


FINAL REPORT for APN PROJECT

Project Reference Number: CBA2011-17NSG-Devy

***Scoping Workshop to Develop an APN Proposal on  
“Building Partnerships for Developing a South  
Asian Canopy Science Research Program”***



APN  
Asia-Pacific Network for Global Change Research  
CAPaBLE

**- Making a Difference -**

Scientific Capacity Building & Enhancement for Sustainable Development in Developing Countries

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# **Building partnerships for developing a South Asian Canopy Science Research program**

**Project Reference Number: CBA2011-17NSG-Devy  
Final Report submitted to APN**

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## OVERVIEW OF PROJECT WORK AND OUTCOMES

Tropical forest canopies are among the most threatened terrestrial habitats. Worldwide, deforestation in tropics continues unabated. In India, the highest rates of deforestation exist for tropical wet evergreen forests that have the most extensive and species rich canopies. In addition to deforestation, extensive degradation of forests and fragmentation are increasing each decade. Even protected areas are not immune from biodiversity loss. Multiple pressures threaten global forests, ranging from increasing population, misguided development and poor governance and policies.

Climate change poses yet another important threat to forest canopies. Fifteen to thirty seven percent of global species are predicted to become extinct due to climate change over the next fifty to hundred years, and most of these may occur in tropical forest canopies. Furthermore, climate change is likely to affect ecosystem processes, such as changes in phenology, insect outbreaks and decoupling of species interactions. Canopy organisms may be highly sensitive to synergistic effects of climatic changes and other anthropogenic disturbances because of adaptations to very specific environments. Insects in particular may respond with extreme outbreaks, threatening the entire forest ecosystem. As the interface between atmosphere and land, forest canopies are important interface regions for monitoring the impacts of environmental changes. The increasing extremes in global weather patterns may likely be evident among canopy leaves, epiphytes, leaf-feeding insects, and the canopy processes that occur in tropical treetops. Canopy biologists need to create integrative, international collaborative research approaches to insure the best and most effective research programs, in order to quantify and predict the impacts of global change.

The workshop brought experts in the region to build a network to facilitate cross site learning's of this emerging science to solve global environmental challenges particularly biodiversity conservation, climate change and land use change in the Asian region.

Workshop sessions centered on specific questions relating to canopy science, education, technology, and Collaboration including:

- a) What specific tools are required to advance canopy science, especially to address areas of global challenges such as biodiversity conservation, climate change and, land use changes.
- b) How do global changes alter canopy processes (phenology, pollination, etc) that mediate forest health?
- c) What technological tools are required to assess the impacts of climate change on forest canopies, which in turn affects whole-forest health?

- d) How can scientists develop “best practices” for education outreach to citizens, students and policy-makers?
- e) What collaborative projects should be prioritized to answer the most critical questions involving tree canopies, ecosystem services and sustainable use?

The workshop was broadly categorized into three themes:

- 1) Introduction to canopy and orientation:
  - a) Four detailed presentations by Canopy scientists working in India
  - b) Outline on how focused group discussion is carried out
- 2) How to access the canopy
  - a) Demonstration of Single rope Access technique in GKVK campus
  - b) Detailed presentation on the other methods of accessing canopy
- 3) What are the questions that can be addressed in canopy and why?
  - a) Participants distributed to focused groups based on expertise and choice
  - b) Participants discuss and present summary of group discussion

The workshop was conducted ahead of the SCB Asia 2012 meeting held in Bangalore in order to maximize the number of international participants from the Asian region.

The workshop had these specific outcomes:

- 1. Canopy Research in India – a compilation of the on-going canopy research in India (M.Soubadra Devy and T. Ganesh) given to participants as part of workshop kit.
- 2. Orientation towards different aspects of canopy research carried out so far in India
- 3. Tree access demonstration by experts from ATREE
- 4. Focused group discussions on three broad themes: Biodiversity and Monitoring; Patterns and Processes and Outreach, Education and Ecosystem Services.
- 5. Email discussion group established for further discussions on proposals and knowledge development by circulating papers and highlighting deadlines for grants.
- 6. The workshop proceedings will be disseminated in various websites, including: [www.atree.org](http://www.atree.org) , [www.treefoundation.org](http://www.treefoundation.org), ICAN, and GCP (UK-based)
- 7. Furthering the group discussions to form a joint proposal with international participants
- 8. Key host institutions in Sri Lanka, NE India, Bangladesh, Indonesia and Philippines were identified and further interactions would result in developing a co ordinate proposal to be submitted to APN.

## **Non-technical summary**

Over 60% of the world's biodiversity is supported by the forest canopy. Canopies form an interface between the atmosphere and forest. They facilitate interactions such as photosynthesis, respiration, carbon flux and nutrient cycling. The Asian forest canopies remain unexplored and there is an urgent need to scientifically study and assess this unique subset of the habitat. Thus, a regional workshop was proposed with the intention of bringing experts and prospective canopy scientists to establish a network which would facilitate interactions and cross site learning of this emerging scientific field to solve global environmental challenges particularly biodiversity conservation, climate change and land use change in the Asian region. The scoping workshop was publicized in local media and journals and was held ahead of the "Biodiversity Asia 2012" conference which was the Asia chapter meeting of the Society for Conservation Biology held in Bangalore during August 7<sup>th</sup>-11<sup>th</sup>.

The workshop was juxtaposed head of this conference in order to maximize participation from the Asian region. Success of the workshop was marked by the enthusiastic participation by 24 persons from five countries. The workshop gave an insight into the canopy science so far in India and laid ground for focused group discussions. Subsequently, the participants came out with ideas which broadly fit into three categories: Biodiversity and Monitoring; Patterns and Processes and Outreach and Education. In conclusion, the roadmap for future was charted out by initiating an email discussion group in which the participants would interact regularly and develop the concepts proposed in the workshop further.

## **Objectives**

The main objectives of the project were:

1. Advancing canopy research in the south Asian region, using new technologies
2. Implementation of programs for education outreach and citizen science using the flagship image of the canopy
3. Dissemination of canopy research through technology transfer
4. Creation of global and regional collaboration to advance forest canopy research and education programs over the next five years

## **Amount received and number years supported**

The Grant awarded to this project was:

US\$ 15,000

## Activity undertaken

- Online announcement: Biodiversity Asia 2012; ATREE; Mailing lists
- Announcement in Print media: Current Science
- Receiving of Concept notes and CV
- Confirmation of participants
- Workshop
- Post workshop interactions
- Future directions

## Results

A successful workshop was conducted with 26 participants from six countries. This workshop was attended by Dr. Doyil, Scientist from the Department of Science and Technology (DST). The workshop was held at Royal Orchid Resorts convention centre at Yelahanka, Bangalore, India. The sessions started with a short video on forest canopies from the Global Canopy Program. This was followed by Introductions and Ice breaker. The main session involved an inaugural address by Dr. Soubadra and the excerpts of where the recently edited book "*Forest Canopies of South Asia, A glimpse*" was shown to participants and a copy was distributed to each of the participant as part of the workshop kit. This was followed by Dr. Doyil who highlighted various options of funding to popularize canopy Science. Following a tea break, there were three presentations on the following themes; Camera Traps and Climate monitoring; Birds and Small rodents and Frogs, Climate and forest sound scapes. The presentations were interactive in format and participants indulged in discussion over lunch. This was followed by a demonstration of tree access using Single Rope Technique by experts from ATREE. Tree climbing was held in the botanical garden of the University of Agricultural Sciences, Bangalore. This session was further strengthened by a detailed presentation on the various methods that have been and are currently being used to access the canopies. Also appropriate access methods for various studies were highlighted.

After a short tea break, the participants broke up into three groups viz., Biodiversity and monitoring; Patterns and Processes and Outreach, Education and Ecosystem services. The main idea of this focused group discussion was to chart out broad proposals with cross country and cross site collaborations. These ideas would subsequently be developed and pitched for funding in various national and international sources such as APN and Department of Biotechnology (DBT). After the focused group discussion, the participants defended their idea by presenting to the other two

groups. They also received comments from the workshop organizers in improving certain aspects of the study. Biodiversity mapping in the canopies; studying ecophysiology, application of remote sensing techniques and aspects of Eco tourism and long term program for outreach and education in the canopy were the three broad themes discussed.

Workshop was summarized with closing remarks from the organizers and it was decided and agreed that participants would remain in touch to further develop the ideas over an email discussion group that would be created for this sole purpose. Most participants felt this was the best way forward for working across political boundaries and work towards strengthening the science. The email discussion group was created and named "Asia Canopy Network".

Participants were enthusiastic and discussed the ideas over dinner before they dispersed for the day. Numerous participants also presented at the Biodiversity Asia 2012 conference and kept in touch with the workshop organizers. Many participants were also provided with travel support and dearness allowance to attend this workshop. Several of them also received a participation certificate upon request.

### **Relevance to the APN Goals, Science Agenda and to Policy Processes**

#### **Self evaluation**

Did the workshop have sufficient representation from Asian Region?

*Yes, there were 26 participants from five countries excluding India*

Was there sufficient representation from both genders?

*Yes 13 male and 13 Female participants*

Were the participants having necessary skills to carry out canopy research?

*Yes, there was representations from Students, Ecologists, Outreach activists, Remote sensing specialists, Funding agency etc.*

Did the workshop have a flow which led to substantial outputs?

*Yes, the workshop was structured to highlight the gaps in knowledge of canopies of Asian region; few examples of good studies in the Asian Region; Demonstration of how to go up into the canopy and the various methods that are available to do so. Brief introduction to focused group discussions on broad themes which are relevant to most funding agency requirements were highlighted. A short*



*workshop proceeding is being written and will be published in peer reviewed journals.*

### **Potential for further work**

The participants have agreed to develop a coordinated joint proposal for canopy studies and will be applying for the APN grant. The DST, as the Indian counterpart of the funding has agreed to initiate summer schools to popularize canopies with help from experts from India. Such efforts to bolster canopy research could be undertaken in other participant countries.

### **Publications (please write the complete citation)**

How to strengthen Canopy Science in Asia? Soubadra Devy (In prep)

### **Acknowledgments**

We acknowledge the support from Dr. Gladwin Joseph, Director of ATREE who provided encouragement for this grant. The workshop success was attributed to the undue support from Mr. Ramesh, Mathivanan, Saravanan, Tamizalagan, Urbashi, Ronita, Seena, Rajkamal, Allwin, Aravind, Vivek, Kiran, Seshadri and other staff from ATREE. Gopi, Sindhu, Varthika, Bogiah and several others from the Finance section of ATREE helped the processing of funds and preparation of financial reports. Dr. Ganesh provided inputs in the development of the program schedule. Dr. Doyil agreed to be part of the program with a short notice.

### **ATREE expert team**

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1. Soubadra Devy M	F	India	Faculty
2. Ganesh T	M	India	Faculty
3. Seshadri.K.S	M	India	Student
4. Aravind.N.A	M	India	Faculty
5. Vivek Ramachandran	M	India	Student
6. Saravanan. A	M	India	Coordinator
7. Mathivanan. M	M	India	Coordinator
8. Tamizalagan	M	India	Assistant
9. Seena.K	F	India	Student
10. Ronita Mukherjee	F	India	Student
11. Allwin Jesudasan	M	India	Student
12. Rajkamal Goswami	M	India	Student
13. Urbashi Pradhan	F	India	Student
14. Priyan Dharmarajan	M	India	Faculty

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### **Preface**

Forest canopies are at the interface between the forests and the atmosphere. Many important forest–atmosphere interactions such as photosynthesis, respiration, carbon flux, and water and nutrient cycling mainly take place in this region. On a global level, we need to know how plant–atmosphere interactions are likely to be affected by the changing global process. Forest canopy research can also provide inputs to many global-level processes such as climate change. There is an urgent need to replicate these models in other regions to understand processes related to global change. The capacity building workshop to facilitated exchange of knowledge from established site in Western Ghats, India to develop program in parts of South Asian where the gap exists now.

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## 1.0 Introduction

Tropical forest canopies have been studied systematically in very few sites both in New and Old World tropics. The estimate on global species richness was drastically revised after a short exploration of forest canopies. Yet, it still remains one of the least understood regions in our biosphere. Many brave researchers in the recent past have explored these regions involving great risk with limited canopy accessing capabilities across the tropical forests and have revealed interesting findings on the species richness and behavior of plants and animals. In recent times canopy science is emerging as a new discipline with the help of recently developed canopy accessing techniques. Canopy science provides important interdisciplinary and large-scale research possibilities such as canopy–atmosphere interactions, structural and functional aspects of canopy on biodiversity, plant animal interaction etc. Forest canopy research can also provide inputs to many global-level processes such as climate change. Here, we review the direction that canopy science has taken in recent times in the tropics and also explore the possibilities of pursuing canopy science more intensively in the Asian countries. The canopies of tropical forests are unique in many aspects with diverse habitats, of which we know very little. These have been recognized as the last biotic frontier and the heart of biodiversity. Much of the biodiversity found in tropical forests is in the canopies. Canopy science is now emerging as a recognized field and is slowly evolving as a distinct discipline. Some aspects of canopy research now involve multiple researchers approaching a common question from various dimensions and trying to use more harmonized methods and cross-site analysis. Forest canopies are not just an abode for biologists, but also to many meteorologists who have also been contributing to ‘canopy science’. Forest canopies are at the interface between the forests and the atmosphere. Many important forest–atmosphere interactions such as photosynthesis, respiration, carbon flux, and water and nutrient cycling mainly take place in this region. On a global level, we need to know how plant–atmosphere interactions are likely to be affected by the changing global process. Changes in plant–atmosphere interactions can have cascading effects on animals which interact with plants as well as with the atmosphere. In recent times, such issues have gained momentum especially in the present context of global climate change. For instance, increasing atmospheric CO<sub>2</sub> is likely to affect rates/existence of herbivory. South Asian forest canopies remain unexplored and there is an urgent need to draw the attention of the scientific community to this unique habitat. However, there has been a concerted effort in the Malaysian region by a Japanese team through

state of art access techniques. Next site is in Australian where similar efforts are underway. The Asian forests remain as emphasized earlier, forest canopies require special skills, techniques and equipments to access, and also needs special training. However, there has been a tremendous progress in the is area in other parts of the world while it is still in its nascent stage in Asian region

In this regional workshop we brought key experts in the region to build a network for capacity building and facilitate cross site learning's of the relatively young, emerging science of forest canopies can inspire new and innovative research with advanced tools and technologies to solve global environmental challenges particularly biodiversity conservation, climate change and land use change . And further, canopy science can serve as a catalyst for ecology education and collaborative projects that foster local conservation initiatives.

## **2.0 Methodology**

The workshop initiated with lead lectures on the progress of canopy science around the world. This was followed by in depth presentations on the various ecological and interdisciplinary researches in canopy science, underway in the Asian region. Specific case studies in the canopy within this region were also discussed. Issues related to the technological advancement for accessing the canopies and the need for a variety of methods were also emphasized. Following this, participants were exposed to actual method of access such as single rope technique (See Appendix 4, 5 & 6). This gave them feel of what it means to actually access the canopy. Subsequently, the participants were divided into groups based on their capacity and field of interest for group discussion (Appendix 7).

Each group was asked to deliberate under three topics viz., Biodiversity and Monitoring; Patterns and Processes and Ecosystem services, Outreach and Education. The group had a moderator from the host organization (ATREE). The participants discussed and charted out the following details.

- Identify existing expertise within the group
- Larger research goals within each theme
- Which part (s) of the world, what region, which habitat etc.
- Existing expertise in the field

- Possible linkages with current research on similar or related topics
- Identification of a host organization for the country
- Possibility of collaborations: for knowledge sharing as well as capacity building
- Probable funding agencies- for within countries, between countries of Asia
- Who will steer it
- Timeline

### **3.0 Results & Discussion**

A successful workshop was conducted with 26 participants from five countries excluding India. This workshop attended by Dr. Doyil, Scientist from the Department of Science and Technology (DST). The workshop was held at Royal Orchid Resorts convention centre at Yelahanka, Bangalore, India. The sessions started with a short video on forest canopies from the Global Canopy Program. This was followed by Introductions and Ice breaker. The main session involved an inaugural address by Dr. Soubadra where the recently edited book "*Forest Canopies of South Asia, A glimpse*" was shown to participants and a copy was distributed to each as part of the workshop kit. This was followed by Dr. Doyil. Following a tea break, there were three presentations on the following themes; Camera Traps and Climate monitoring; Birds and Small rodents and Frogs, Climate and forest sound scapes. The presentations were interactive in format and participants indulged in discussion over lunch. This was followed by a demonstration of tree access using Single Rope Technique by experts from ATREE. Tree climbing was held in the botanical garden of the University of Agricultural Sciences, Bangalore. This session was further strengthened by a detailed presentation on the various methods that have been and are currently being used to access the canopies.

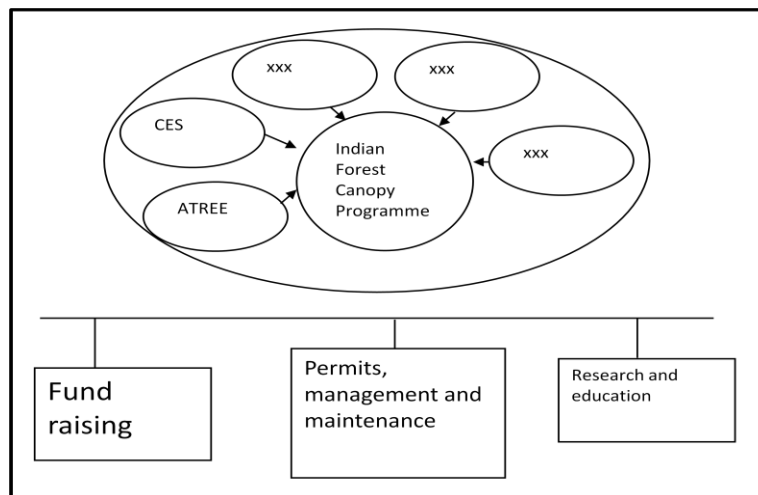
The group discussion was carried out under three themes: Biodiversity and monitoring; Patterns and Processes and Outreach, Education and Ecosystem services. The main idea of this focused group discussion was to chart out broad proposals with cross country and cross site collaborations. These ideas would subsequently be developed and pitched for funding in various national and international sources such as APN and DBT. After the focused group discussion, the participants defended their idea by presenting to the other two groups. They also received comments from the workshop organizers in improving certain aspects of the study. Biodiversity mapping in the canopies; studying

ecophysiology, application of remote sensing techniques and Aspects of Eco tourism and long term program for outreach and education in the canopy were the three broad themes discussed.

The group came with following organization structure for each country level program (e.g India). The need to raise funds was recognized as an important component for the success of a research study followed by the procurement of permits and maintain the infrastructure. The group discussions resulted in ways towards identifying a set of research priorities, largely based on the local expertise within the participating countries and bridged with other ongoing programs with countries like India. Most participants suggested ATREE to steer the Asian program as they had experience in the canopy in the region.

From the discussion, fund raising was identified as a major constraint which has hindered canopy research in participant nations. Subsequently, the difficulties associated with obtaining research permits and maintenance and management of research initiatives and the lack of awareness about importance of canopies among the policy makers and local communities.

The illustration provided below shows how other organizations could infuse strengths into the Indian Program. This same framework will work for the Asian Programs where participating countries would bring in strengths and help set up a long term monitoring program.



Flow Chart Showing the probable model for Asian Program

Workshop was summarized with closing remarks from the organizers and it was decided and agreed that participants would remain in touch to further develop the ideas over an email discussion group that would be created for this sole purpose. Most participants felt this was the best way forward for

working across political boundaries and work towards strengthening the science. The email discussion group was created and named “Asia Canopy Network”.

#### **4.0 Conclusions**

Forest canopies besides supporting about 60% of the biodiversity, is also an interface between the forests and the atmosphere. Most forest–atmosphere interactions such as photosynthesis, respiration, carbon flux and nutrient cycling take place in this region. Asian forest canopies remain unexplored and there is an urgent need to draw the attention of the scientific community to this unique habitat. Here I propose a regional workshop to bring experts in the region to build a network to facilitate cross site learning’s of this emerging science to solve global environmental challenges particularly biodiversity conservation, climate change and land use change in the Asian region.

The overall goals of the workshop were to bring together prospective canopy biologists from Asian Region and involve them in advancing canopy research in the Asian/South Asian Region. Bringing together the participants would also help in developing outreach and awareness programs and begin citizen science program using the flagship of the canopy. The interactions would further help in dissemination of canopy research through technology transfer. The workshop was intended to result in global and regional collaborations to advance forest canopy research and education programs over the next five years. One of the conclusive outcomes of this workshop was that a proposal is now being developed for the APN- ARCP grant for the upcoming deadlines. This proposal will most likely involve parties from Sri Lanka, Japan and India and they will aim to start a long term monitoring program for facilitating site level comparisons of biodiversity under climate change scenarios in Asian Region.

#### **5.0 Future Directions**

The next capacity building workshop was proposed in Sri Lanka with SAARC funding. Countries such as Indonesia and Philippines proposed a follow up workshop in Kuching , Malaysia which is the nearest site where a canopy crane and a long term program in canopy science exists. The main idea of having the workshop there is to have an exposure of the infrastructure and the on-going research program in the site.



Since the researchers from India are having expertise in canopy science research, they will work with the other Asian Country Counterparts to set up a long term canopy research program. In this direction, ATREE will be submitting a joint proposal for the APN-ARCP grant.

The proposal for long term monitoring will begin with on site capacity building in canopy access and other research and sampling techniques necessary for canopy science. Subsequently, the participating countries will identify regional and international funding sources to supplement and bolster the existing funds and continue the long term monitoring for pan Asian comparison.

Much of this discussion has been carried out on the email discussion group ([asiacanopynetwork@googlegroups.com](mailto:asiacanopynetwork@googlegroups.com)) which has been created for this very purpose at the workshop in Bangalore.

### Conferences/Symposia/Workshops

The workshop was conducted by ATREE at Royal Orchid Resorts, Bangalore, India. The detailed program is listed below (See appendix for program list, participant list, meeting minutes and Program proceedings)

#### Funding sources outside the APN

*No other funding sources*

#### List of Young Scientists





*None*

#### Glossary of Terms

*KMTR: Kalakad Mundanthurai Tiger Reserve; ATREE: Ashoka Trust for Research in Ecology and the Environment; DST: Department of Science and Technology; DBT: Department of Bio-technology; SAARC: South Asian Association for Regional Co-operation.*

## Appendix 1

### Program Schedule

**Scoping Workshop on Canopy Research**

**Biodiversity Asia 2012**

**Society for Conservation Biology Asia Conference**

**Venue:** Royal Orchid Hotel, Doddis, Yelahanka

**Date:** 6<sup>th</sup> August 2012; **Timing:** 10:00—17:00

Time	Program Schedule	Speaker
0930-1000	Registrations	
1000	Icebreaker-GCP video	
1000-1030	Welcome and Introduction	Dr. Ganesh
1030-1100	A view of the canopy science of south Asia	Dr. Soubadra
1100-1120	Role of DST in supporting canopy science	Dr. Doyil
1120-1145	Tea break	
	ATREE in forest canopies	
1145-1200	Camera traps and climate monitoring	Dr. Ganesh
1200-1215	Birds and small rodents	Mr. Vivek
1215-1230	Frogs, climate and forest sound scape	Mr. Seshadri
1230-1300	Overview of proposal outline and things to do for noon	Dr. Soubadra
1300-1400	Lunch	
1400-1430	Reaching GKVK	
1430-1530	Demonstration of Tree Climbing	
1530-1545	Back to Royal Orchid	
1545-1600	Tea Break	
	Focused group discussions	Moderators
1600-1630	Monitoring- climate	Dr. Ganesh and
	Biodiversity assessment	Seshadri
	Patterns and processes	Mr. Vivek
	Outreach, education and ecosystem services (NTFP, eco tourism etc)	Dr. Irfan
		Dr. Soubadra
1630-1700	Summarize and prepare presentations	
1700-1800	Presentations by four groups	
	Points from four groups summed up into format and how to proceed	Dr.Soubadra
1800-1830		Mr.Seshadri
1830-1845	Wrap up	
1900	Dinner	
2100	Drop back	

## Appendix 2

### Meeting Minutes

Sessions	Activity	Speaker	Summary
Introductory session- Icebreaker	Ice breaker	Allwin	GCP Video screened
	Welcoming the guests	T Ganesh	Welcomed all the participants
	Introductions	All participants	All participants briefly introduced themselves
	A view of the canopy science of south Asia	Soubadra Devy	Summarised the current scenery of canopy research in South Asia and spoke about future plans, goals and direction that canopy science should take in South Asia. She called upon the funding agencies to support the giant leap that canopy science is waiting to take in S Asia: i.e. installation of canopy cranes. She highlighted that the main thrust of the workshop is to identify a targeted research program which will enable the canopy science of S Asia to gain global prominence.
	Role of DST in supporting canopy science	Doyil	Highlighted DST as a premier govt institution whose priority is to financially support innovative science programs. The canopy project of Soubadra was one such program which was duly funded. He reiterated that if a science proposal fulfils the criteria and has adequate man power or collaborations DST will consider funding such proposal in future too. He urged the group to design studies which focusses on the gaps in the current state of knowledge of canopy science. He urged the organisers and the participants to broaden the canopy studies from its current foci on wet evergreen canopies.
<b>TEA</b>			
ATREE in forest canopies	Camera traps and climate monitoring	T Ganesh	Highlighted the use of automated equipments, mainly hobo and camera traps, which can be used effectively in carrying out research and monitoring activities in the tropical forest canopies.
	Birds and small rodents	Vivek	His study, through proper canopy sampling of birds and rodents, showed that only ground sampling of canopy species might provide an eclipsed view of the behavior and abundance of the concerned taxa. His study has shown that birds of canopy remain active throughout the day and a small endemic rodent of KMTR the malabar dormouse, earlier thought to be rare, is one of the commonest rodents of KMTR.
	Frogs, climate and forest sound scape	Seshadri	He spoke about his study whereby he started long term monitoring of canopy frogs using song meters and aims to study the impact of climate change on the frog population, behaviour and niche-level interactions.
<b>LUNCH</b>			
Post Lunch Session	Climbing at GKVK	Chian/Seshadri/Saravanan/Vivek	All participants were provided a demo of the technique of tree-climbing using the double rope technique. Few participants also attempted to climb using the technique.
	Historical overview of tools employed to practise canopy science	Vivek	Highlighted how canopy access methods have changed over the years and how newer and more sophisticated methods of canopy access has helped advance the canopy science
	Focused group discussions	Soubadra Devy	Introduced the participants to the objective of the exercise after which she divided them into three groups whereby they were expected to comeup with a broad framework for a research proposal which included a broad description of the proposed work, potential study sites, methods, collaborators and funding agencies.
Focused group discussions	Biodiversity and Monitoring	T Ganesh & Seshadri	Proposed projects: Biotic inventory of the available taxa of the canopy in selected sites including micro-organisms. Study sites would be in India (Western Ghats, Western Himalayas and Eastern Himalayas), Sri Lanka and Indonesia. Funding sources to be identified and explored at both regional and global scale. Participating countries: Phillipines, Bangladesh, Sri Lanka and India.
	Patterns and processes	Soubadra & Vivek	Dominated by Indians with just a lone participant from Java. The first potential proposal dwelt on ecophysiology of canopy leaves along a gradient of disturbance in the dangs of Gujarat with ATREE as a collaborator. The Javan participant wished to implement a phenological proposal from a forest in Java where there is a pre-existing canopy rope way which can also be used to study ecophysiology. This study can also be replicated in the Nicobar Island of India where almost no studies has been carried out. The third proposal from this group aims to look at the three dimensional interactions in the canopy using LIDAR technique and ecological niche-modelling. The fourth proposal wants to study the biomass, physiological properties and nutrient dynamics of the leafy components of the canopies. He wishes to implement this study in collaboration with ATREE, GUIDE WII, NRSA & BHU. Funding agencies: MOEF, DST
	Outreach, education and ecosystem services.	Allwin	Thurst areas: Ecotourism, NTFPs and a long term education program on canopy science. Proposed project title: Linking Education & Ecosystem services of forest canopies. Participating countries: India (Great Himalayan National Park, KMTR); Indonesia (Mount PHS National Forest); SriLanka (Low land wet zone); Expertise: Community Engagement, Ecology and Behavioral Science.
Concluding Session	Wrapping up	Soubadra	Key outcomes and targets: 1. Start an email group. 2. Start discussions on the projects towards the end of Aug. 3. Literature about canopy to be shared on the email group. 4. ATREE willing to train or organise training programs on tools and methods to access canopy and to carry out research and monitoring in the canopy. 5. ATREE to share contacts and initiate cross-stakeholder dialogue. 6. December 2012 is the deadline for a rough draft of proposal. 7. News about potential fundings to be shared with the group. 8. To share a report about the workshop to current science.
	Concluding Remarks	Doyil	Found the initiation of the interaction very encouraging and reiterated that future proposals should look to push boundaries of knowledge and science and wished the participants all the best for future endeavors.
	Note of Thanks	Seshadri	Thanked the participants, organisers and volunteers.
<b>DINNER</b>			

### Appendix 3

#### Participant details

Name	Sex	Country	Position	Affiliation	Email
1. Devanshu Gupta	M	India	Student	Zoological Survey of India	devanshuguptagb4102@gmail.com
2. Karthik K	M	India	Student	The Energy Research Institute	karthik.teri@gmail.com
3. Prasanna Jagdish Kolte	M	India	Student	Ashoka Trust for Research in Ecology and Environment	prasanna.kolte@atree.org
4. Esperanza G. Mangabat	F	Philippines	Faculty	Mindanao State University Tibanga, Iligan City	gm88esperanza@yahoo.com
5. Olga Macas Nuneza	F	Philippines	Faculty	Mindanao State University Tibanga, Iligan City	olgamnuneza@yahoo.com
6. Rajmohana Keloth	F	India	Faculty	Zoological Survey of India	mohana.skumar@gmail.com
7. Tati Suryati Syamsudin	F	Indonesian	Faculty	Institut Teknologi Bandung	tati@sith.itb.ac.id
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## Appendix 3

### Abstracts of lectures delivered during the workshop by experts

#### 1. Asian Canopies – opportunities and gaps

Dr. Soubadra Devy the co-organizer of the capacity building workshop set the stage by highlighting the canopy studies that has been carried out in India. Ashoka Trust in Ecology and the Environment was a pioneer in accessing the canopy in India. The program was kicked started In India by adopting network of ladders in wet forest site of Kalakad Mundanthurai Tiger Reserve in Southern Western Ghats, India. The work involved interactions of honey bees with a guild of their food plants. Over years, a period of 10 years the community level pollination study was also undertaken. Contacts with other leading canopy biologist Dr. Margaret Lowman enabled bringing in safer access methods such as single rope technique (SRT) to the site. This paved way for many interesting studies with also resulted in robust sampling. The work undertaken by using SRT was highlighted in the following presentations. ATREE also convened the 5<sup>th</sup> International canopy conference under theme 'Forest Canopies: Conservation, Climate Change and Sustainable Use'. This has representation of 33 countries and helped showcase the progress in developed countries to the Asia region. This conference served as opportunity to collate all work in South Asia which was edited into semi-technical book titled 'Forest Canopies of South Asia- A Glimpse. The book was distributed to all the canopy workshop participants.

She also highlighted how the canopy science has gained impetus particularly in connection with climate change. Scientists have used crane and walkways to install heavy equipments and also to carry repeated sampling. Also funders of other cranes around the world have been either the government or the science foundations. A greater proportion of the studies have looked at canopies independently and not in conjunction with the ground level studies. The need to link with other on-ground programs such as permanent plots was also emphasized so that there is understanding of the 'whole forest'. A consortium institutions need to come together to develop co-ordinate proposals to acquire and utilize infra-structures such as crane. Gaps of such infra-structure in South Asian region had marred the progress of canopy science. Also the need for more harmonized methods and protocols were required, so as to enable region level comparison. Certain organization should lead role in collaborations with experts and develop a protocol which be adopted at regional level in Asia. The way forward is integration both at country level and regional level program. For

example, India at country level needs work with represents its hotspots of biodiversity (Western Ghats, Eastern Himalayas, Western Himalayas and Andamans and Nicobar Islands). It could integration with other countries such as - Sri Lanka for comparing Western Ghats; and with Indonesia for Andamans and Nicobar.

Countries could start work in an exploratory mode by using simple access techniques such as SRT in the area of biodiversity by training young individuals. Interaction that followed the presentation had the participants quizzing on the safety issues and the costs involved for the infrastructure and there was a consensus on the urgent need for an Asian Canopy program.

## **2. Remote sensing the canopies: Cameras and thermometers**

Dr. T.Ganesh provided details on the challenges faced in documenting and studying animals in the canopy. In recent times, with the availability of still and video camera traps it has become easier to capture some of the elusive animals. Camera traps allow the observation of shy, cryptic animals without disturbing them. The biggest advantage is getting continuous observation across day and night on the presence and movement of animals in any location. Our purpose of using camera traps in the canopy was not just to photograph mammals or birds but also document the use of a particular patch of resource such as flowers or fruits and understand other interactions at such patches over.

Camera traps were used to study frequency of visits to the flowers of a canopy tree, *Cullenia exarilata*. The traps were mounted inside wooden boxes with a metal frame mesh to protect it from macaques. We tested the reliability of cameras to record visitors by doing parallel observations from hides. Several factors like sunlight heating up the leaves, placement of the camera, the power of flash, weather especially wind need to be considered to avoid false trigger. Once these are taken care camera traps might be the best non-intrusive method for sustained monitoring at one point in the canopy.

The other important variables that can be measured in a non-intrusive way are weather parameters. With the availability of several cheap weather data loggers it's possible to network the canopy with such loggers to determine the changes in temperature, humidity, light flux across time and space. Simple HOBO data loggers protected from direct rain and macaques were deployed in the canopy and ground to determine the variations in microclimatic changes at 1 hr interval in a rainforest in south India. This was the first continuous measurement of these variables in a rainforest site in India.

The variation in temperature in the canopy across a day was 5.5 C and in the understory was 2.5 C. The maximum difference occurred in the July when intermittent rain and strong sunlight heated up the canopy and not so the understory. Humidity was 2-20% higher in the understory and during the monsoons it remained at 100% for more than 25 days at a stretch. These differences may be useful to interpret the dynamics of seedling growth and phenological patterns of rainforest trees.

### **3. Bird and small mammal communities in structurally diverse habitats of Kalakad-Mundunthurai Tiger Reserve – a canopy-centric approach**

Vivek Ramachandran provided an overview of the canopy research on birds and small mammals done by ATREE at KMTR. He spoke about the need to study birds and small mammals from the canopy as against the traditional ground based sampling. Illustrated examples of the advantages of sampling from the canopy were outlined and strategies to improve sampling were discussed. There was a general consensus that stand alone terrestrial sampling was giving an eclipsed view even for well studied taxa such as birds. For mammals, canopy sampling was not only shown to detect crepuscular species but was augmenting the biodiversity assessment of the area. The canopy based approach also provided useful insights into vertical stratification and niche differentiation in bird and small mammal communities. The advantages of repeated access and sample scale were shown to provide valuable insights into community structuring of the target taxa. The talk was well received and stimulated a lively discussion on various aspects of canopy access for taxa based sampling.

### **4. Frogs, Climate and Forestscape**

Seshadri gave an overview of his research work on frogs in KMTR. One of the reasons for this shortfall has been the difficulty of access to the tree tops, especially in the old world tropics. Most canopy research require several man hours of effort, often in harsh conditions with little infrastructure. A vast majority of anurans use vocalizations as signals to attract mates. Many anuran species are known to be complete canopy specialists having severed links with the ground. Epiphytic bromeliads in canopy provide much of the moisture essential for anuran communities. While such complete canopy dwellers are numerous in the neo-tropics, they have so far, not been documented in old world tropical forests like those in India. In the larger context of global climate change, the forest canopy, being the first to interact with the atmosphere, stands to be most affected. Anurans in particular are unique models to document and understand the impacts under climate change scenarios as minor changes to the moisture availability or temperature are known to show profound



impacts on the breeding success of anurans. While monitoring anurans using their vocalizations has been in practice, no such efforts exist in developing countries like India.

A crucial problem with monitoring anurans using vocalizations has been the difficulty in discerning the changes caused by human induced modification and those of natural causes. However, recent technological advancements in Automated Sound Recording systems (ASR) have helped overcome a few limitations. The ASRs, with ability to be deployed in harsh field conditions for long durations are increasingly being used to monitor wildlife. Here, the pros and cons of a non-intrusive acoustic method to record anurans in the canopy and ground to understand their community in a rainforest of southern India.

#### **5. Canopy Access Techniques: history, methods, future direction**

Vivek introduced the concept of canopies and its place in history from early society to the present scientific endeavors. Early access techniques such as climbing, use of monkeys were discussed. Early scientific curiosity and collection were shown to use these techniques. The development of technology improved access and scientific curiosity led to research. The various advancements such as binoculars, telescopes, photography were illustrated as proxy tools. The development of towers and walkways was traced and their contribution to the furthering of canopy science was explained. Rope access techniques were discussed. Canopy cranes and walkways from various temperate and tropical forests were shown. Lighter than air platforms such as the 'canopy raft' and the "hornbill" were also described. Low tech access and high tech methods were compared and contrasted so the participants could decide which methods would be suitable for their areas of research. Access facilities for a regional canopy research facility were also discussed.

## Appendix 4

Photographs of the workshop (All captions in clockwise from top to bottom)



FIGURE 1 DR. SOUBADRA WELCOMING THE PARTICIPANTS; DR. DOYIL GIVING AN OVERVIEW OF THE DAYS EVENTS; PARTICIPANTS DURING THE WORKSHOP



FIGURE 2 MR. VIVEK PRESENTING ON BIRDS; DR.GANESH PRESENTING ON CLIMATE MONITORING



FIGURE 3 MR. SESHADRI PRESENTING ON FROGS AND DR. SOUBADRA SUMMARIZING THE PROCEEDINGS





FIGURE 4 MR. VIVEK DEMONSTRATING CANOPY ACCESS USING SINGLE ROPE TECHNIQUE AT GK VK





FIGURE 5 MR. TAMIZALAGAN AND SARAVANAN DEMONSTRATING CLIMBING; PARTICIPANT TRYING CLIMBING



FIGURE 6 PARTICIPANT ON THE TREE





FIGURE 7 THREE GROUPS ENGAGED IN GROUP DISCUSSION AND ONE MEMBER OF THE TEAM PRESENTING THE IDEA FOR DEBATE





FIGURE 8 CLOSING SESSION AND GROUP PHOTOGRAPH





