



## **TCA Scoping study in China: baselines, gaps and opportunities**

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### **1 Background**

Funded by the International Climate Initiative (IKI), The Carbon Institute is a collaboration of the Greenhouse Gas Management Institute (GHGMI), the Forest Carbon Accounting and Monitoring Centre (FCAMC) of the State Forestry Administration (SFA) in China and the Centre for Climate Risk and Opportunity Management (CCROM) at Bogor Agricultural University (IPB) in Indonesia. The Carbon Institute partners will develop comprehensive and world-class Terrestrial Carbon Accounting (TCA) certificates that address national needs and fulfill international standards. By developing academic courses and teaching capacities in China and Indonesia on TCA, The Carbon Institute will help create the human capacity for countries to account for, and implement, their Nationally Determined Contributions (NDCs), continue to improve national greenhouse gas inventories, and receive performance-based payments for REDD+.

One of the first work packages that must be completed by The Carbon Institute as part of the IKI grant, SFA and IPB (especially FCAMC and CCROM) will prepare three scoping studies on: 1) existing baselines of in-country academic TCA instruction, 2) gaps based on country needs, and 3) opportunities for new academic TCA Certificate programs. With support from GHGMI, FCAMC is conducting these three scoping studies to first understand what TCA courses and programs are already being taught in China; second, understand what government needs are for comprehensive TCA instruction, or gaps identified by government; and third, develop or propose new TCA academic



programs, filling unmet government TCA training needs with a new TCA certificate, led by SFA. This is the second scoping study, gaps of TCA in China.

## **2 Materials and Methods**

### **2.1 Course survey**

As shown in the guidelines from GHGMI, TCA training covers six thematic areas: policy context, GIS and RS, IPCC guidelines/land classification, field methods, TCA statistics, and communication of results. These six topics were chosen through an extensive stakeholder process to identify what subjects were most needed for training in terrestrial carbon accounting, and that will yield a certificate course that was truly comprehensive.

We inventoried 12 universities, academies and institutions in China. (1) Four universities that are first- and second-class universities in China: Beijing Forestry University, Beijing Normal University, Peking University, Xiamen University; (2) Two academies that are lead by SFA: Academy of Forest Inventory and Planning, and Personal Exchange and Development Center; (3) Six institutions that present research capacity at country and province level: Institute of Geographic Science and Natural Resources Research (CAS), Institute of Botany (CAS), South China Botanical Garden (CAS), Chinese Academy of Agricultural Sciences, Chinese Academy of Forestry, and Beijing Academy of Agricultural Sciences.

We collected the curriculums of the universities, the training schedules of SFA, the presentations and reports of the institutions from websites and by personal communication. Then, we divided all these information into the six thematic areas and other areas that are not related to TCA area.



## 2.2 Gaps survey

A questionnaire was designed by referring to the information from The Carbon Institute and taking China's actual condition into consideration. The questionnaire is aimed to figure out interviewees' or potential students' needs of TCA and to improve the quality of TCA course content for government demand. It consists of five parts: Background information of interviewee, Six TCA Courses (Policy context GIS/RS, Field Work and Data Collection, IPCC Guidance, Statistics, and Results Communication), Logistics and Implementation of the training, Potential Students and Tuition, Relationship-Building (details of the questionnaire in Appendix).

We focused on the training needs of local forestry department and potential students. Therefore, the interviewee mainly provincial technicians who work on forestry carbon accounting from provincial forestry department (10 people), students (3 people) and young teachers (1 people) that majored in the topics or relevant fields. Interviewees from forestry system were divided into two levels: senior (9 people) and intermediate grade (5 people) professional title, by professional skills and working life.

The questionnaire was answered by six people in a face-to-face way and the other eight through e-mail. The background and purpose of the TCAIAP (i.e., the IKI TCA International Academic Partnership grant), the meaning of the content and how to answer the questionnaire were introduced in advance by reading material and oral explanation. Information was checked immediately after the inquiry, and corrected (if necessary) by communicating with the interviewees to avoid misunderstandings or other mistakes. All the information on the questionnaire was then transferred into an excel file for data management and statistical analysis.



### 3 Baseline

#### 3.1 Curriculum at the university

Curriculum: The professor carries on the specialized courses to students. The purpose of students is to learn knowledge and basic skills. Evaluation of course is test and score. Curriculum usually has strong theoretical and general adaptability.

The TCA related courses focus on forestry remote sensing (31 courses), measurement (7 courses), field methods (1 courses), statistical analysis (14 courses) and other basic knowledge are taught in one term for the four universities. Generally, the course of TCA has not been set up at the university. Their courses lack policy context and Communication of results.

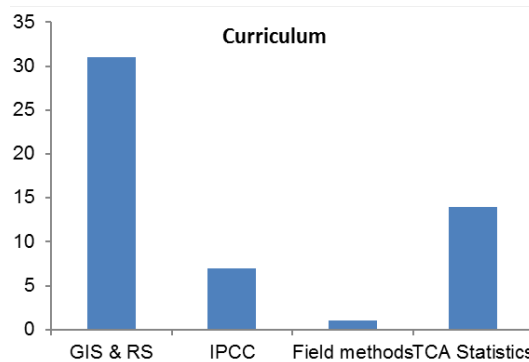


Fig 1 TCA related curriculums at the university in China

#### 3.2 Training at SFA

Trainings are short-term, specialized, systematic teaching for practitioners. The purpose of training is to obtain professional skills. Evaluation of training is professional certification or certificate. Training usually has stronger focus on methods and operation than curriculum.



The training at SFA teaches policy context (10 courses), GIS and RS (2 courses), IPCC guidelines (5 courses), and field methods (2 courses) in recent the three years (Fig. 2). And the training topics are mainly focused on forests and land use. They lack specialized statistic courses and GIS and RS for TCA. Communication of results is not mentioned in these trainings.

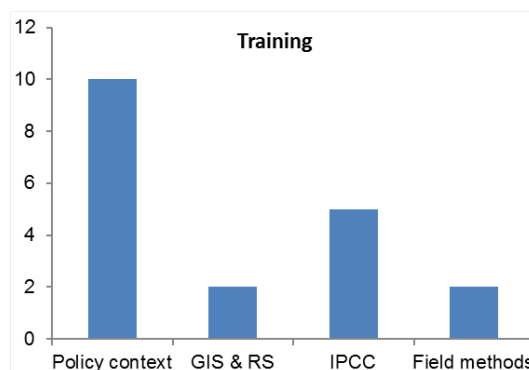


Fig. 2 TCA related trainings at the State Forestry Administration (SFA) in China

State Academy of Forestry Administration organized four programs related to forest carbon accounting during the 12<sup>th</sup> Five Year Plan period (2011-2015). A total of 360 experts and technicians from provincial Forestry Departments, Offices of Carbon Sink, Forestry Institutes of Designing and Planning, Forestry Institutes of Survey and Planning, Detection Centers for Forest Resources had been trained. The Courses are: Elaboration on Policies Related to Evaluation of the Work of Carbon Sink and Afforestation, Guideline for Monitoring Carbon Sink of Afforestation, Case Study for Monitoring Carbon Sink of Afforestation, Guideline for Monitoring Carbon Sink of Forest Management.

State Academy of Forestry Administration has also organized 10 training programs of Forest Surveying and Monitoring at the provincial level during the 12<sup>th</sup> Five Year Plan period (2011-2015). A total of 1100 experts and technicians from provincial level



Institutes of Forest Research and Planning, local Commissioner Offices, Forest Resources Division of Forest Bureaus, and Forest Research Centers have been trained. The Courses are: An Overview of the Research; Monitoring and Management of Forest Resources and the Integrated Monitoring of Forest Resources; Sampling Survey Techniques for Forest Resources; The Application of Remote Sensing Technology in Forest Resources Management And Ecological Building; An Overview of Forest Resources Survey in Foreign Countries; Forestry Mathematical Modeling; Technical Order of Planning, Designing and Surveying Forest Resources.

### **3.3 Presentation and report**

Presentation and report: Experts understand their professional topics, and focus on the accurate and new result. The audience is covered with professional students and researchers. It is very difficult to identify the degree or knowledge context of the audience. The relationship between the speaker and the audience is more equal, and they have more opportunities for communication and interaction.

The topics of presentation and report cover policy context (3 times), GIS & RS (1 time), IPCC (1 time), field method (2 times) and communication of results (4 times) in a half year for the six institutions. Usually, policy context and IPCC is used for explaining why they did the works. Presentation and report reflects the basic skills about communication of results, but no special communication for TCA.

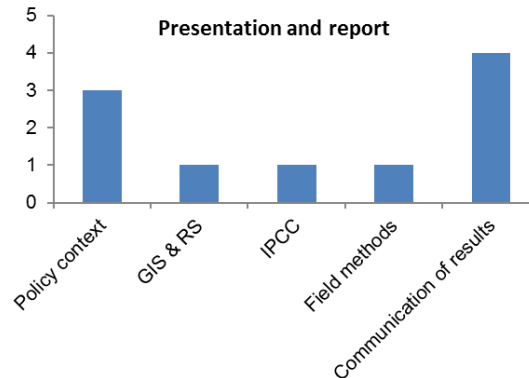


Fig 3 TCA related presentation and report of terrestrial carbon accounting in China

## 4 Gaps

### 4.1 Requirements of agency or ministry

Ten interviewees mentioned in the questionnaire that they need terrestrial carbon accounting monitoring in their work, such as to estimate terrestrial carbon storage and carbon change based on field data of Forest Resources Inventory or Inventory for Forest Planning and Design. Five interviewees need training of writing reports with a certain composition parts and formats; so as to do some works that focus on carbon sink afforestation and forest management. Three interviewees need skills to verify the data of terrestrial carbon accounting monitoring. For example, carbon change should be synchronously monitored with forest volume and forest coverage, and the carbon change could be explained by Forest Resources Inventory. The other three interviewees did not propose specific needs on the TCA training, and they agree that the course could train future technicians for them in carbon accounting monitoring.

### 4.2 The role of government

Six interviewees think that the government could provide policies and background



information, propose training needs, make the top level design of training courses, approve international certificates and so forth. Four interviewees believe that government could be a supervisor and a guarantee of high level and strict standards for the TCA training course, and work for the knowledge popularization of TCA and climate change. The government could also play an important part in many aspects like providing financial support, data sharing, improving teaching conditions and general affairs management of the training course.

### **4.3 Course Contents**

#### **4.3.1 The levels of understanding the six courses**

The levels of understanding for the six courses were divided into four categories, (A) deep understanding, (B) work related, (C) have heard of and (D) never heard of. The results show GIS/RS and TCA statistics courses are better understood than IPCC guidelines and field method, while policy context and result communication were the worst (Fig. 4). The cumulative percentage of category A and B for six courses increased as follow: result communication (18%), polices (31%), IPCC Guidelines (58%), method (67%), TCA statistics (73%) and GIS/RS (86%).

The six courses were divided into three categories based on the relationship between A and B. (1) A and B are both high, which means work related course and the interviewees are deep understanding, for IPCC guidelines and field method; (2) A and B are both low, which means not work related course and the interviewees are little understanding, for result communication and polices; (3) B is high but A is low, which means work related course but the interviewees are little understanding, for GIS/RS and TCA statistics.



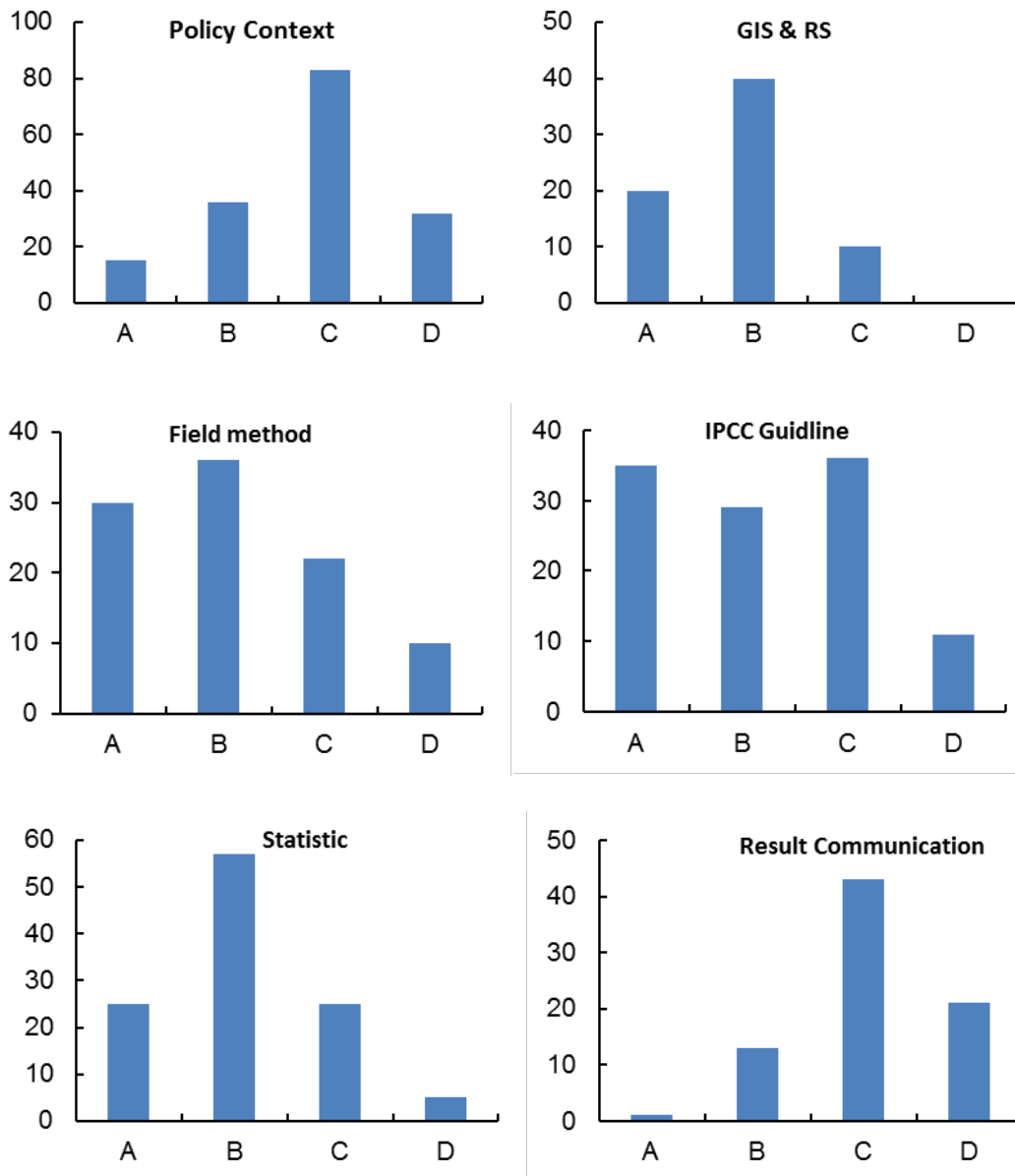


Fig. 4 Four levels of understanding the topics about TCA are labeled by interviewees. A deep understanding, B work related, C have heard of, D never heard of. The vertical axis is the total number of chosen topics.



### 4.3.2 Needs of the six courses

According to the questionnaire, the TCA work required courses decreased from IPCC guidelines, field methods, GIS/RS, TCA statistics, policy context to result communications (Fig. 5). The TCA training need course decreased as follow: GIS/RS, TCA statistics, policies, result communication skills, field method and IPCC Guidelines. The training need of IPCC Guidelines and field method are low, although it played an important role in carbon accounting works. GIS/RS and statistics are widely used and the most needed training course.

Therefore, the TCA work required knowledge, which is acquired and need no more training, like IPCC Guidelines and field method. The other four courses need training like GIS/RS, TCA statistics, policy context and result communications.

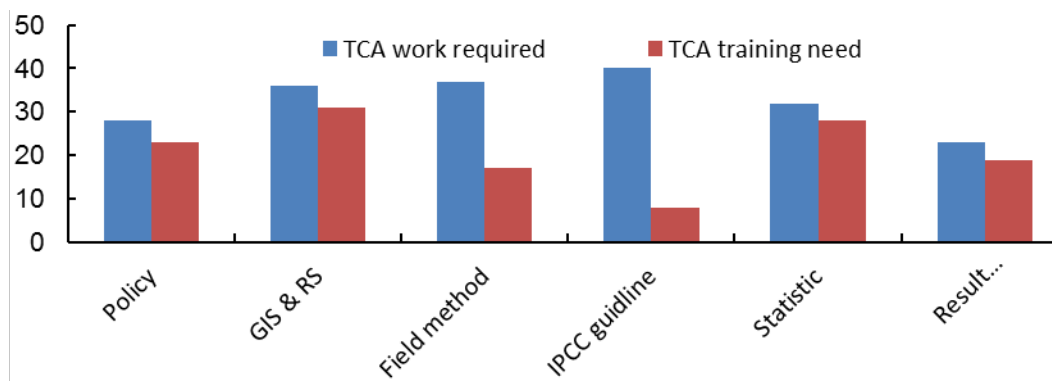


Fig. 5 TCA work required and TCA training need of interviewee for the six curriculums. The vertical axis is the total number of chosen topics.



### 4.3.3 The levels of understanding the knowledge points

#### Policy context

According to the results of the questionnaires, most interviewees are quite familiar with the goal and measurement of TCA, the percentage of category A (a deep understanding) and B (work related) added up to 50%. The policies about carbon funds outside of China, international negotiations, and national carbon market are not understood so well, less than 40% of the interviewees chose A or B. The situation for the former two is even worse, as the ratio of A and B is less than 20% (Fig. 6). From their work requirements and training needs, the carbon trading market rules and regulations in China and market of forest carbon trading program are needed compared with other subjects (No. 4 to 6 topics).

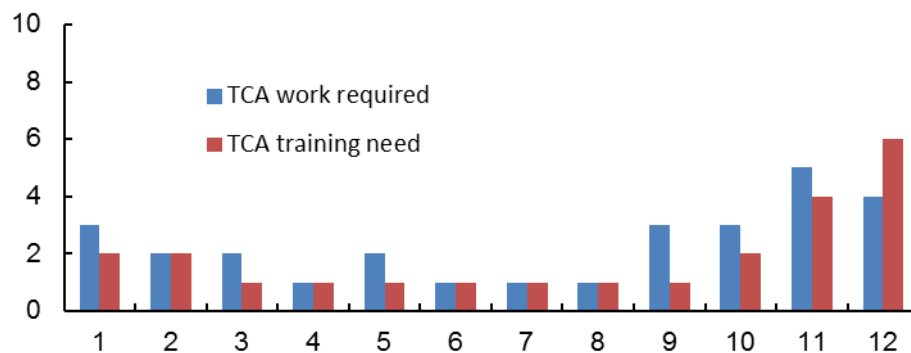
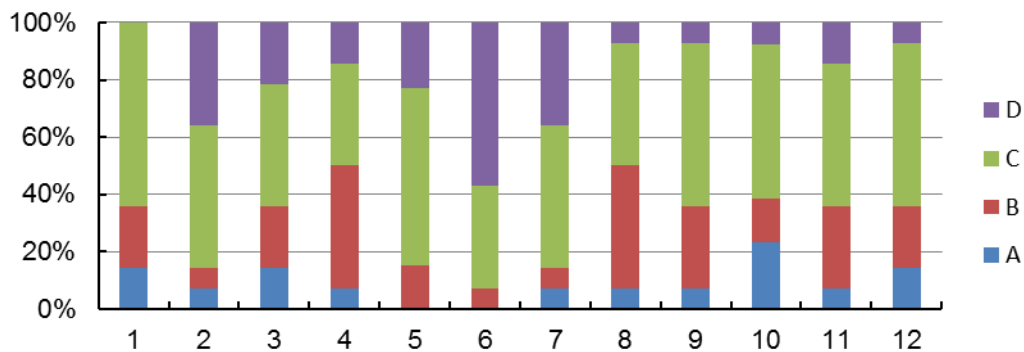




Fig. 6 Four levels of understanding the topics (top), TCA work required and TCA training need topics (down) of interviewee in Policy Context course.

1: UNFCCC; 2: NDCs (Nationally Determined Contributions); 3: REDD+ reference level; 4: MRV and the goal of limiting the temperature increase above pre-industrial levels under the Paris Agreement; 5: TCA and verification related to World Bank and the Carbon Fund, voluntary markets and sub-regional markets; 6: NDF (Nordic Development Fund); 7: Conference of the Parties (COP) to the UNFCCC; 8: National GHG inventories; 9: COP decisions relating to forest; 10: The main goals in “The 13th Five-year plan” of forestry response to climate change in China; 11: Carbon trading market rules and regulations in China; 12: Markets for forest carbon trading programs.

### GIS/RS

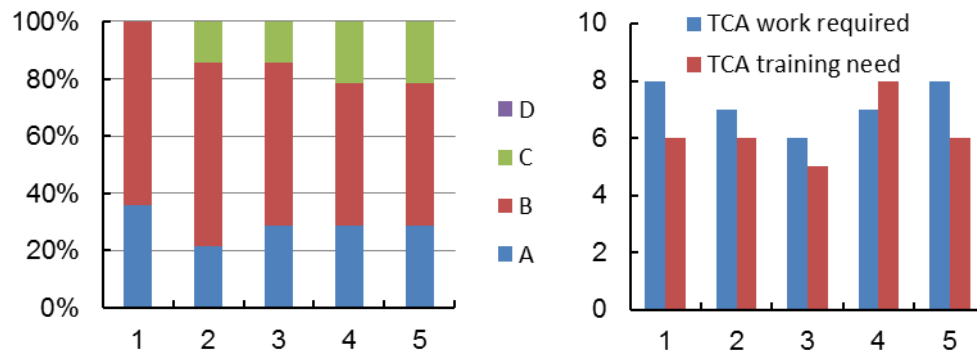


Fig. 7 Four levels of understanding the topics (left), TCA work required and TCA training need topics (right) of interviewee in GIS & RS course.

1: GIS Software (ArcGIS, Supermap et al); 2: Remote sensing software (ENVI, ERDAS, PCI, Google Earth); 3: Classifications for LULUCF based on remote sensing data; 4: Estimate forest biomass based on remote sensing; 5: Forest area and aboveground biomass change monitoring based on remote sensing.

Almost all the interviewees know the importance of GIS/RS for TCA, and 75%



people have a deep understanding of GIS/RS or rate it as work related. Most of the interviewees use GIS/RS approaches in their work but they are not competent enough, as more interviewees chose B (work related) than A (a deep understanding). All the training subjects are needed for the interviewees. Five or more interviewees need training courses for GIS and remote sensing software application, classifications for LULUCF based on remote sensing data, estimate forest biomass based on remote sensing, forest area and aboveground biomass change monitoring based on remote sensing. Eight interviewees are eager to learn monitoring forest area and aboveground biomass change based on remote sensing (topic 5).

### Field method

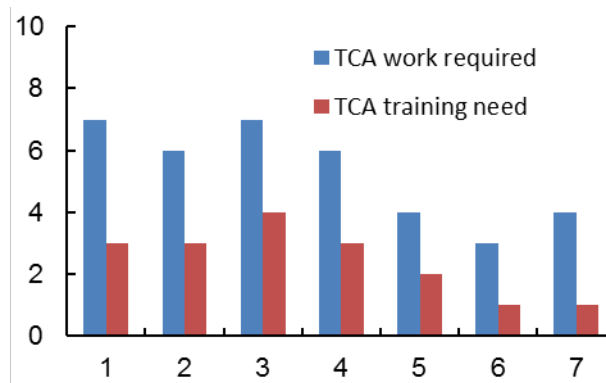
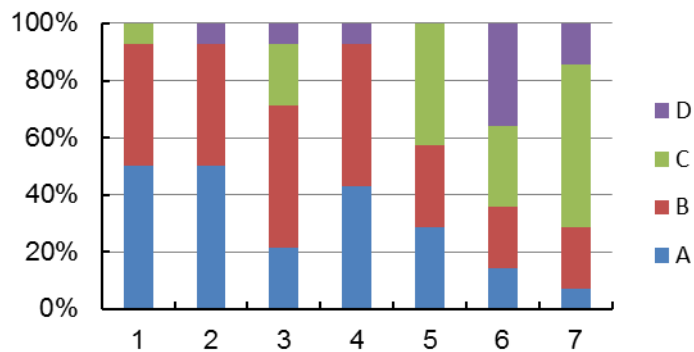




Fig. 8 Four levels of understanding the topics (top), TCA work required and TCA training need topics (down) of interviewee in Data Collection course.

1: Forest resources inventory, forest measurements (sampling design, forest plot, measure DBH of each tree); 2: Forest carbon pools (biomass, dead wood/litter, soil organic carbon); 3: Soil organic carbon analysis method; 4: Estimate ecosystem carbon stock; 5: Emission factors of national GHG; 6: The data requirement of Tier 1, 2, 3 in IPCC report; 7: Data quality assessment.

Most interviewees understand well about forest survey and forest carbon at home, for 95% people chose A or B. Reporting requirements and results communication from field data are grasped not so well, the cumulative percentage of A and B is 60% and even below 40%. It shows that most people know the field work and data collection process quite well at home, but are not so proficient in report communication with international organizations. For example, forest resources inventory, forest measurements (sampling design, forest plot, measure DBH of each tree), allometric equations, forest carbon pools including biomass, dead wood/litter, soil organic carbon, soil organic carbon analysis method, estimate ecosystem carbon stock are required components of the TCA work and have been acquired by the interviewees. They do not need substantially more training of these aspects except method of soil organic carbon analysis.

### **IPCC Guidelines**

All the interviewees have a well understanding of IPCC Guidelines, land use classifications, forest carbon accounting monitoring guidelines published by the SFA and forest inventory techniques, with an accumulative proportion of A and B ranged from 58% to 80%, due to former training courses. But they have less knowledge about how to analyze the data and report results (topic 4), and convert forest carbon to tradable carbon (topic 7) and information of other industries except forestry (topic 8). The portion of level



A and B is totally no more than 40%. All the knowledge points related to IPCC Guidelines are work required, but no training needs. Only two or even less interviewees need a training for each knowledge point.

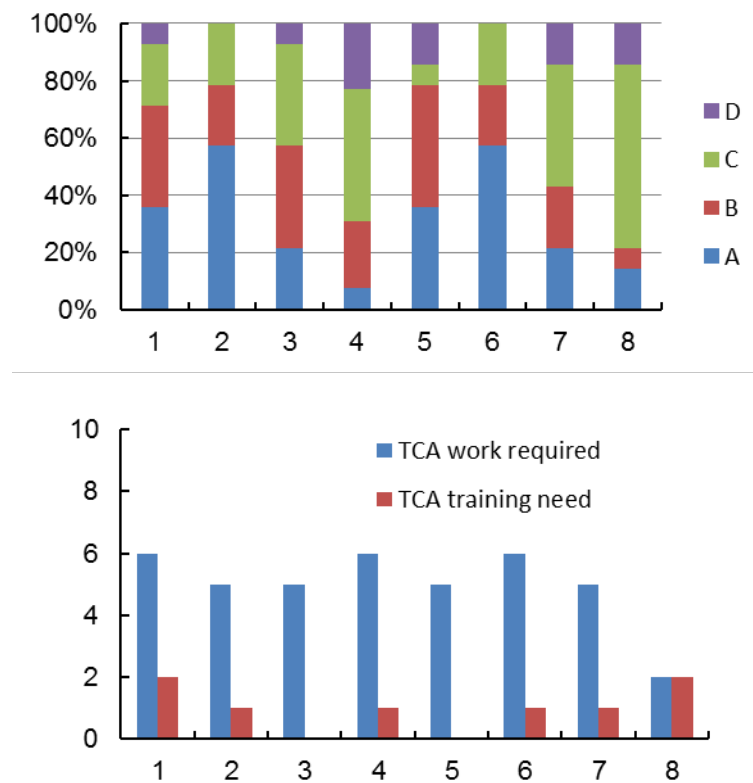


Fig. 9 Four levels of understanding the topics (top), TCA work required and TCA training need topics (down) of interviewee in IPCC Guidance course.

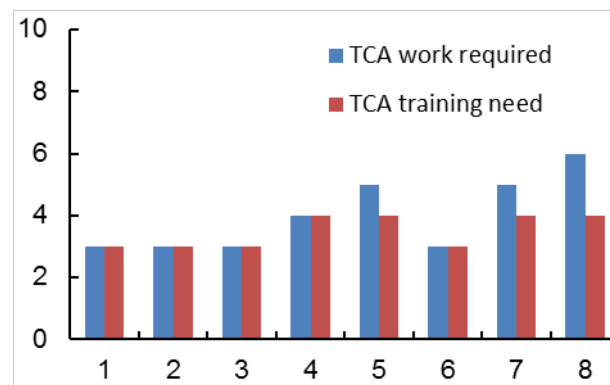
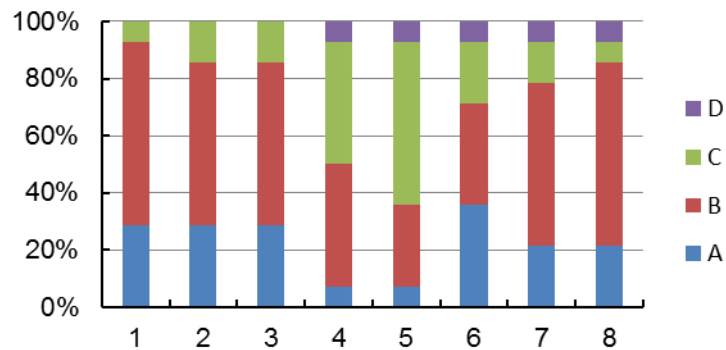
1: IPCC Guidance and Guidelines, e.g., 2006 IPCC Guidelines for National Greenhouse Gas Inventories; 2: Land use: forest, grass land, crop land, wet lands, settlements, other land; 3: The requirement of forest carbon accounting in IPCC Guidelines; 4: Editing National and provincial Greenhouse Gas Inventories; 5: Forest carbon accounting and monitoring guidelines and technical specifications; 6: Land use and forest types in National Forest Inventory; 7: Forest Management Inventory and Forest Operation Inventory; 8: Time series maps with land classifications.



## Statistics

The interviewees understand basic statistics well (mean and mean squared error, t-distribution, t-test e.g.), regression and their application in forestry and forest carbon accounting specifically. About 70% to 95% interviewees belonged to A and B levels. But much more people chose B than A. This means fewer interviewees appropriately use the methods than work needed (Fig. 9). The situation of error estimator, error propagation and uncertainty analysis, which attract much attention from IPCC, is not optimistic. Less than 10% interviewees had a deep understanding of these subjects.

Generally speaking, the training needs to include application practices of related knowledge points and the use of statistics software, especially error estimators and error propagation, uncertainty analysis and statistic application in forestry and forest carbon accounting.







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Fig. 10 Four levels of understanding for the the topics (top), TCA work required and TCA training need topics (down) of interviewee in Statistic course.

1: Mean and Mean Squared Error (MSE); 2: t-distribution; 3: t test; 4: Error estimator and error propagation; 5: Uncertainty analysis (bootstrap, Monte Carlo methods); 6: Multivariable linear regression; 7: Statistic software: Matlab, SPSS, Origin, Statistic, R; 8: Statistic application in forestry and forest carbon accounting.



## Results communication

Most of the interviewees are not so proficient in communication of TCA results, the proportion of level C and D added up to 60%. Reporting the TCA results in a suitable way, formatting analysis of results for reporting requirements and general presentation and writing skills were vital influences in communication. All the interviewees lack the above capabilities, such as UNFCCC reporting, reporting requirements to government entities in China.

However, the perceived training need is low for results communication, because it is seldom used in their work. Only three to four interviewees, who work in the department of communications, need a systematic training including formats and methods, in order to present the TCA results appropriately.

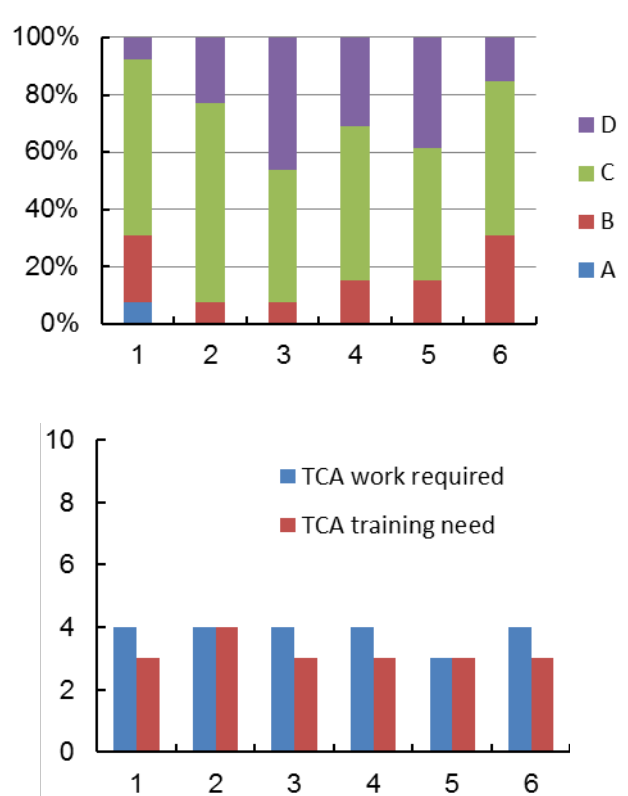


Fig. 11 Four levels of understanding the topics (top), TCA work required and TCA training need of these topics (down) of interviewee in Result Communication course.



1: Carbon from TCA to trade; 2: UNFCCC reporting (e.g., national communications, INDC); 3: Reporting requirements to government entities in China (e.g., PEP reporting); 4: REDD+ reporting (e.g., FCPF, FIP, bilateral); 5: Good communication (presentation and writing) generally; 6: Forest carbon trading methodology, carbon trading program application and trading transaction procedures.

#### **4.3.4 Demands of potential students in four categories**

All the interviewees could be classified into four levels: senior professional title (close to the administrative level), technicians (intermediate grade professional title), graduate students or Ph. D candidate majored in related subjects, professors or researchers in universities or institutes, based on their own characteristics.

For interviewees with senior professional title or administrators, their demand mainly concentrated on carbon credit trading and carbon market. They are familiar with related policies and data analysis processes or at least had direct practical work experiences.

For technicians or interviewees with an intermediate grade professional title, specific techniques and methods are really needed. They are experts in TCA monitoring techniques, but lack a systematic and senior study of relevant policies. Some of them admitted that they work in TCA related aspects and only have a superficial knowledge of the contents. Further systematical training courses on TCA are really needed if possible.

For graduate or undergraduate students with forestry majors, they pay more attention on improving their knowledge and understanding whether all these skills could be applied in their future. They have no work experiences, do not know much about TCA related policies and use these skills or methods in to TCA works.

For lectures and researchers, the TCA result communication is in great demand, in order to apply for more financial supports and publish their research results.



### **4.3.5 Data for practice**

11 interviewees wish to use real data during training, while other three didn't have suitable data. For example, introduce the process of matching a regional real data of TCA with carbon credit trading value, developing a real carbon emission reduction program or calculating forest biomass or forest stock volume, and so on. Related data include carbon sink survey, plot and remote sensing, in .dbf, .shp, .TIFF or .xls formats. The interviewees are willing to provide real data for practice, but a common data format that can be exchanged between a variety of services and languages is necessary for training.

## **4.4 Training implementation**

### **4.4.1 Basic requirements for students**

In order to keep a good understanding of the training, the student who has working experiences and technique about TCA is preferred. Therefore, the training courses should be designed more targeted to make sure all the students become competent and practicable in a short time and avoid waste of resources. The students need to keep on working or have actual work demands of TCA. 10 of the interviewees suggested that the students should have TCA related working experiences, working foundation, work requirement or job-hunting requirement. Seven of them proposed that fundamental knowledge is essential about Statistics, Forestry, Ecology and many other related subjects. Another two people thought it is better to provide the training courses to anyone who needed without any requirement. It is suggested that the training courses should be classified into different levels according to the demand and fundamental knowledge should be arranged systematically for better understanding.



#### **4.4.2 Training scale**

All the interviewees' agencies or organizations have one to five people need to be trained every year. The number of people who need TCA training is mainly constrained in a narrow range, from two to three. For others, four to five people every two years or 10 persons in total need TCA training. Accordingly, the training scale is about 60 to 90 people per year on the basis of provincial forestry department demands (two to three were required each year). Totally 150 to 300 people from provincial forestry departments all over the country need TCA training courses, and five to ten people for each province.

#### **4.4.3 Training schedule, duration and times**

Six of the interviewees (mainly forestry practitioners) preferred to have training courses in winter or spring, as they are busy with field work in summer according to their annual work arrangement. Summer vacation, when the potential teachers and students from university are free, is another popular choice (six people), since it is preferred to arrange full-time training courses. Only two others chose autumn or winter. Considering the above factors, the best period for forestry practitioners is between Spring Festival and May, while summer vacation is a good choice for graduate and undergraduate students.

Training duration possibly depends on TCA course content. Four interviewees choose one month or even longer to ensure an in-depth, systematic training course. Six people want to receive a one-two weeks training course including systematic theories, practical activities and also demonstration or investigation. Three others prefer special subject training courses in three to four days instead of comprehensive training.

All the interviewees think one to two training should be arranged per year, so that the potential students may choose their training plan more conveniently and more people could attend the training.



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#### **4.4.4 Tuition fees and costs**

All the interviewees hope their ministry or agency can cover the tuition fees and costs especially those who work at the forestry departments. Others want to get financial support from their research project. Graduate or undergraduate students need to pay by themselves. Only three people are willing to pay for the costs by themselves, and all 14 of them believe agencies need to pay for it.

The payment of the TCA training, they suggest that the consignment and commissioned agencies sign a training contract and pay the cost by project cooperation. Another way is a training invoice and the items needed to be clearly pointed out in training notice. The best way of the payment could be putting the training fee together with catering and lodging, paying half before and half after training. Both bank transfer and Alipay should be supported.

Tuition fees should be determined by all the following elements like duration, content, experts and the certificate value. It is really hard to make an estimate without corresponding data support. The most affordable tuition fee standard is no more than 500 yuan (including accommodation) per day and less than 3000 yuan each time.

#### **4.4.5 Capability and certificate**

Seven of the interviewees want to receive an international TCA certificate, while 10 of them want to learn more TCA related knowledge, TCA methods and software, as well as how to estimate forest carbon stocks, carbon sinks and the skills of carbon trading.

The TCA certificates should state its main content, agency, ranges of application and expiry date. It is suggested to associate TCA certificate with TCA qualifications of agency. 11 interviewees recommend stating the certificate agency, and eight of them hope to label training courses. Five people proposed that the certificate should be divided



into several levels based on personal ability and also state the expiry date.

#### **4.5 Support and long-term mechanism**

Eight interviewees stated a need for online support after the training courses. 11 people would like to get training data, lectures and reference materials. Nine people need related software for TCA. 13 people hope a shared draft course of TCA training that would be developed before COP 23. Other supports include: TCA work procedures and method consultation, TCA policies and a collection of related techniques, statistics, images processing and quantitative remote sensing. The support could be accomplished through multiple channels, such as on line help, Wechat and QQ group.

The interviewees also provide the advice to give a long-term support of TCA training as listed:

(1) The Chinese Society of Forestry, the Afforestation Department of SFA or relevant association to organize seminar, and invite relevant organizations to join the conference.

(2) The Academy of Forest Inventory and Planning leads to establish training institutions or projects. The relevant organizations join the work on TCA studies or pilot projects. Develop curriculum by the project would enhance the quality of curriculum and project.

(3) Provinces and departments that are willing undertake the specific training.

(4) Issue documents by the State Forestry Administration and call for relevant provincial departments to participate the TCA training.

(5) Draft long-term training plans and make the training course focus on application, and provide long-term technical support for the training organization.