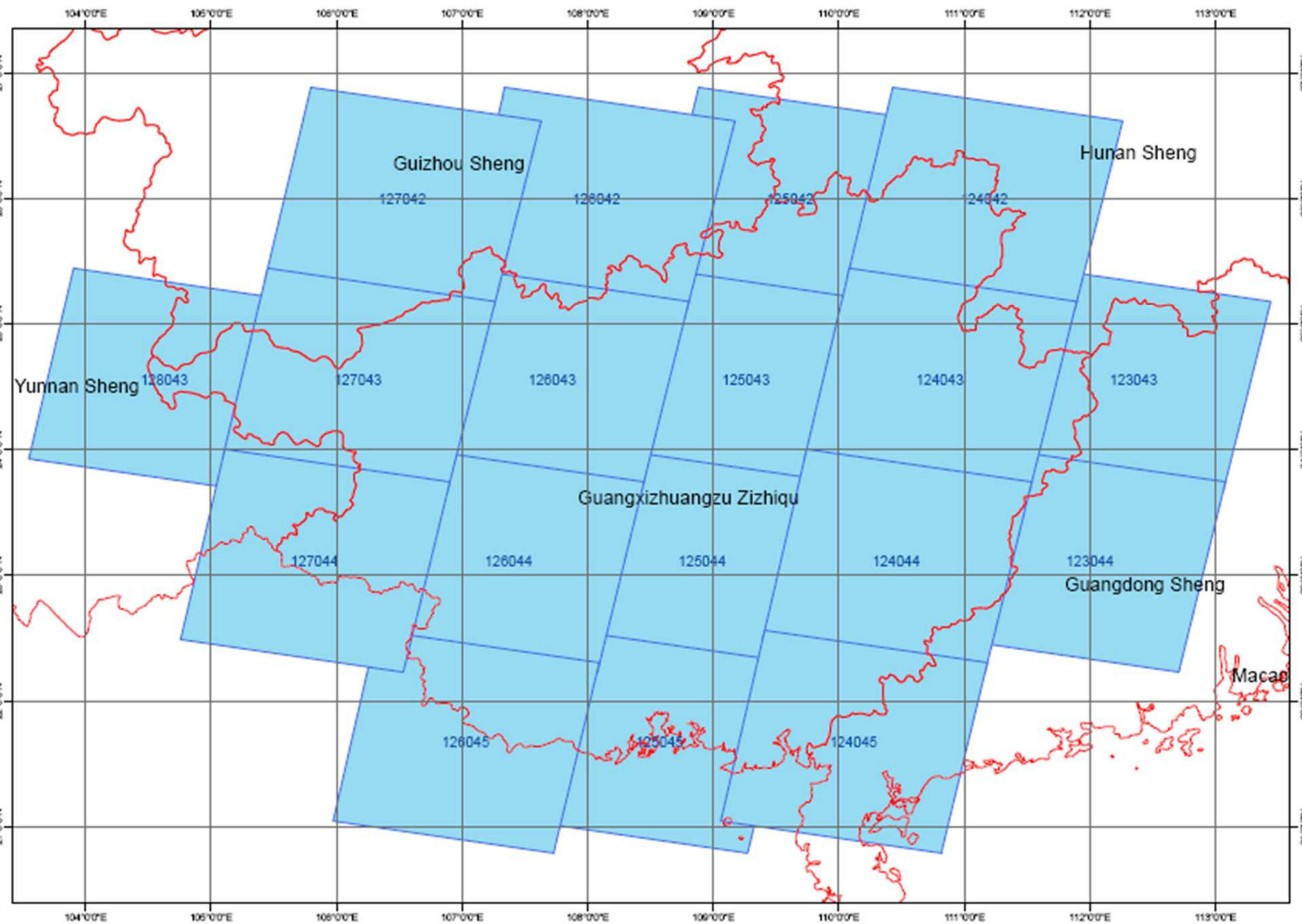
Rocky peaks common in the Guangxi Province.

CHG Accounting System Components…



Regional CHG Accounting System…





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Yunnan Sheng
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Guangdong Sheng
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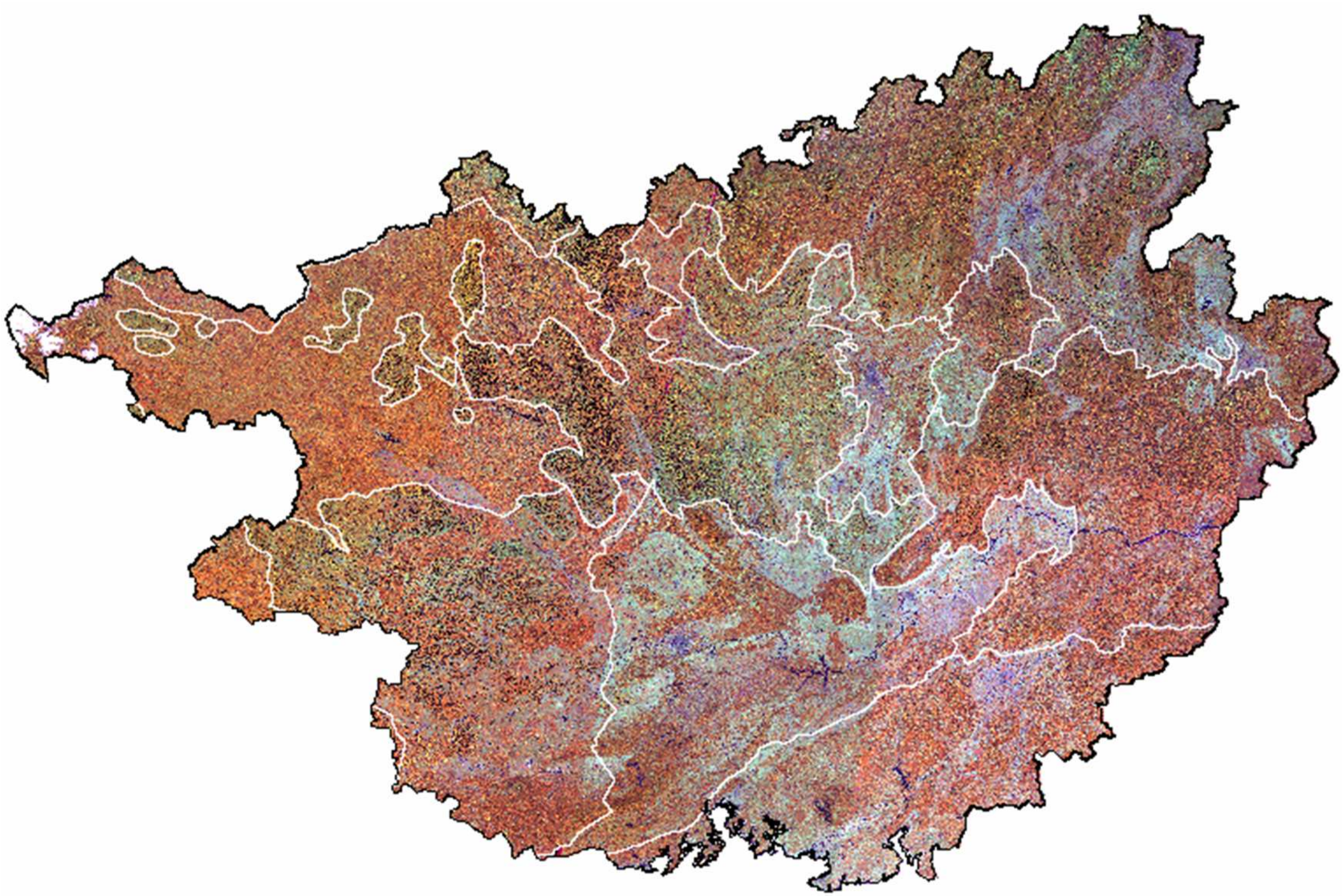
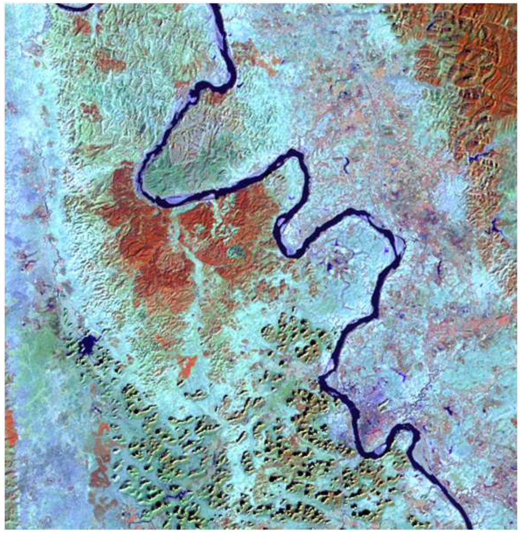
Analysis and processing - stratified into 10 zones which were then intersected with the image date boundaries



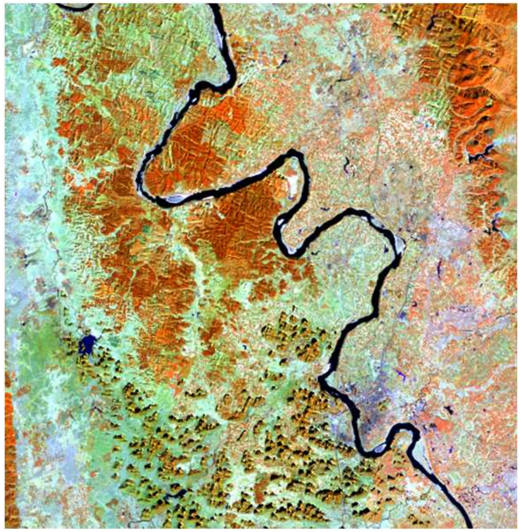
Land Cover Change –
>100 Landsat images forming 6 provincial coverages were processed for forest presence/absence

1992



2006

2000

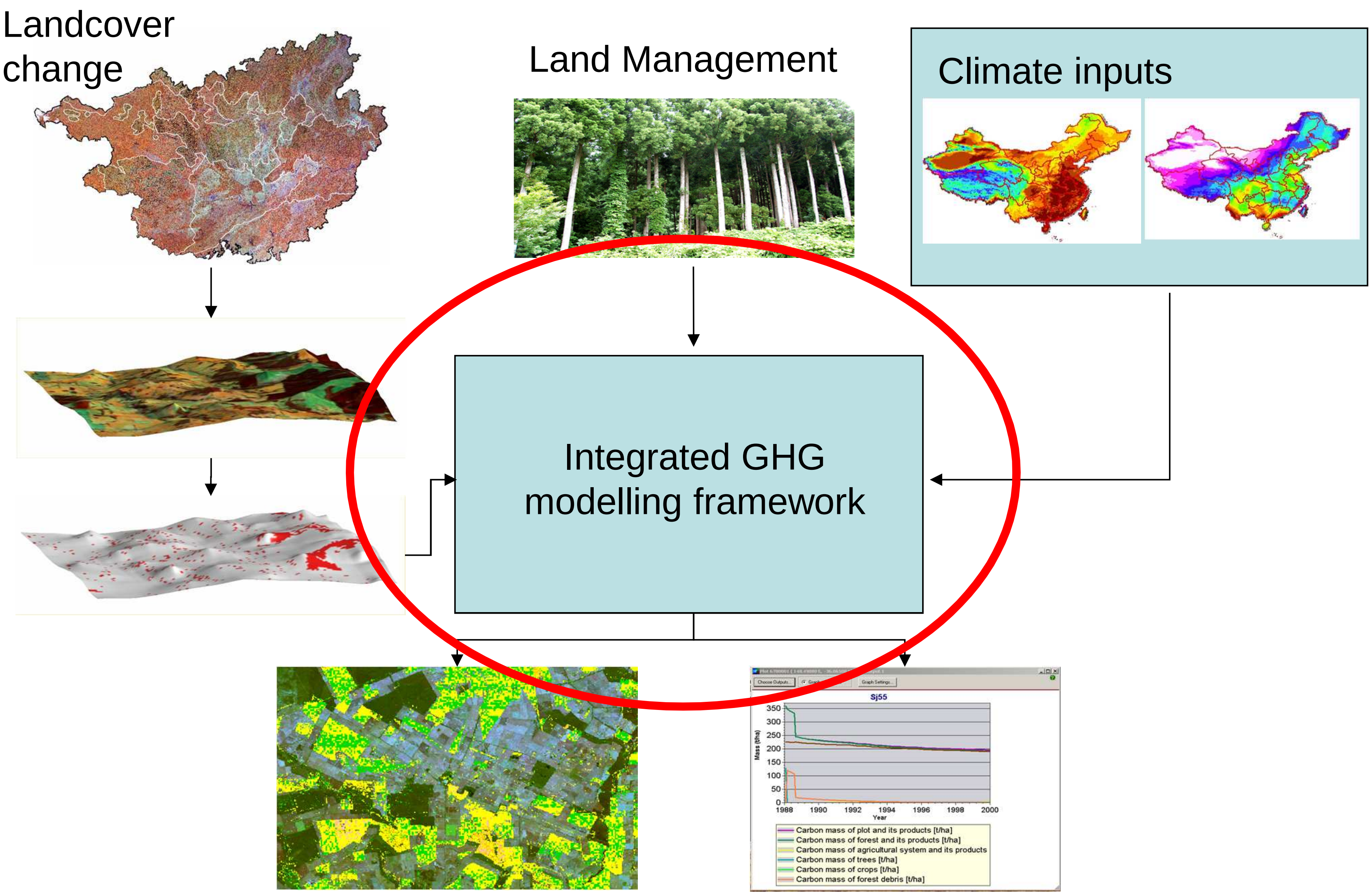


Change in forest cover

Red, yellow = cleared

Blues = regrowth

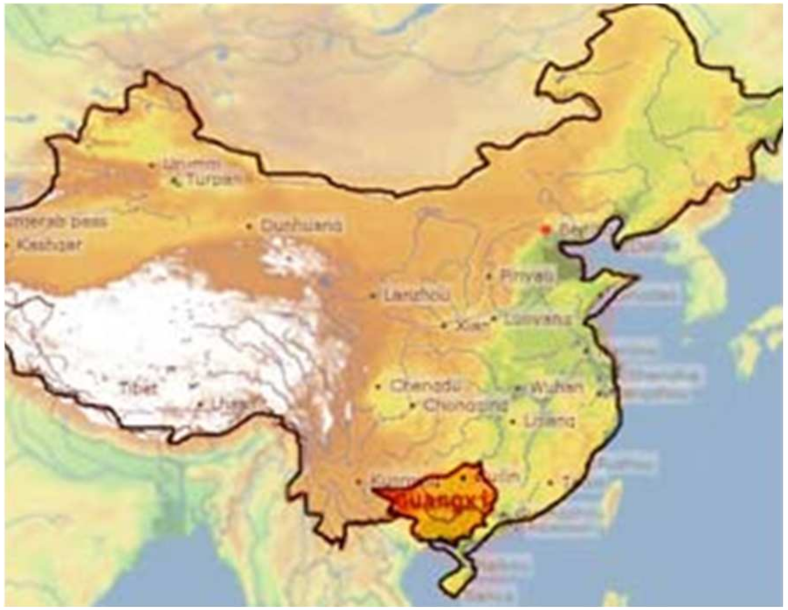
Regional CHG Accounting System…



Model calibration for the Guangxi province

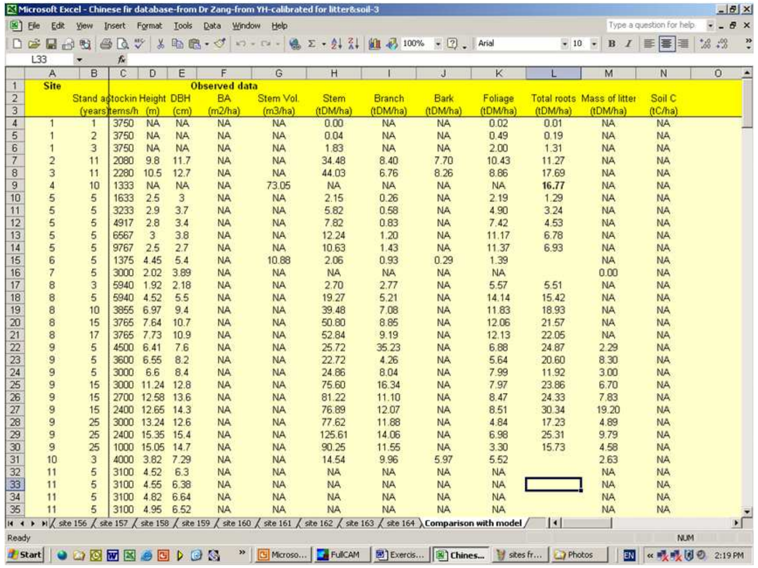
- Stage 1: Produce a series of FullCAM models using IPCC defaults (Tier 1 methods) or, where available, existing China specific data (Tier 2).

- Calibrated the NCAT for:
  - *Cunninhamiana lanceolata* – Chinese Fir and
  - *Pinus massoniana* - Masson pine



Database

- Database collated by CAF.
  - 946 sites of chinese fir
  - 370 sites for masson pine.
- Data collated for each sites includes:
  - Location (latitude, longitude, altitude)
  - Soil and site description
  - Long-term average climatic data
  - Age and stocking
  - DBH, height, BA and stem volume
  - Biomass of tree components
  - Mass of litter
  - Soil carbon



Site	Observed data											
	Stand age (years)	Stocking (stems/h)	Height (m)	DBH (cm)	BA (m2/ha)	Stem Vol. (m3/ha)	Stem (tDM/ha)	Branch (tDM/ha)	Bark (tDM/ha)	Foliage (tDM/ha)	Total roots (tDM/ha)	Mass of litter (tDM/ha)	Soil C (tC/ha)
1	1	3750	NA	NA	NA	NA	0.00	NA	NA	0.02	0.01	NA	NA
1	2	3750	NA	NA	NA	NA	0.04	NA	NA	0.49	0.19	NA	NA
1	3	3750	NA	NA	NA	NA	1.83	NA	NA	2.00	1.31	NA	NA
2	11	2080	9.8	11.7	NA	NA	34.48	8.40	7.70	10.43	11.27	NA	NA
3	11	2280	10.5	12.7	NA	NA	44.03	6.76	8.26	8.86	17.69	NA	NA
4	10	1333	NA	NA	NA	73.05	NA	NA	NA	NA	**16.77**	NA	NA
5	5	1633	2.5	3	NA	NA	2.15	0.26	NA	2.19	1.29	NA	NA
5	5	3233	2.9	3.7	NA	NA	5.82	0.58	NA	4.90	3.24	NA	NA
5	5	4917	2.8	3.4	NA	NA	7.82	0.83	NA	7.42	4.53	NA	NA
5	5	6567	3	3.8	NA	NA	12.24	1.20	NA	11.17	6.78	NA	NA
5	5	9767	2.5	2.7	NA	NA	10.63	1.43	NA	11.37	6.93	NA	NA
6	5	1375	4.45	5.4	NA	10.88	2.06	0.93	0.29	1.39		NA	NA
7	5	3000	2.02	3.89	NA	NA	NA	NA	NA	NA		0.00	NA
8	3	5940	1.92	2.18	NA	NA	2.70	2.77	NA	5.57	5.51	NA	NA
8	5	5940	4.52	5.5	NA	NA	19.27	5.21	NA	14.14	15.42	NA	NA
8	10	3855	6.97	9.4	NA	NA	39.48	7.08	NA	11.83	18.93	NA	NA
8	15	3765	7.64	10.7	NA	NA	50.80	8.85	NA	12.06	21.57	NA	NA
8	17	3765	7.73	10.9	NA	NA	52.84	9.19	NA	12.13	22.05	NA	NA
9	5	4500	6.41	7.6	NA	NA	25.72	35.23	NA	6.88	24.87	2.29	NA
9	5	3600	6.55	8.2	NA	NA	22.72	4.26	NA	5.64	20.60	8.30	NA
9	5	3000	6.6	8.4	NA	NA	24.86	8.04	NA	7.99	11.92	3.00	NA
9	15	3000	11.24	12.8	NA	NA	75.60	16.34	NA	7.97	23.86	6.70	NA
9	15	2700	12.58	13.6	NA	NA	81.22	11.10	NA	8.47	24.33	7.83	NA
9	15	2400	12.65	14.3	NA	NA	76.89	12.07	NA	8.51	30.34	19.20	NA
9	25	3000	13.24	12.6	NA	NA	77.62	11.88	NA	4.84	17.23	4.89	NA
9	25	2400	15.35	15.4	NA	NA	125.61	14.06	NA	6.98	25.31	9.79	NA
9	25	1000	15.05	14.7	NA	NA	90.25	11.55	NA	3.30	15.73	4.58	NA
10	3	4000	3.82	7.29	NA	NA	14.54	9.96	5.97	5.52		2.63	NA
11	5	3100	4.52	6.3	NA	NA	NA	NA	NA	NA		NA	NA
11	5	3100	4.55	6.38	NA	NA	NA	NA	NA	NA		NA	NA
11	5	3100	4.82	6.64	NA	NA	NA	NA	NA	NA		NA	NA
11	5	3100	4.95	6.52	NA	NA	NA	NA	NA	NA		NA	NA

Stratification of the Guangxi province

The tropic of cancer runs through central Guangxi.

Different climate zones distributed across the province from south to north

The relative use of chinese fir and masson pine throughout the six biogeographic regions of Guangxi.

Climate Strata	Elevation strata	Relative use of strata by Chinese fir in 2001-2006	Relative use of strata by Masson pine in 2001-2006
North tropical	<400 m	0	0
North tropical	>400 m	10	40
Mid sub-tropical	<400 m	20	30
Mid sub-tropical	>400 m	60	30
South sub-tropical	<400 m	0	40
South sub-tropical	>400 m	10	50

Yield curves

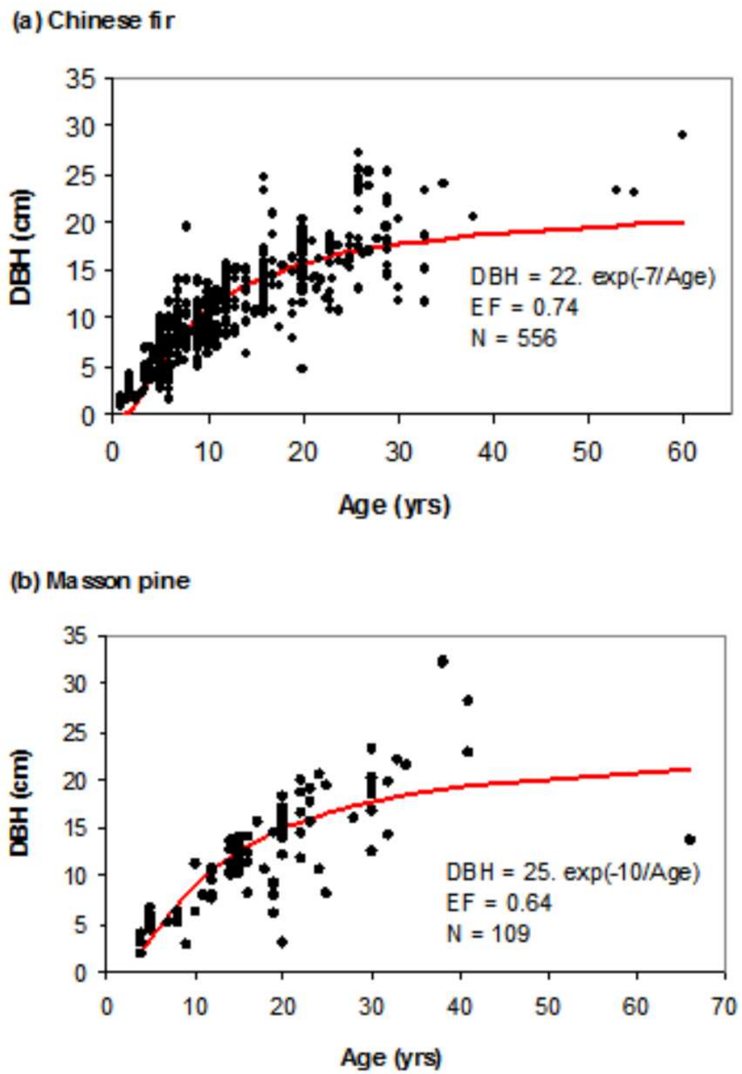


Figure 8: Generic growth curves for chinese fir (*Cunninghamii lanceolata*) and masson pine (*Pinus massoniana*) for china. Source: Published and unpublished data collated by CAF (Hou pers. comm., 2009).

Yield curves

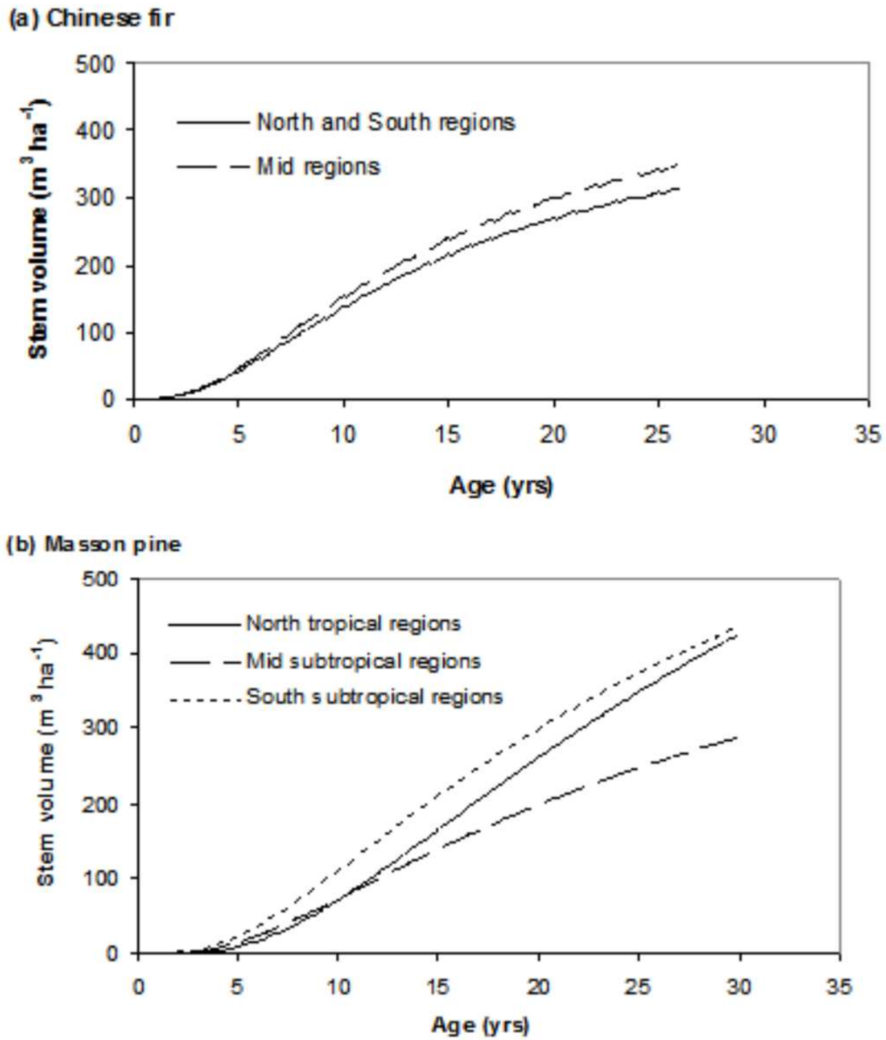


Figure 9: Growth curves (of unthinned stands) for chinese fir (*Cunninghamii lanceolata*) and masson pine (*Pinus massoniana*) for various biogeographic regions of Guangxi. These curves are derived by modifiying generic growth curves to attain final MAI predicted that matched that observed in Table 2.

Partitioning of biomass

(trunk, branches, leaf litter, roots etc)

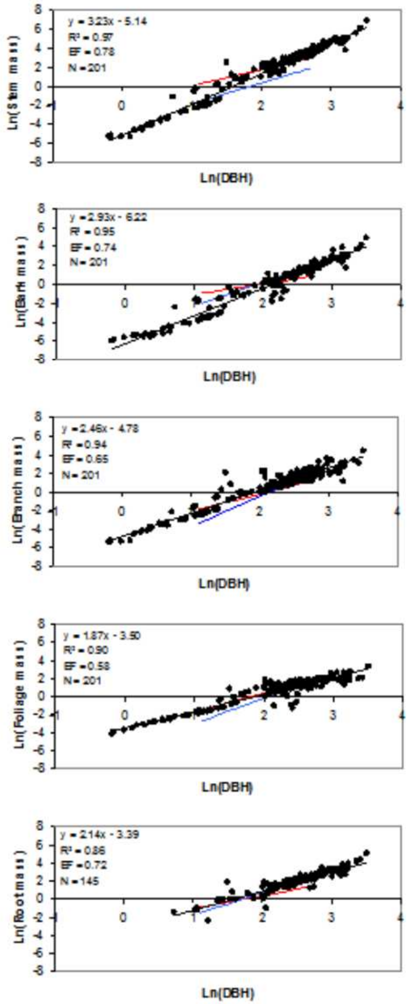


Figure 10: Allometric relationships between tree DBH and mass of tree components of chinese fir (*Cunninghamii lanceolata*) grown in various locations throughout China. Source: Published and unpublished data collated by CAF (Hou pers. comm., 2009). Blue and red lines are the allometric relationships attained by Zheng et al. (2008) and Xue (1996), respectively.

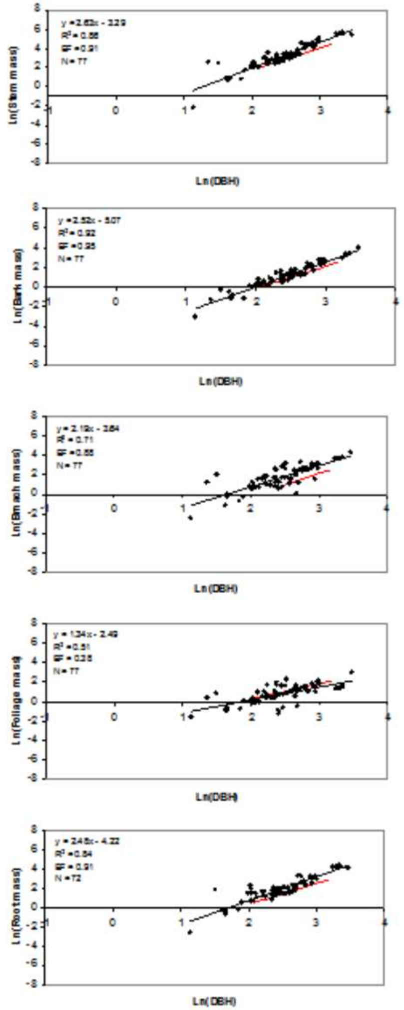


Figure 11: Allometric relationships between tree DBH and mass of tree components of masson pin (*Pinus massoniana*) grown in various locations throughout China. Source: Published and unpublished data collated by CAF (Hou pers. comm., 2009). Red lines are the allometric relationships attained by Zheng et al. (2008).

Partitioning of biomass: roots

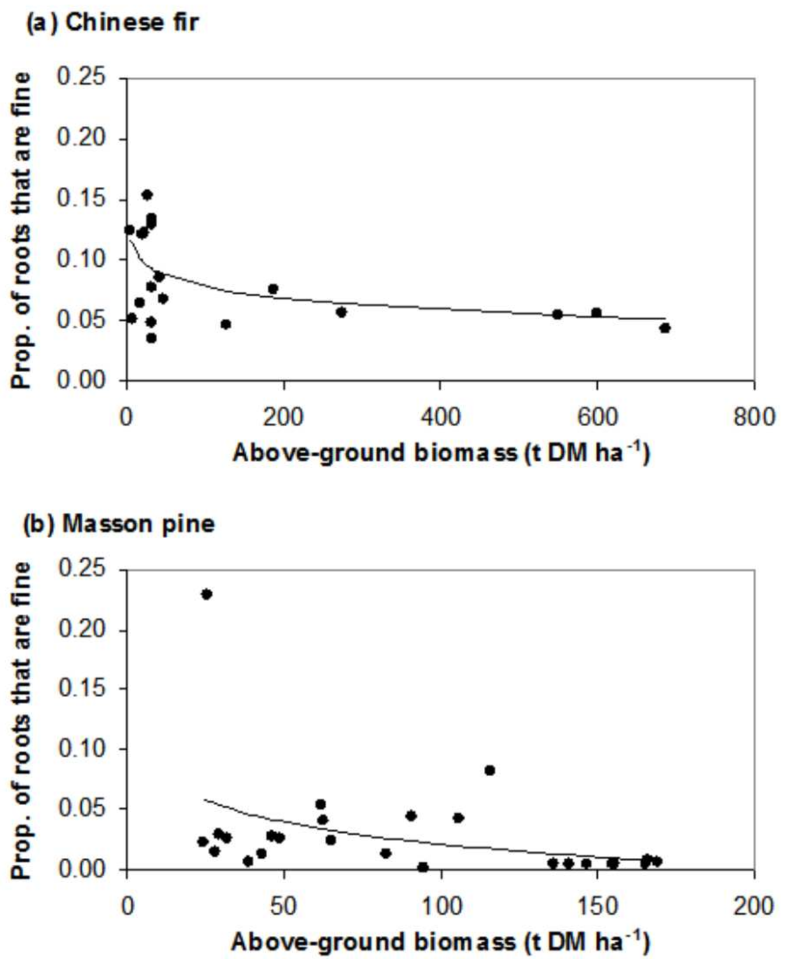


Figure 12: Relationships between the proportion of root biomass that is comprised of fine roots and the total mass of above-ground biomass in tonnes of dry matter per hectare for chinese fir (N=22) and masson pine (N=26). Source: Published and unpublished data collated by CAF (Hou pers. comm. 2009).

Carbon content

Table 3: Carbon content of tree components (percentage of dry matter) of chinese fir. Source: Fang et al, (2002a); Ruan et al, (1997); Fang et al, (2002b); Zheng et al. (2008); Hou, pers. comm. (2009).

Tree component	Fang et al, (2002a)	Ruan et al, (1997)	Fang et al, (2002b)	Fang et al, (2002b)	Zheng et al. (2008)	Hou pers com. (2009)	*Ave*
Stem wood	47.44	47.4	47.29	47.58	47.62	51.0	*48.06*
Branches	46.05	49.1	45.92	46.81	45.82	51.0	*47.45*
Bark	50.03	53.3	51.01	49.05	49.03	51.0	*50.57*
Foliage	49.16	51.9	48.12	50.22	50.42	51.0	*50.14*
Coarse roots	47.81	NA	48.72	46.79	48.70	51.0	*48.60*
Fine roots	45.64	NA	43.83	47.44	45.04	51.0	*46.59*

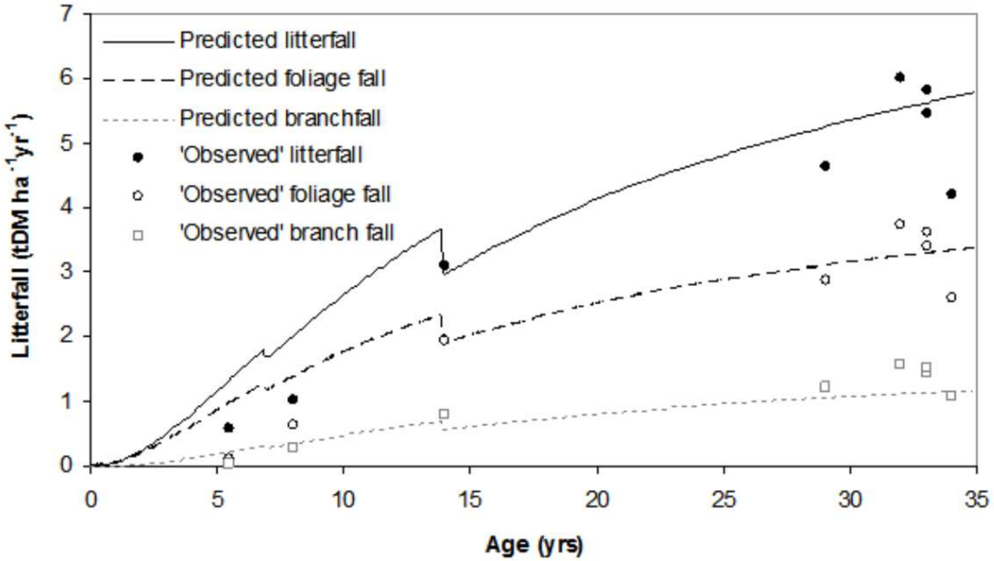
Table 4: Carbon content of tree components (percentage of dry matter) of Masson Pine. Source: Zheng et al. (2008); Hou, pers. comm. (2009).

Tree component	Zheng et al. (2008)	Hou pers com. (2009)	*Ave*
Stem wood	60.68	49.0	*54.84*
Branches	54.37	49.0	*51.69*
Bark	53.91	49.0	*51.46*
Foliage	44.71	49.0	*46.86*
Coarse roots	59.68	49.0	*54.34*
Fine roots	57.51	49.0	*53.26*

Litterfall

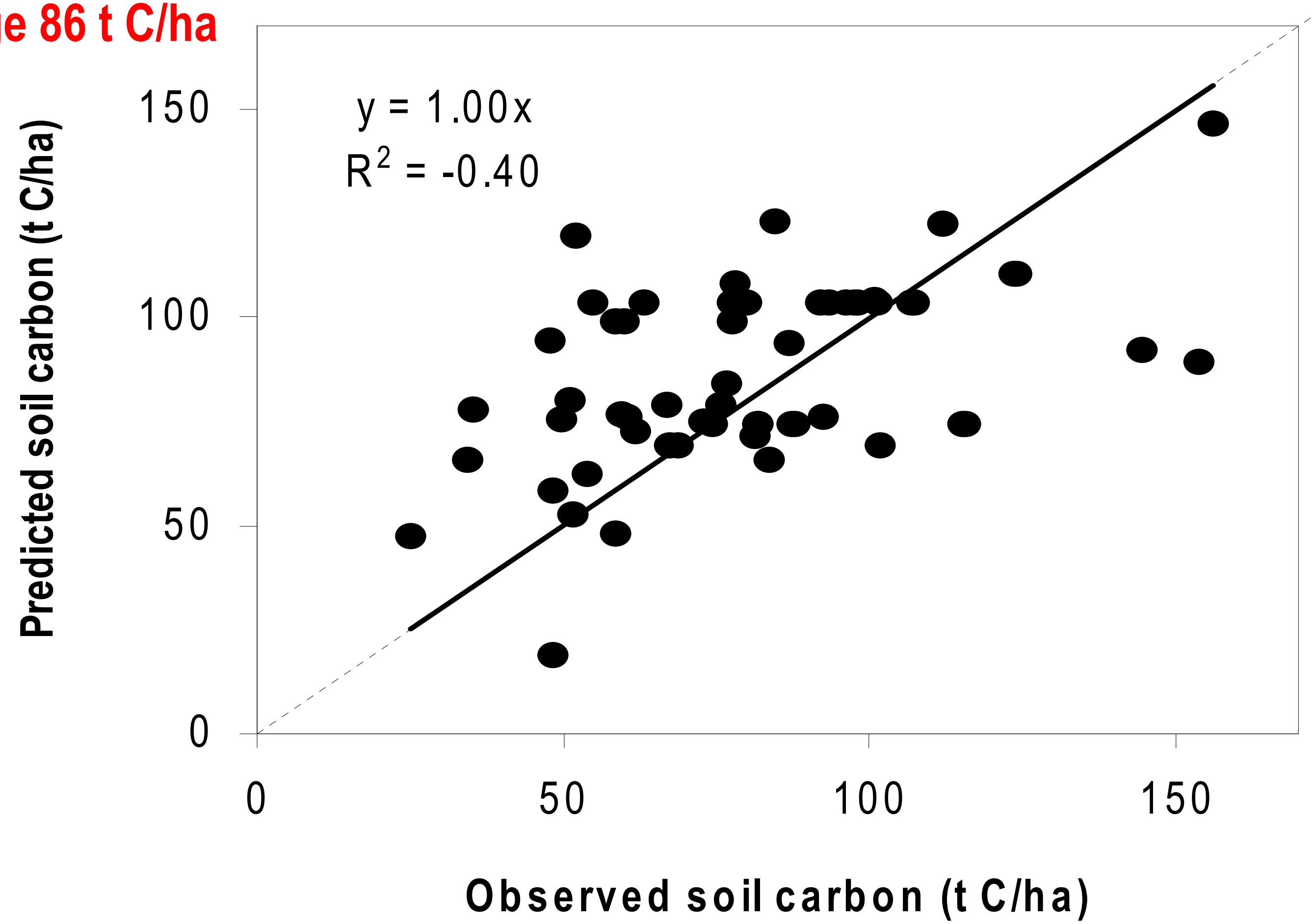
Table 5: Turnover rates of litter under stands of chinese fir growing in southern China. Note that based IPCC GPG (2003), it was assumed that litter has a carbon content of 37%.

Stand age (yrs)	Turnover (t DM ha^{-1} yr^{-1})	Turnover (t C ha^{-1} yr^{-1})	Reference
5 to 6	0.59	0.22	Shi et al. (2006)
8	1.01	0.37	Ma et al. (2007)
10	0.39	0.14	Xue (1996)
14	3.10	1.15	Ma et al. (2007)
34	4.18	1.55	Ma et al. (2007)
29	4.63	1.71	Yang et al. (2005a)
32	6.00	2.22	Yang et al. (2007)
33	5.47	2.02	Yang et al. (2004a)
33	5.81	2.15	Chen et al. (2005)



Soil carbon

Average 86 t C/ha



Average 81 t C/ha

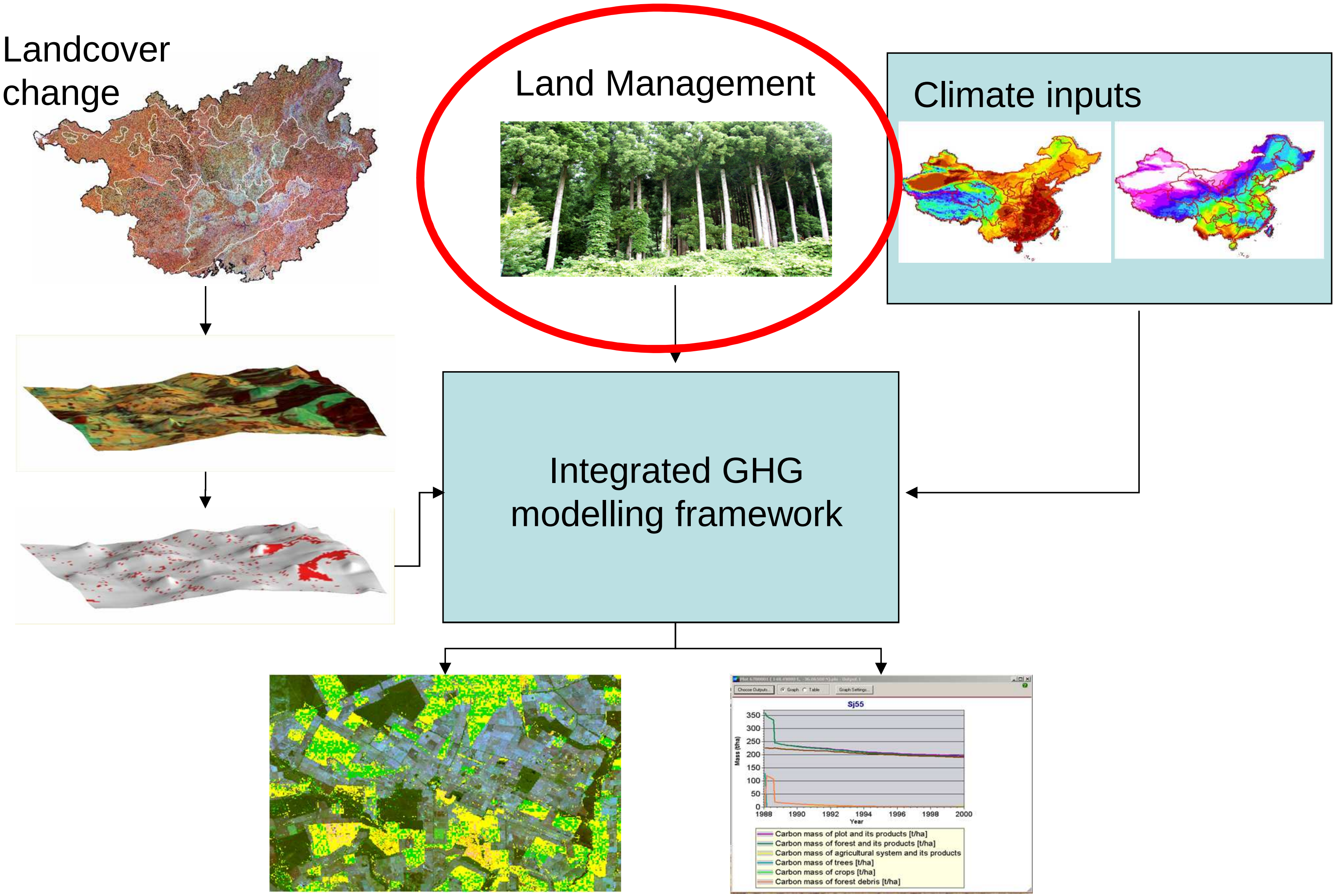
48 sites, N=57

Management

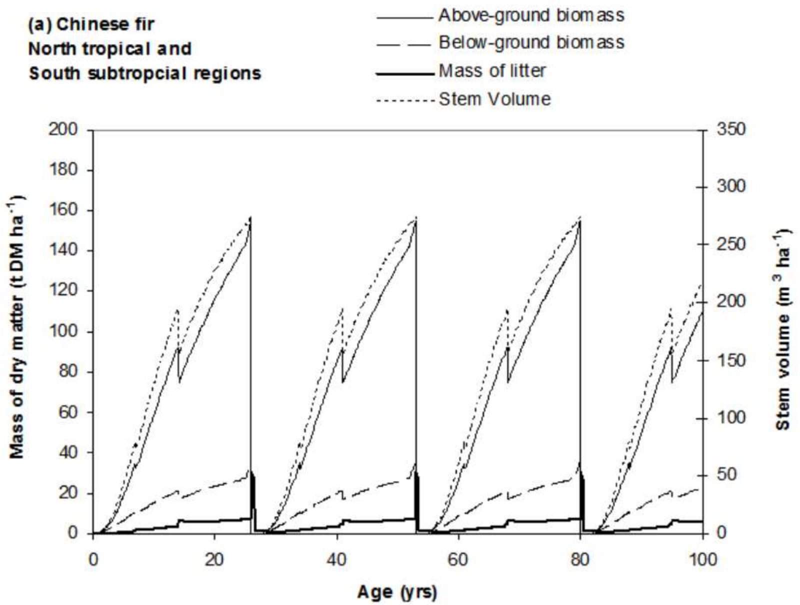
Table 7: Management regimes assumed for the Guangxi province. Note that there is currently no difference in management practices o f these species between tropical and sub-tropical regions (Hou pers com. 2009).

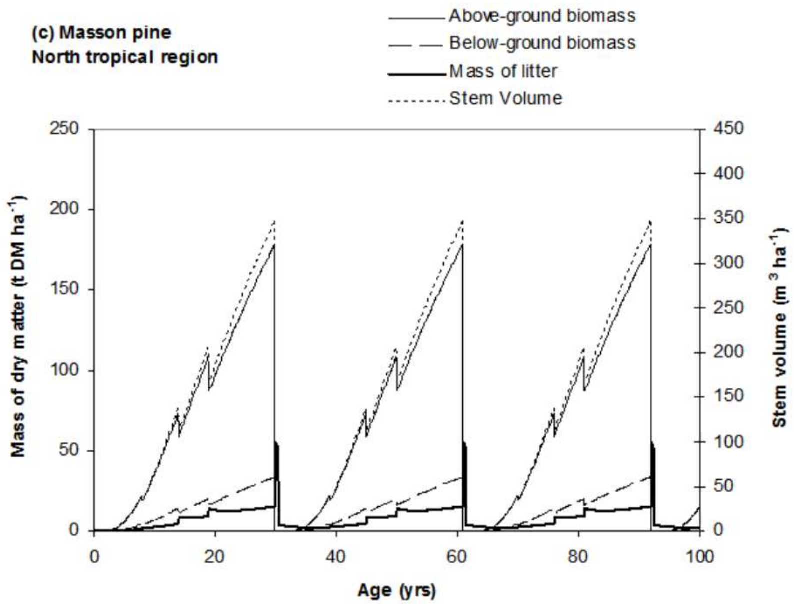
Tree component	Chinese fir	Masson Pine
Age of first thin	6 years	7 years
% of stems removed at first thin	10%	17%
Age of second thin	13 years	13 years
% of stems removed at second thin	20%	20%
Age of third thin	NA	18 years
% of stems removed at third thin	NA	20%
Rotation length	25 years	29 years
Residues burnt following harvest	Yes	Yes

Regional CHG Accounting System…



Simulations





Calibration for the Guangxi province

- Large amount of data already collated.
- Results are demonstrative at this stage.
- Results indicate that calibration and application of the NCAT is feasible in China.
- Further work is required to extend the number of species.
- More data is required on growth rates and management regimes for different bio-geographical regions.

Comments/Conclusions

- Rates of deforestation are relatively low in Guangxi and this is reflected in the low level of estimated emissions.

- Conversely reforestation rates have been particularly high, leading to considerable amount of CO2 uptake.

- The methods show the potential of combining remote sensing data with empirical data to estimate emissions, though considerably more work is required to move the modeling system towards a comprehensive Tier 3 method that fully integrates remote sensing data within the modeling framework.

- Moving towards this goal will require more development in remote sensing analysis, spatially referenced management data and model calibration.