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Climate Change Adaptation: A case Study of Bangladesh.

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1. Introduction of Forest Management of Bangladesh:

Himalayan-Hindukush landscapes with Tibet plateau as the topmost headwaters comprising permafrost, glaciers and lakes, comprise mega watersheds of socio-economic and ecological importance to sub-continental countries including Bangladesh. They are the sources of important perennial rivers, originating from glaciers and watersheds, which before flowing into Indian Ocean including Bay of Bengal lead to huge river basins and deltas like Bangladesh inhabit large but mainly improvised population with great socio-economic and ecological dependence on natural resources including forests and waters.

Bangladesh is a country of about 160 million people with the highest population density of the world. The fourth assessment report of the world scientific community, represented by the Intergovernmental panel on Climate Change (IPCC), demonstrates that human activities are responsible for global warming and global climate change .Bangladesh is one of the most climate vulnerable countries in the world and become more affected as a result of climate change. Floods, tropical cyclones, storm surges and droughts are likely to become more frequent and severe in the coming days.

According to recent forest resource assessment, 11% of the country's land mass is under forest cover (FAO 2010) but 90% of the people living in villages depend on natural resources (wetlands and forests). As a result, forest's of Bangladesh is under tremendous pressure. According to FAO, 2010 the country lost its forest cover on an average 0.17% per year between 1990 and 2010. Deforestation in Bangladesh is caused by the rapid urbanization, industrialization, agriculture expansion, shifting cultivation, lack of effective implementation of forest policy and laws in the forest land and resource management, etc.

Millennium Development Goal (MDG) country analysis revealed that Bangladesh has made good achievement in Social Forestry. Bangladesh is in the leading position in creation of coastal plantations which act as green shelterbelts to reduce natural disasters. Bangladesh Forest Department (BFD) has changed its management regime from "Revenue Generation" to "Participatory Conservation" through Co-management approach.

In an effort to stem deforestation and forest degradation, BFD has strengthened forest protection by revising the Forest Act of 1927. The parliament has approved the wildlife (Preservation and safety) act, 2012 on 10th July, 2012. FD has revised the Forest Act, 2000 and created the Social Forestry Rules, 2004 and again it has revised in 2009. BFD has taken initiatives for drafting Co-Management rules and Revenue sharing mechanism of social forestry.

2. Key issues to be resolved in response to main challenges from Climate Change Adaptation:

Climate change is a threat to global civilization. Bangladesh is amongst the countries most vulnerable to climate change. Our national growth and development is hindered due to floods, droughts, cyclones, salinity ingress and sea level rise. The Bangladesh government has given utmost importance on our national capacity to address negative impacts of climate change and that is why the government has developed Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009.

Bangladesh is first among the developing countries produced an integrated action plan like BCCSAP. The country has established its Climate Change Trust Fund from its own revenue and also the Bangladesh Climate Change Trust to implement the BCCSAP. Main objective of the fund is to increase capacity of local people and reduce vulnerability through implementation of projects. Several laws, guidelines and policies are in place for proper management of the fund.

These include:

- Climate Change Trust Act, 2010 (Act no 57 of 2010, 12 October 2010)
- Climate Change Trust Fund Policy (15 February, 2010)
- Guideline for preparing project proposal, approval, amendment, implementation, fund release and fund use for government, semi-government and autonomous organizations under the Climate Change Trust Fund (27 March 2012)
- Guidelines for selection of NGO/Nongovernment organization and project implementation under the Climate Change Trust Fund (9th March, 2010)
- Bangladesh Climate Change Trust (BCCT) Governing Rules, 2013 (24 January 2013)
- Bangladesh Climate Change Trust (BCCT) Employees Service Rules, 2013 (24 January 2013).

During the last four consecutive fiscal years(2009-2010, 2010-2011,2011-2012, 2012-2013) the government has allocated taka 2500 (Two thousand Five hundred) crore against Bangladesh Climate Change Trust Fund. According to Climate Change Trust Act 2010 the Trustee Board is authorized to approve 66 %of the fund for project implementation while rest 34 % is to be deposited in banks for future emergencies. An amount of taka 1155 crore has been already deposited in different bank accounts to meet the mandate of Trust Act 2010. During this period a total of 194 Projects (131 government and 63 NGO projects) have been funded with committed expenditure of taka 1513.59 crore taka from the BCCTF. So far 19 projects have already been successfully completed.

It should be noted that adaptation has been given the highest priority in the selection and funding of projects. Though our country contribution to GHG emission is minimal, only 0.3% of global emission, still we have shown our voluntary commitment through undertaking mitigation projects. Among the projects funded by BCCTF, 77% are adaptation based while 23% projects are contributing to the mitigation of greenhouse gas (GHG) emission.

The BCCTF funded projects are providing benefits to the climate vulnerable communities through providing cyclone tolerant houses in cyclone *Aila* affected areas, ensuring safe drinking water for women and children, seed production of stress tolerant rice-wheat-oilseed varieties, improving sanitation, construction of rubber dam for irrigation, repair and construction of embankments in coastal and river erosion prone areas, protection of river banks, improvement of drainage systems, excavation and re-excavation of canals and rivers, cropping system improvement in drought and coastal saline areas, land reclamation through construction of cross-dam, creation of coastal green belt to protect coastal areas, biodiversity conservation and reduction of greenhouse gas(GHG) emission. The Climate Change Trust Fund is also developing skilled human resources through awarding Scholarships for PhD and M Phil researchers on climate change issues.

BCCRF

Beside the BCCTF, Bangladesh Climate Change Resilience Fund (BCCRF) has been established with the support from Development Partners. These funds managed by the Governing Council in which government, development partners, civil society are member. Achievements of BCCRF are following:

- Development partners already allocated US$ 125 million (UK, Sweden, EU and Denmark);
- US$ 200 million under consideration by the various Development Partners;
- Two projects approved (Cyclone shelter for coastal areas and afforestation) and (Climate Resilient Participatory Afforestation and Reforestation Project).

REDD+

The country as part of its climate change mitigation and adaptation strategy prepared REDD+ Readiness Roadmap with technical support from UNDP and FAO in May, 2012 and approved the REDD+ roadmap in December, 2012.

Though Bangladesh has taken many initiatives still many issues should be addressed. The following issues can be addressed in Bangladesh for Climate Change Adaptation:

a) National Policy and Planning Documents with strong political commitment should be implemented for saving nature and natural resources.
b) Capacity of Forest Department, Environment Department and other major stakeholders (including law enforcing agencies) should be increased
c) Awareness builds up among all stakeholders and users of forest resources.
d) Reduce the dependencies on forest resources with creating alternative energy resources.
e) Transparency, Accountancy and participation should be assured in spending BCCTF and BCCRF funds.

3. Data Analysis and Modeling application:

Country level NFA was undertaken during 2005-07 with the technical assistance of FAO. The NFA was designed under “Strengthening capacity to generate quality information on forest resources” project of FD. Topographical sheets of 1: 50,000 scale maps produced by the Survey of Bangladesh were used to delineate the tracts. 299 tracts were identified and they were systematically distributed throughout the country at an interval of 15 degrees latitude and 10 degrees longitude. A globally harmonised classification system was developed and five major land use classes were identified for the inventory. 29 land use classes were identified for field data collection. Field data collection comprises multiple functions of forests and trees, covering their socio-economic, environmental as well as productive functions, associated with a wide range of variables and collected using different methods. A group of trained field crews collected the data. Wall-to-wall Landsat TM satellite imageries were used to identify the land use classes. Ground truth data were collected to classify the imageries. The country was divided into four parts and the images were accordingly mosaicked. These mosaics were used for visual interpretation of the land use types and on screen digitization was carried out to separate the classes. Accuracy was not checked for the classified images. With the technical assistance of SPARRSO, RIMS Unit of BFD was engaged to generate the land uses of Bangladesh. On the basis of GIS the country was divided on 300 plots and each plot had 4 subplots.

Other than NFA, BFD has an experience on carbon inventory on SRF and 6 other Protected Areas (PAs) under the USAID-funded IPAC project during 2010. For these carbon inventories, a Tier 3 approach (IPCC guideline) was considered. The carbon inventory methodology followed a similar sampling design and data collection methodology that was used in forest inventory of 1995 for the forest. Systematic sample grids and a clustered plot composed of five circular subplots were employed for data collection.

A case study for Community based Adaptation to Climate Change through Coastal

1. Afforestation:

Community based Adaptation to Climate Change through Coastal Afforestation is a joint initiative by the Government of Bangladesh (GOB) and United Nations Development programme (UNDP). The $5.823 million project is being implemented by the UNDP under Least Developed Countries Fund (LDCF) of the Global Environment Facilities (GEF) to reduce climate vulnerability it four coastal districts - Barguna, Bhola, Noakhali & Chittagong and considers its future in the rest of the country. The project duration is from July, 2009 to November, 2013. Since 2009, the pilot project has given 33,770 landless people (out of which 20,262 are male and 13,508 female) included in afforestation programme as beneficiaries as well as day labourers on the basis of cash for work in coastal districts access to otherwise unusable government lands to grow fruit, vegetables and fish. It is also attempted to reduce greenhouse gases and protect the land and people from further storms and erosion by planting new mangroves species along the coast.

2. Result and discussion:

The project enhanced resilience of coastal ecosystems through increasing forest coverage and creating livelihood diversification practices to vulnerable communities. Multiple social, ecological and institutional drivers which are related to reducing coastal vulnerability have been well-integrated in the project interventions. The significant features of the pilot project has opened innovative land management and livelihood diversification, social equity through ownership, capacity building of diverse stakeholders, and access to local government supports and services. Some of the key results of the project since inception to current observations have been summarized in this report.

3. Resilience of Protective Ecosystems

Coastal afforestation through mangrove afforestation in more 6,000 ha of newly accreted lands has improved continuous land stabilization capacity which is important for maintaining protective green coverage in the coastal areas as well as securing the lives and livelihood of local communities. Model plantation with introducing 10 new mangrove species in the existing gaps of coastal forests ensured response diversity of the species to thrive and continue functions in changing climatic shocks. Compared to monoculture plantation and facing lower regeneration trend in the existing coastal forests, the new species diversity is well-deserving and potential to highly dynamic bio-physical characters of coastal areas. The project covered 95 ha with model plantation and involved 143 coastal families. The innovative model plantation in the project provides policy impetus for understanding fast and slow effects of extreme events in coastal areas. This type of plantation approach enriched plant density per unit area contributing to reducing wind velocity, tidal surges and other climatic events and ultimately increase the resilience of protective ecosystem. Long-term spatial and temporal risk management for mangrove sustainability and protection capacity of coastal communities is now incorporated by different types of afforestation interventions of this project.

Figure 1: Mangrove afforestation in newly accreted coastal lands

Figure 2: Model Plantation

Figure 3: Mound Plantation

Mound and dyke plantation also reclaimed for innovative use of unused coastal lands to accommodate non-mangrove species in salinity dominated coastal belts by involving local communities. It also leads to increase species heterogeneity in coastal landscape with improved functional diversity to manage risks in coastal areas. As of today, 112 ha of dyke plantation has been targeted, out of which 40 ha is completed by involving 320 families while 72 ha is now underway. Hence, overall 896 families are expected to be engaged in the dyke plantation. The project covered 332 ha mound plantation by involving 554 coastal families under benefit sharing approach. The project provided income opportunities through cash for work to 12, 371 coastal people in afforestation interventions for nursery bed preparation, seedling raising, plantation and maintenance.

Important to mention that more than 3400 coastal households are currently involved as long-term beneficiaries of the strip plantation in four project sites. Thus the project ensures not only the resilience of protective ecosystem, but also protect critical infrastructure of the coastal areas including embankment and roads through community engagement and benefit sharing approach. As a result, the project enhanced resilience of coastal ecosystems and impacted particularly in two ways contributing to both adaptation and global mitigation efforts. With a total of 6372 ha of coastal afforestation, the project made mitigation arrangements to absorb more than 63, 7200 tons of carbon annually.

4. Enhancing resilience of coastal communities through livelihood diversification

Innovative land use technique

The project provided innovative land uses and diversification of livelihood practices over traditional income generation sources in coastal areas. The multi-level resource management practices under the project support, secured recurrent income generation options to coastal households which are subsequently important for short-, mid- and long-term economic gains for increasing adaptive capacity. Restoration of coastal fallow lands under the project for community based resource generation in ditch and dyke structure has created new ownership sense among the beneficiaries. Access to land with improved resource management practices secured seasonal food production and income.

Figure 4: Multi-level resource generation practices

Table-1: Intervention-wise annual income and beneficiary groups of Triple F model

Beneficiary Group*	Household income before project interventions	After Agriculture interventions		After Fisheries interventions		After Livestock interventions	
		Income (BDT)	Beneficiaries (%)	Income (BDT)	Beneficiaries (%)	Income (BDT)	Beneficiaries (%)
A	<2000	500 – 3,000	23.08	500 – 5,000	6.82	500 – 2,000	38.64
B	2000-3500	3,001 – 5,000	30.77	5,001 – 10,000	65.91	2,001 – 3,000	31.82
C	3500-6500	5,001 – 10,000	38.46	10,001 – 20,000	25	3,001 – 6,000	27.27
D	6500-10000	10,001 – 15,000	7.69	20,001 – 30,000	2.27	6,001 – 9,000	2.27

*Groups were categorized based on baseline income of each beneficiary family

Marginalized coastal people who have either only homesteads or landless or less capable to cultivate traditional agriculture or fish, are getting the innovative adaptation practice as significant way for their household food security, additional income and subsequently reducing vulnerability. The ditch and dyke is currently benefiting 320 coastal families and more 256 HHs are now underway to be involved through Forest, Fish and Fruit (FFF-Triple F) model. Each family is producing different vegetables on their dykes in two seasons which secures their household food and income generating up to BDT 20,000-25,000 from selling of vegetables (Table 1).

Fish cultivation in the ditch system is providing household protein sources and income for poor households in coastal areas. The rainwater harvesting creates freshwater fish cultivation and irrigation for extended fish culture throughout the year. Though coastal areas are dominated by fishermen groups, with changing extreme events, most of the people are losing seasonal fish catch. Each family is producing 400-500 kg of fishes annually from own ditch which secures their household protein and additional income after consumption. Within only six (6) months of project supports, a family generates at least BDT 20,000-30,000 from selling of fish (Table 1). Involved each coastal family also generated incomes from poultry rearing with improved duck varieties. Currently, each family is getting 900 eggs from 5 ducks annually supported by the project. It means that they are generating BDT 4000-9000 from duck rearing which increased household income of the beneficiaries.

5. Modern aquaculture practice

The project has benefited coastal people through improving knowledge and technical capacity for fish cultivation in their homestead ponds. 64 coastal families participated in improved aquaculture training and received, with technical assistance, the Fisheries Department trained introduced multi-layer fish culture to coastal families which has increased fish production in the project sites. The participant families developed skills on pond preparation, appropriate quantity of fingerlings for pond, precaution measures of cultivating different layer species and pond maintenance. After the project interventions, each beneficiary generated from at least BDT 40,000 up to 1, 50,000 from the fish cultivation (Table 2). As a result, the average income of the families increased up to BDT 80,000 while these families could only generate not more than BDT 35, 000 in their traditional pond culture.

Improved Agricultural Practices

Salt tolerant and high yielding rice variety

Salt tolerant (BR 47) rice demonstration under CBACC-CF project has been found as a potential crop for coastal areas. Since introduction in 2010, the variety increased rice production and land coverage in consecutive years. The rice production technique improved the farmers' capacity to use of fallow lands which are previously unutilized periodically and salinity affected in coastal areas. Compared to other local varieties, the new variety has yielded three times more rice production in project areas. In one of the project areas-Naltona of Barguna District, only 8 ha of lands were cultivated with the variety in 2010, and subsequently rice production increased in 50 ha in 2011. In current year, it has expected that not less than 500 ha of lands will be cultivated with the salt tolerant varieties. The high yielding capacity of the rice variety secured household foods for coastal people in particular to manage climate change related risks and lower production seasons with the traditional agricultural cropping practices. As most of those families could not own farming lands or produce crops due to water logging and soil salinity, aquaculture practice secured their annual economic capacity. The significant benefit return from the advanced aquaculture appreciated people's further engagement and investment of time and labor in the pond fish culture.

Table 2: Household income change after project interventions for fish demonstration

Beneficiary Group*	Baseline income before project (BDT)	Changes in Household Income after Fisheries Intervention (BDT)	Percentage of beneficiaries
A	25000-30000	30,000 – 50,000	18.75
B	30000-35000	50,001 – 80,000	50.00
C	30000-40000	80,001 – 120,000	12.50
D	>40000	120,001 – 180,000	18.75

* Groups were categorized based on baseline income of each beneficiary family

Improved livestock rearing

The project introduced improved livestock including poultry in four project sites. Total 470 coastal families received training on cow and poultry rearing and input support. Implementing Upazila Livestock Department provided technical support and capacity building training in the project areas. The participant beneficiaries developed their skills on improved livestock rearing with additional measures for increasing production, pre-caution on seasonal disease management and eventually contributing to household income generation. Compared to local varieties, the introduced poultry varieties are high yielding in terms of egg production and benefiting the beneficiary families for protein and additional income.

Figure 5: Shifting land use of single to double crop with salt tolerant rice variety

The significant benefit of the rice farming technique was maximizing land uses while taking account of seasonal risks in coastal areas. Due to changing precipitation events followed by water logging risks, the traditional rice cultivation is increasingly becoming difficult in coastal areas. To that point, coastal farmers have increased their capacity to reduce salinity risks by cultivating the rice variety which consequently provides opportunity for double cropping. To most of the coastal farmers in the project areas, double cropping with the new variety secures households foods and additional income even traditional rice production is not possible.

Salt tolerant and high yielding fruit variety

Under CBACC-CF project, introduced fruit varieties Guava and BAU Kul have shown a new way of rational land use for homestead horticulture in coastal areas. Mostly using fallow lands and dykes around homesteads for the fruit cultivation is providing seasonal food and income to poor families. The fruit varieties are new of these kinds in project sites which have been found highly demanding for household food consumption and local market. Since the project training and demonstration support of the Department of Agriculture Extension Services, beneficiary households started harvesting of the fruit varieties two times in a year.

Each beneficiary generates BDT 10,000-15,000 from selling of the fruit varieties. The income has secured additional economic benefits for marginalized coastal families who have limited livelihood options. While agricultural cultivation is not possible due to water logging and soil salinity, the fruit variety provide financial insurance for particular lean time like onset of monsoon with delayed agriculture and peak of dry season having not enough work in the area. Due to its cultivation on raised dyke of fallow lands around the homestead, the variety maximizes land uses and avoids water logging risk and salinity during inundation time.

While the livelihoods of coastal people are increasingly threatened with changing weather and extreme events, the diversified use of homestead areas motivated them to maximize their land uses and secure household food security. The high yielding quality and size of the Guava has raised local people's acceptance to cultivate the varieties. From current experience, the beneficiary estimates that each Guava fruit weighs 600 gm and total production reaches to 8-10 kg per plant which is higher than local variety. Guava serves as substitute of apple in the vulnerable coastal areas and locally known as poor man's fruit. Due to high pectin content, the fruit variety can be easily used for the preparation of jam and jelly. It contains high Carotin, vitamin C, B1, B2, Calcium, Phosphorus, Iron and may serve against different type's diseases resulting from climate change impacts in the coastal areas. Notably people are highly likely to multiply their benefits from the variety through additional grafting of the best plus tree selection.

6. Capacity building and strengthening community-institutional linkage

The project made a database of existing government officials working at upazila and district level in four project sites. Proper understanding on climate change risks, impacts and CBA measures is limited within local and district level institutions. Climate change concerns are relatively new and hence upazila and district level training programmes have been considered as one of the priority measures to fill up the capacity gaps. The project has developed briefing note, fact sheet, two brochures and training modules as immediate science of capacity

Figure 6: High yielding fruit variety improves household food security and nutrition

building materials and organized 12 district and 24 upazila level training workshops.

Figure 7: Capacity building of local govt. institutions

Government officials of implementing local institutions including BFD, BFRI, DAE, DoF, DoL identified their roles for providing information on climate changes and service delivery to the coastal communities. Government officials comprising 151 at district and 337 at upazila level enhanced their capacity on Coastal Afforestation, Livelihood Diversification and Early Warning Communications in four project sites. Eighty district officials undertook exposure visit from one project site to other sites to enhance knowledge on community based adaptation activities. During exposure visit, local govt. officials have showed their interests to extend the project activities in other coastal areas of Bangladesh and to disseminate information on climate resilient advanced livelihood varieties in respective areas and incorporate the current actions within local development structures.

Thirty Lesson Sharing dialogues for 240 government officials are now underway. The lesson sharing of the project experience provides showcase of the best practices to different govt. officials for identifying their strength and weakness in implementation of the activities and eventually taking integrated measure to sustain the project benefits in the long run. The Co Management Committees (CMC) is actively representing different implementing government partners, local community, elected members and civil society in implementing project sites. Some of the key activities, the CMC already undertook: to coordinate activities and draw feedback of different implementing institutions; take necessary actions in response to effective service delivery of the govt. departments.

All above mentioned activities have been successfully conducted with the GoB officials in order to incorporate climate risk reduction and CBA measures in their coastal area management frameworks. Apart from these, the project has developed 8 training modules for project beneficiaries and all participant beneficiaries were involved in skill development training programmes by the respective implementing partners. Besides, community awareness training programmes by involving 600 local communities is now underway in order to create better understanding on climate change, adaptation and CBA measures as well as to strengthen linkage between local institutions.

7. Mainstreaming women's role in adaptation

CBACC-CF project has focused on women involvement and multiplying their roles in local adaptation decision making, resource planning and implementation process. In each project site, women beneficiaries participated in training measures for addressing climate change related risks in household livelihood security and identified their valuable roles and skills required for empowering in the long-run. Until recently the project involved 6,389 women in forest, agriculture, aquaculture and livestock based training, demonstration and income generating activities. Total 5543 women beneficiaries received training on climate change related risk management and diversified livelihood practices including mangrove and

non-mangrove nursery management, dyke plantation, agriculture and advanced aquaculture in project sites. Women beneficiaries learned nursery preparation and plantation, diversification of homesteads crop cultivation and maintenance activities including pest control, use of compost and weeding.

Box 1: Triple F based women's adaptation practice

The Triple F based adaptation initiative of the project has opened unique opportunity to mainstream women development through providing land entitlement for resource generation in coastal areas of Bangladesh. The ownership arrangement has brought positive transformation among community for protection of women's social rights and valuation of their skills for household risk management and ensures economic well-being for long-term adaptation. At least 42 percent of the beneficiaries are women involved in the livelihood model, currently playing active role to direct resource generation for households in the project areas. Women representatives from locally elected representatives raised their voices in Co-Management Committee, decision-making and resource distribution. Skill development training of women beneficiaries along with male participants improving their knowledge and understanding on climate resilient measures to contribute to alternative household income, mangrove nursery raising and plantation.

Total 656 women benefited from afforestation activities of the project through their short-term income (cash for work) and long-term agreement with Forest Department for benefit sharing from harvested timbers after a certain time period. Skilled women beneficiaries contributed to their household income generation and adapt to particular weather risks in climate change affected coastal areas. Currently, 394 women are directly engaged to diverse livelihood demonstration activities including agriculture, fish cultivation and livestock rearing. The project sensitized women's role beyond traditional household activities to improve their additional understanding of climate change and disaster related knowledge in regular livelihood practices. While women participants enhanced their capacity, they have access to information and resources from local govt. institutions. Women beneficiaries are now capable to claim additional support from service delivery government departments and taking advanced measures for livelihood protection and ensuring household income security.

Figure 8: Women have direct access to land rights and resource generation practices

Figure 9: Empowering women through improving their resource generation capacity

8. Success Evidences

Case study #1: "I had sufferings of food. Now accessing to this land, I have learned how to feed my family not in a day, even in the next months with this project support" *Masura*

(32 years), a mother of two children living in the outer slopes of Sonatala Coastal Embankment of Barguna expressed her distress living in such way. She had no cultivable lands and only her husband maintained family by small fishing boat for 3-4 months and sold labor in the rest time of a year. Her family was severely shocked in 2007, when the terrible cyclone "Sidr" smashed her little shelter and last means of surviving "river boat". Her husband lost fishing and sometimes, her family passed 3-4 days without food and only survives by eating green banana. One of her children could not tolerate the food crisis and left home and never came back. She received only relief money BDT 3000 for making house and food which was meager to her. At that time, she brought a loan from local NGO for rearing a cow. The cow died after 4 months and she fell under debt. In the meantime, her husband missed the fishing season and remained unable to earn from selling labor in deep sea boat. All these agonies of Masura quickly swept away after her joining in the CBACC-Coastal Afforestation project. She got access to land right without loan for the first time experience in her life. By getting training for different livelihood support, she started producing agriculture vegetables on the dyke and duck cum fish rearing in the ditch of the land. In only three months, she saved BDT 12000 from selling vegetables after family consumption. She also earned BDT 20,000 from selling fish and eggs of duck supplied by the project. She revolved her saved money to build a boat for her husband, buy rice and paid to school for education of the only child. She is waiting that her income will increase when fruits will ripe and trees become harvestable in next years.

She found access to land right is entirely an ownership opportunity to her that she could do something. Now, Masura is hoping a better living future for her family as they have no food and income shortage. Her child get in school education and she plans to buy a land for rice cultivation. Her confidence is more than expectation that she has been selected as one of the community leaders.

Case study #2: Hasan Gorami (Barguna) used to sell his labour as a fisherman on big boats during the fishing seasons to support his family. "When I used to be a fisherman on the rivers, it's not like I was out there all the time. I used to come home, sit and do nothing. Now when I come back, I maintain this ditch and dyke and this helps me earn extra money." The 29-year-old says he used to grow trees but most of them died. "I grow *Korolla*, *Mishty* kumra, *Chal* kumra, *Jali* kumra, lau, shim, and different types of fish – *Rui*, *Katla*, *Silvercup* and *Telapiya*." He has already earned Tk 25,000 from selling fish and vegetables and expects to double this by the end of the Bengali year.

Figure 10: Diversification of household income

Case study #3: Zakir Hossain (30 yrs) is living at Gazi Mahmud village of Barguna Sadar Upazila. The Cyclone Sidr has displaced his family and recently he has made his new home along the embankment. "I have a piece of land which is not suitable for farming. I can cultivate only single crop and even some years this remains vacant and insufficient for regular household food and income. I prepared the pond with the support of the CBACC-CF project. I learned to maintain the actual depth of water in the pond, for the first time I knew how to apply fertilizers and lime in appropriate quantity and time for pond preparation. Cultivating fish with different varieties and maintaining numbers and food, I harvested fishes of good quality in six months".

He generated BDT 60,000 from fish cultivation after his regular consumption in six months. In current year, Zakir excavated another small pond around his homestead which

he understood to be much more profitable as he adds more fingerlings by own cost apart from project support. “While I am cultivating fish in the ponds, I have now different seasonal vegetables and scaffolding around the pond dyke and poultry and duck inside it. My incomes will be manifolds, as I continue to cultivate multi-layer fish species with standard rules”. The initial financial and technical support of the project enhanced skills of Zakir and handful benefit of the project raised his confidence to safeguarding own future in highly disaster prone coastal areas.

Case study #4: Shaheena Akther, who supports a sick husband and three daughters, is one of the 42 percent of women beneficiaries of the project in Barguna. She says, “I was able to make Tk 12,000 from just selling the vegetables on my scaffolding and around Tk 10,000 from other vegetables after taking what I needed for my own family. I'm expecting to make Tk 40,000-50,000 from selling the fish at the end of the year.” Shaheena is a unique example of transformational approach by the project. She says, “The project is really benefiting my family because I don't have to buy fish and vegetables for my family's needs and with the money I earn from selling the rest, I can buy medicines and afford my children's education fees.”

9. Key Achievements

The project has strong result oriented achievement in terms of creating climate resilient protective ecosystem and livelihood for the coastal communities. The project has been enhancing adaptive capacity of involved coastal families through increasing household food production and income benefits from the livelihood diversification. Some of the key project success already got momentum and recognized across national and international decision-makers, donors and Medias:

The project was awarded “Earth Care Awards 2012” on 14th September, 2012 organized by “the JSW- the Times of India” at New Delhi for “innovative Fish, Forest and Fruit (FFF-Triple F) model and providing access to government lands for the landless in coastal districts of Bangladesh in India”, in the category of “Community Based Mitigation and Adaptation to Climate Change”.

The GEF Secretariat recognized the project through selecting two (2) projects including the CBACC-Coastal Afforestation from the Asia-Pacific region for presentation in the “Adaptation Practioner Days, side event organized by the GEF in collaboration with IIED, JICA, IDRC and CDKN, held at CoP 18 Doha.

Successful evidences of the project field activities have already been covered by national and international printing and electronic media to draw attention of decision-makers on the importance of the innovation practices towards adaptation and global mitigation. The private satellite TV channel-71 telecasted special bulletin on 17/10/2012; The Daily Star, leading English newspaper published news “Bangladesh climate project gets Earth Care Award” on 31/08/2012, and special report titled “Rising from Barren Lands” in the weekend magazine on 26/10/2012; The Dhaka Courier published report titled “A wall against the sea” on 19/10/2012; and The Power and Energy, the fortnightly magazine published news on “Climate project wins Earth Care Award 2012” on 01/10/2012. g forest coverage and creating livelihood diversification practices to vulnerable communities. Multiple social, ecological and institutional drivers which are related to reducing coastal vulnerability have been well-integrated in the project interventions. The significant features of the pilot project has opened innovative land management and livelihood diversification, social equity through ownership, capacity building of diverse stakeholders, and access to local government supports and services. Some of the key results of the project since inception to current observations have been summarized in this report.

10. Looking Ahead

The project approach and adaptation techniques are unique in coastal areas which draws quick response of local community and diverse stakeholders in successful implementation process. Integration of climate change related risks and adaptation in land use and long-term coastal development strategy keeps the project up to significant achievements. Drawing on current contribution of the project to protecting and conserving coastal forests and developing co-benefit regime of local communities to adapt to changing climate, there is highly likely to sustain the activities for the wellbeing of the coastal ecosystems. Coastal afforestation with model plantation techniques has enhanced institutional capacity of FD and additional areas will be covered with the forestry approach in response to sustaining mangrove vegetation for protection of coastal ecosystems. The project also provided emergency responses for post-disaster rehabilitation and recovery of mangrove plantation and nursery beds.

Each beneficiaries of the project improved self-capacity received new livelihood knowledge and ensured resource generation in the land use model and diversification techniques, while the project brought institutional measures for continuous support of local government department to provide additional services to the communities. To maximize the economic benefits of the goods produced in the model seasonally and annually, the project is currently undertaking initiatives to promote local market shed for the beneficiaries. Due to remote social settings of the beneficiaries and lack of inadequate access of produced goods in local market, the proposed market shed in near distance of the community will provide opportunity for bridging with local business stakeholders.

With the support of the project, coastal land use policy is currently under review to delineate land ownership and incorporate climate change related in dynamic coastal zone management. The innovative livelihoods with mangrove afforestation through restoration of fallow lands and providing ownership of landless households have eventually got momentum across local, national and international stakeholders. For example, the grant money from the Swiss Agency for Development and Cooperation (SDC) and the Embassy of the Kingdom of the Netherlands (EKN) has been incorporated in the revised project document to extend the project activities.

Case Study - Fiji Islands Forest Adaptation

1. Introduction

The roles and responsibilities of the Fiji Islands Forestry Department are the formulation and implementation of policy initiative and the administration of the regulatory framework to facilitate Sustainable Forest Management (SFM) in all types of forest. The vision of the department; Our future generation inherits a prosperous & enhanced Forest sector, this is to enhance the improving livelihood through SMART policies on sustainable forest resources.

SMART policies:
S – Simple
M – Measureable
A – Achievable
R – Realistic
T – Timely.

The first Fiji Forest Policy for Fiji was approved by the Legislative Assembly in 1950. Subsequently, the Forest Act was endorsed in 1953 to give legal effect to this policy. In 1988, the Government of Fiji initiated a Forest Sector Review with a comprehensive analysis of the sector and reformulated sectoral objectives, strategies and development programmes as a basis for the development of the forest sector. Although the Review did not result in the formulation of a new forest policy, it initiated changes in the forestry legislation. The Forest Act was reviewed in early 1990, and in 1992 replaced by the Forest Decree, which simplifies, clarifies and updates its preceding legislation taking into account the need for sustainable forest management and changes in the policy environment.

Since the elaboration of the first forest policy, the perspectives on the role of forest for the society have changed and broadened considerably as a consequence of social, economic, environmental, cultural and political changes. In addition, as a result of the international forest-related discussion initiated by the 1992 UNCED conference in Rio and continued by the InterGovernmental Panel and Forum on Forests (IPF and IFF) and its successor the United Nations Forum on Forests (UNFF), the contribution of forests to the international conservation functions has become an important part of the national policy discussions.

Actually, there is a rising pressure on the forest resources by the increased demand for timber and other forest products and the ongoing conversion of forest land for other uses. Timber has become an important export commodity with the Government support for forest industry development. On the other hand, landowners aspirations for increased benefits from the use of their land need to be taken into account as well as the potential of forestry activities for improved livelihoods predominantly in the rural areas. With these challenges, today, the management of Fiji's forest resources as a national heritage in an integrated and sustainable manner to optimize their environmental, economic, social and cultural values has become an urgent necessity.

In 2003, the Forestry Department stated the "…need to redefine Forest Policy to reflect the adoption of appropriate sustainable forest management system to ensure the full and successful implementation of current strategic directions and landowner aspiration on the management of their resources."

This need has been addressed by the elaboration of the new forest policy in a process that involved wide stakeholder consultation at the national and de-centralised level. With endorsement of the Rural Land Use Policy by Cabinet in 2005, the new Fiji Forest Policy can

be put into an adequate policy framework for sustainable land use and elaborate on details to be addressed by a comprehensive sectoral policy.

The future development of the forest sector in Fiji must be firmly founded upon the sustainable utilization of natural resources and preservation of a healthy environment. To be able to contribute to Fiji's sustainable development, the forest sector must be based on sustainable forest management principles and direct its prime attention to improving the livelihoods of rural landowners. There is an urgent need to overcome the sector's current focus on timber production and to widen the perspective to a balanced attention to the multiple economic, ecological and social values of Fiji's forest resources.

Consequently, a **vision** for the future forest sector would comprise of:

• A permanent forest cover, including a protected forest area network, that provides the full range of ecological, economic and social functions for the local, national and global level;
• Forest management practices that provide high value goods and services by effective planning and utilization techniques while soil erosion and siltation in vulnerable watersheds are substantially reduced, balanced water supply is ensured, pollution avoided, and valuable biodiversity preserved;
• A thriving forest industry that provides stable employment and contributes significantly to national economic development by value-added processing and exports of quality products;
• Greatly improved rural livelihoods by substantial involvement of landowners and communities in sustainable management of their forest land and in forest -based industries; and
• An institutional framework that encourages investment in sustainable forest management and forest industries with a forest administration that delivers high quality services that are widely sought and paid for by its clients.

To achieve this vision, the nation is obliged to address the following **broad strategies** (*cf* Rural Land Use Policy):

• Protecting the integrity of ecological systems and biodiversity
• Reducing the rates and areas of land degradation
• Maintaining and extending natural forest and forest plantations cover
• Rehabilitating areas of degraded natural forest remnants
• Preventing and controlling pollution
• Promoting sustainable forestry and agroforestry systems
• Fostering the involvement of landowners in the management and utilization of their own forests
• Implementing international environmental accords to which Fiji is signatory

By 2020, the following **milestones** should be achieved:

•Overall national land use planning controls natural and plantation forest areas and protects them against degradation or uncontrolled conversion.
•The clearing of forested land is regulated under the Rural Land Use Policy to ensure the area of permanent natural forest cover in Fiji exceeds 40% of the total land mass including a substantial part set aside for conservation and protection.
•A comprehensive national system of nature reserves, parks and protections forests, including mangroves, is established and managed.
•At least 3 Management Plans for natural forest areas are in place for trial implementation.
•Unsustainable forestry practices have ceased.

• The Fiji Forest Harvesting Code of Practice is universally applied and enforced, and a revised National Harvesting Code of Practice incorporating silvicultural prescriptions and reduced impact logging measures drafted and placed under trial.

• Plantation areas harvested for timber production are completely reforested, with a projected productivity and economic value no less than the current level.

• Effective basic requirements established for the proper management of a forestry business by landowners, including advice on procurement of finance and the management of funds.

• Fiji will have established an industrial structure and infrastructure that can deliver forest products to stringent export quality standards with strong value-added element from timber processing for high end-value niche markets.

• Mechanisms for financing forest conservation activities in operation.

• Appropriate elements of the Forestry Department are commercialized with increasing generation of revenue to assist fund the cost of Government forestry activities.

2. Policies

Small islands, whether located in the tropics or higher latitudes, have characteristics which make them especially vulnerable to the effects of climate change, sea-level rise, and extreme events (very high confidence). Sea-level rise is expected to exacerbate inundation, storm surge, erosion and other coastal hazards, thus threatening vital infrastructure, settlements and facilities that support the livelihood of island communities (very high confidence). There is strong evidence that under most climate change scenarios, water resources in small islands are likely to be seriously compromised (very high confidence). It is very likely that subsistence and commercial agriculture on small islands will be adversely affected by climate change (high confidence). *IPCC 4th Assessment Report, 2007*

The Fiji Islands like any other Small Pacific Island countries is also affected with the challenges brought about with climate change. There are issues of rise in sea level for the low-lying islands and change in seasons and weather. To address this issue the Forestry department has put in place a REDD+ Policy for climate change adaptation and mitigation.

"The Fiji REDD-Plus Policy is implemented within the framework of the National Forest Policy 2007 and contributes to the national Forest Sector goal: 'Sustainable management of Fiji's forests to maintain their natural potential and to achieve greater social, economic and environmental benefits for current and future generations'.

In supporting the National Forest Policy, the Fiji REDD-Plus policy will: 'contribute towards the development of a national carbon trading policy' (Section 5.1, National Forest Policy) and 'strengthen the capacities to facilitate access to international financing mechanisms such as opportunities in the context of the UNFCCC' (Policy field 6.6, National Forest Policy).

The Fiji REDD-Plus Policy is aligned to the objectives of the Fiji Sustainable Economic and Empowerment Development Strategy (SEEDS) and will strive to contribute to the overall sustainable development of the Fiji Islands, including poverty reduction.

NATIONAL FRAMEWORK FOR THE POLICY

The Fiji REDD-Plus Policy will be implemented through a Fiji REDD-Plus Programme which will involve the participation of all relevant stakeholders coming from various sectors and agencies. The Fiji REDD-Plus Programme aims to have Fiji achieve national REDD-readiness by 2012 and provide a framework to facilitate access to all available financing instruments for the REDD sector. The REDD-Plus Programme will maximise benefits arising from carbon and climate-related financial instruments in order to:

a) assist Fiji in retaining and enhancing the carbon in its forested landscapes;
b) assist Fiji in achieving core forest sector goals as defined in the Fiji Forest Policy,

including: a transition to sustainable forest management; reducing the loss of forest from the expansion of agricultural lands and other land use change; protecting indigenous forest areas of high cultural, biological diversity and ecosystem services value; increasing timber production from the plantation sector through afforestation/reforestation of non-forest lands (excluding wetlands/peatlands and indigenous palms); increasing agroforestry activities on non-forest lands (excluding wetlands/peatlands and indigenous palms); assist Fiji in achieving its strategic goals in land-based development and environmental management.

The Fiji REDD-Plus Programme will regularly review policy and technical issues in order to maintain alignment with ongoing international policy and technical development. The policy has also highlighted the safeguards to pilot project implementation.

3. Safeguards

The following will be ensured for all REDD-Plus initiatives and projects in Fiji:

i. protection of and respect for the knowledge and rights of indigenous peoples (as stated in UNDRIP and UNCSICH and other international instruments);
ii. full and effective participation of indigenous people and other relevant stakeholders;
iii. equitable distribution of benefits to rights owners;
iv. consideration of gender issues in all phases of decision-making and implementation;
v. no conversion of natural forests but will reward the protection and conservation of natural forests and their ecosystem services, and will enhance other social and environmental benefits;
vi. that these initiatives and projects complement and are consistent with the objectives of the Fiji Sustainable Economic and Empowerment Development Strategy (SEEDS) and relevant international conventions and agreements.

SCOPE OF REDD-PLUS ACTIVITIES

The following activities are eligible for inclusion in a national/sub-national/Project scale Fiji REDD initiative:

(a) reducing emissions from deforestation via forest protection and improved forest management;
(b) reducing emissions from degradation via forest protection and improved forest management;
(c) afforestation/reforestation;
(d) forest/energy sector linkages (biomass electricity generation);
(e) forest/agriculture linkages (biomass residue/biochar);
(f) combination linking afforestation/reforestation with REDD.

GOVERNANCE

Through the Fiji REDD-plus programme, a transparent multi-stakeholder governance structure will be developed. The governance structure will be capable of:

a) ensuring the participation and consultation of all relevant stakeholders in REDD-Plus activities;
b) delivering efficient and effective decisions;
c) enhancing donor and buyer confidence;
d) using existing structures and, where possible, modifying them to suit the implementation of the Fiji REDD-Plus Programme;

e) standing up to an independent, external, expert third party review.

4. Measuring, Reporting and Verification

The Fiji REDD-Plus Programme will establish a forest carbon measuring, reporting and verification (MRV) capability in line with the latest international good practice guidelines and guidance arising from the Intergovernmental Panel on Climate Change under the recognition that:

a) eligibility for participation in international carbon and climate-related financial instruments is dependent on establishing and maintaining an MRV system and capability for the forest sector at the national and sub-national scale;
b) such an MRV capability will provide benefits to other aspects of forest sector monitoring.

5. Pilot Projects

The Fiji REDD-Plus Programme will benefit from 'learning-by-doing' and will therefore include pilot projects designed to assist in building capability in the design and implementation of REDD-Plus activities.

6. Engagement and Communication

Effective engagement with regard to international policy and technical issues at the UNFCCC and other relevant international/ regional forums, agencies, and countries will be strengthened.

The Fiji REDD-Plus Programme will put in place an effective communication and awareness strategy capable of ensuring an efficient, effective and transparent flow of information:

a) among people at the national level (government, industry, non-governmental organizations), local communities, landowners and other stakeholders;
b) between and within government departments and statutory bodies;
c) among national and international bodies and forums to enable more effective international policy and technical engagement.

7. Training

The Fiji REDD-Plus Programme will develop an effective educational and training strategy capable of building policy and technical capacity.

8. Research

The Fiji REDD-Plus Programme will undertake research, where necessary and with the approval of relevant authorities, to enable the achievement of its goals.

The REDD+ policy was endorsed in January 2011, and has identified activities that needs to be done which listed National Carbon Inventory and global efforts to reduce greenhouse gas emissions; the socio-economic development of forest resource owners and local communities; relevant domestic legislation and policies and contribute to the implementation of international agreements, conventions and treaties that Fiji has associated itself with, signed or ratified; Fiji's efforts to conserve Fiji's natural forests and the valuable ecosystem services it provides and biological diversity and contribute to meeting Fiji's international commitments under the CBD (the Convention on Biological Diversity) and UNCCD (United Nations Convention to Combat Desertification).

9. National Forest Inventory

The Forestry department has conducted certain studies and analysis to manage its forest resources and such is the carrying out of its National Forest Inventory which to assess the quantity and quality of Fiji's remaining native forest through:

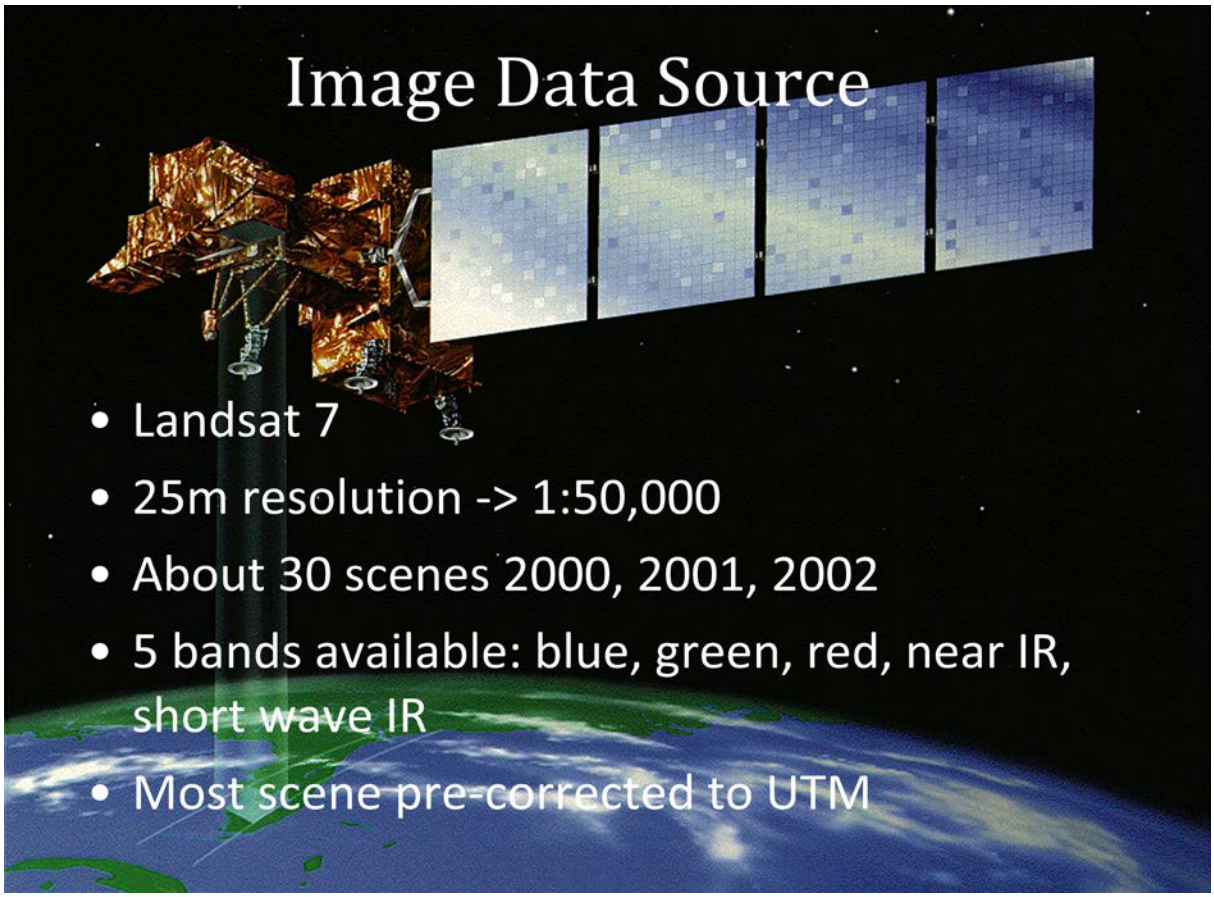
The identification and mapping of commercial forest areas
The identification and mapping of non commercial forest areas
The calculation of the remaining timber volumes in both forest types
Determining the annual allowable cut
Setting up of a Forest Monitoring System

The first phase of the inventory is to analyze the satellite images such forest areas are detected for the determination of random sample plots. There were only seven (7) islands identified for the inventory, such there are more than three hundred (300) islands in Fiji the seven island has more than 80% of the total forest cover for the whole country. The work was divided into phases; remote sensing and mapping of forest types/ functions; field sampling in selected forest types; forest maps 1:50,000, stand and stock tables for sampled strata, area and volume statistics.

The most recent National Forest inventory was undertaken in 2006 to 2007.

10. Remote Sensing and Mapping

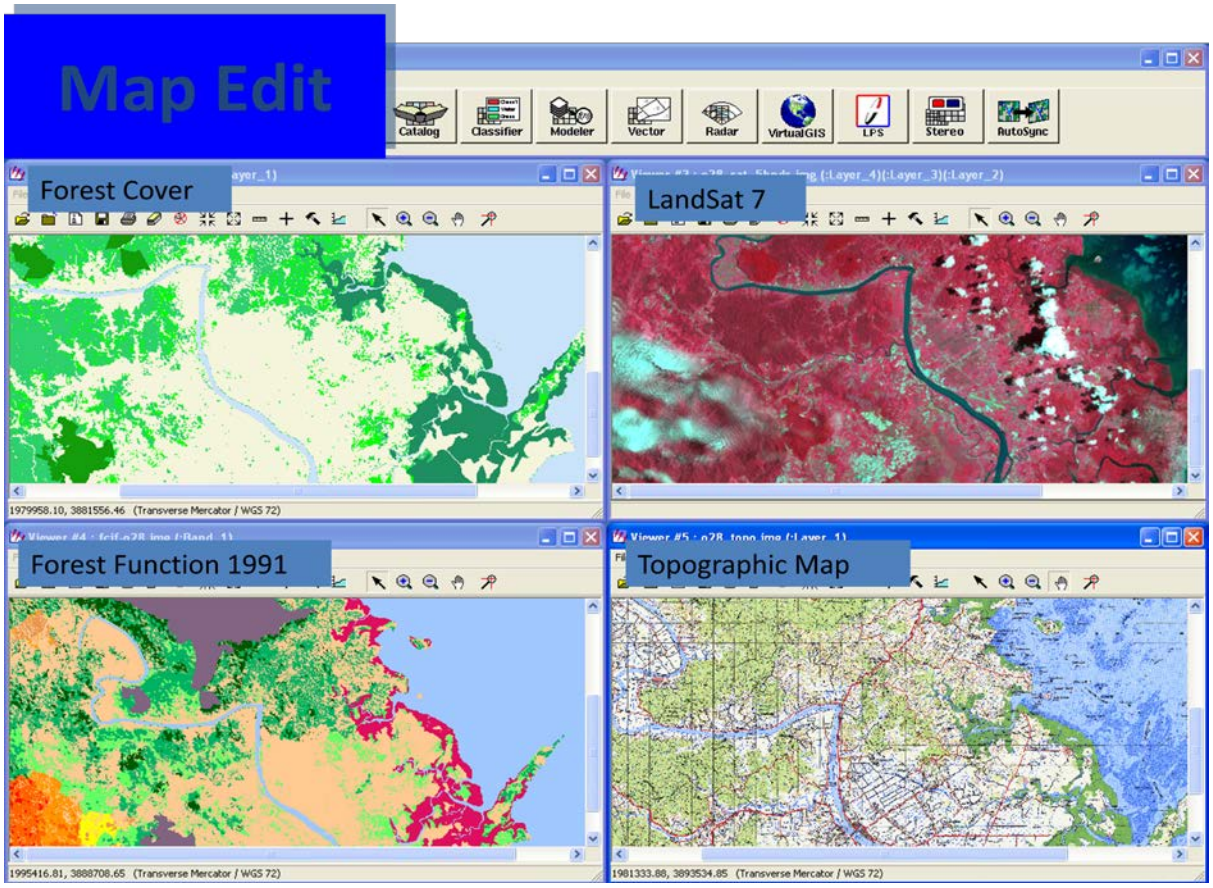
The analysis of the satellite images was something new; since the previous forest inventories were undertaken abroad such the completed maps and table were usually handed to the Forestry department. Most of these analysis was conducted locally with banking on local knowledge and experience as the main key.



One of the shortfalls is that there was not enough funds to purchase the more recent high resolution image at the time, such LandSat 7 of 2000 and 2002 was utilized for analysis.

About 30 scenes were selected, with those of minimal or zero cloud cover. There was little correction done to the images except for some atmospheric analysis due to haze cover that can affect some analysis.

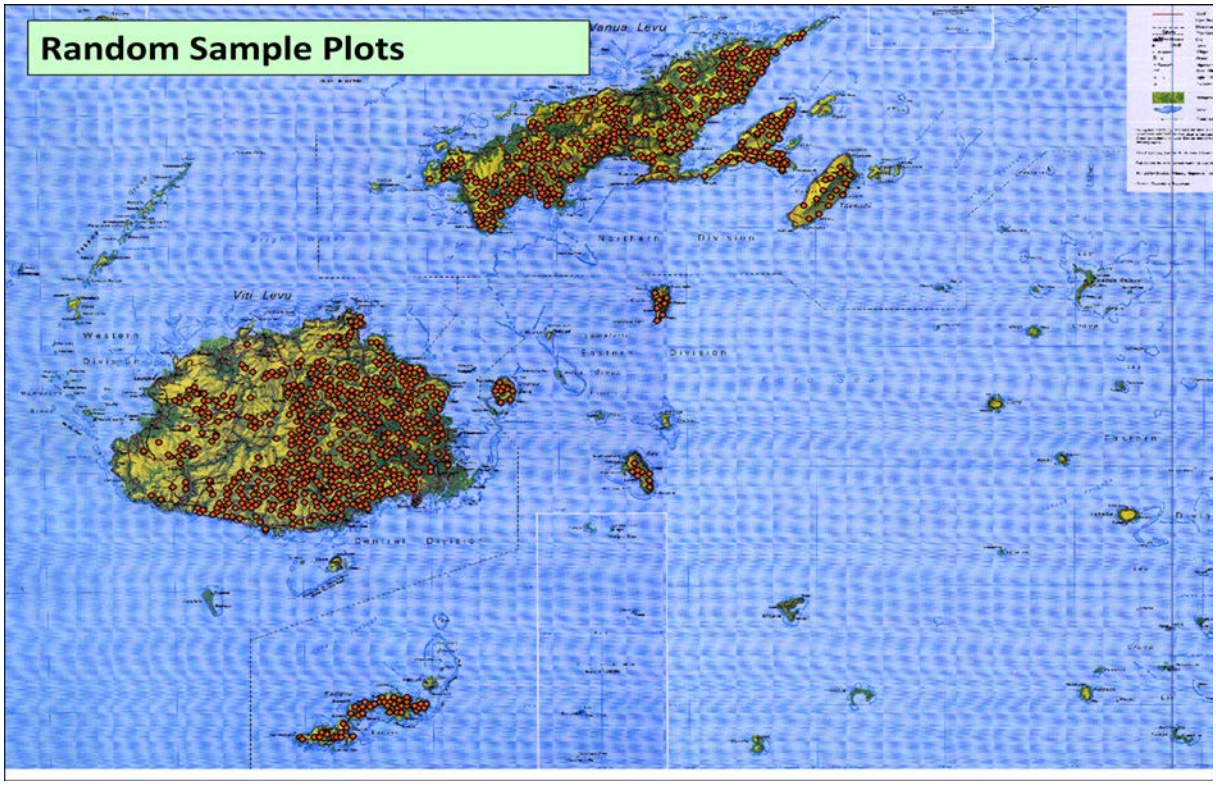
The first methodology on the images is to undertake semi-automatic classification for which the computer generates the coverage of the satellite images according to analysis and areas identified. There was image masking applied to the images; cloud mask, cloud shadow mask, water mask, mangrove mask, non-forest and plantation areas. The masking is to remove these areas from the image such it is left with Forest areas only. These forest areas are then further classified to determine the coverage.



For mapping purposes the viewers displayed the topographic map, previous forest function map (from the NFI of 1991) and the satellite image to enable accurate mapping of the forest area. The semi-automatic classification had some setbacks which is the creation of salt and pepper effects on the map, due to its classification that is determined by the computer and pixels.

The other option is to be change the methodology of the mapping to visual interpretation. The satellite images were calibrated to show contrast on all the scenes or images thus mapping is conducted after workshops and communication with the field teams on the ground. Mapping of the forest cover was depicted from the analysis and extensive mapping of areas which the operator see fit as being forest. There were extensive ground verification undertaken to ensure that the map has the most minimum mapping error of which more than 80% of the map were ensured to be correct. This is also pertaining to the fact the satellite images used were six to seven years outdated.

There were 1022 random sample plots distributed for the collection of information. It was distributed according to forest coverage and not due to area. The classification unit is in Provinces, which were later divided into islands.

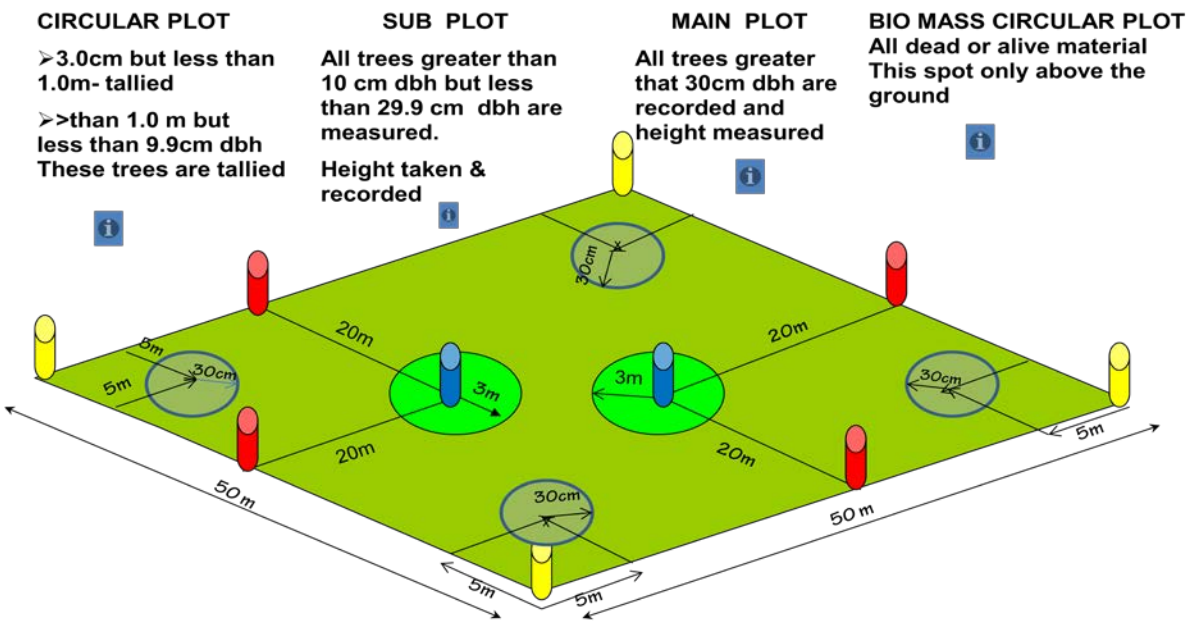


The fieldwork took approximately two years to complete. The maps had to be verified again due to data from the field. There were extensive verification carried out even after the fieldwork to ensure that the map produced has minimal errors. The classification on the forest cover had also changed from Density in the previous inventory to Coverage - widely determined by canopy.

On completion of the National Forest Inventory, it came into mind that there is no Annual Allowable Cut quota on any native species. Such logging of native and indigenous forest can escalate at a fast pace without being monitored. This developed into another project for which it has to determine the growth rate of each species and also allowing for the calculation of carbon.

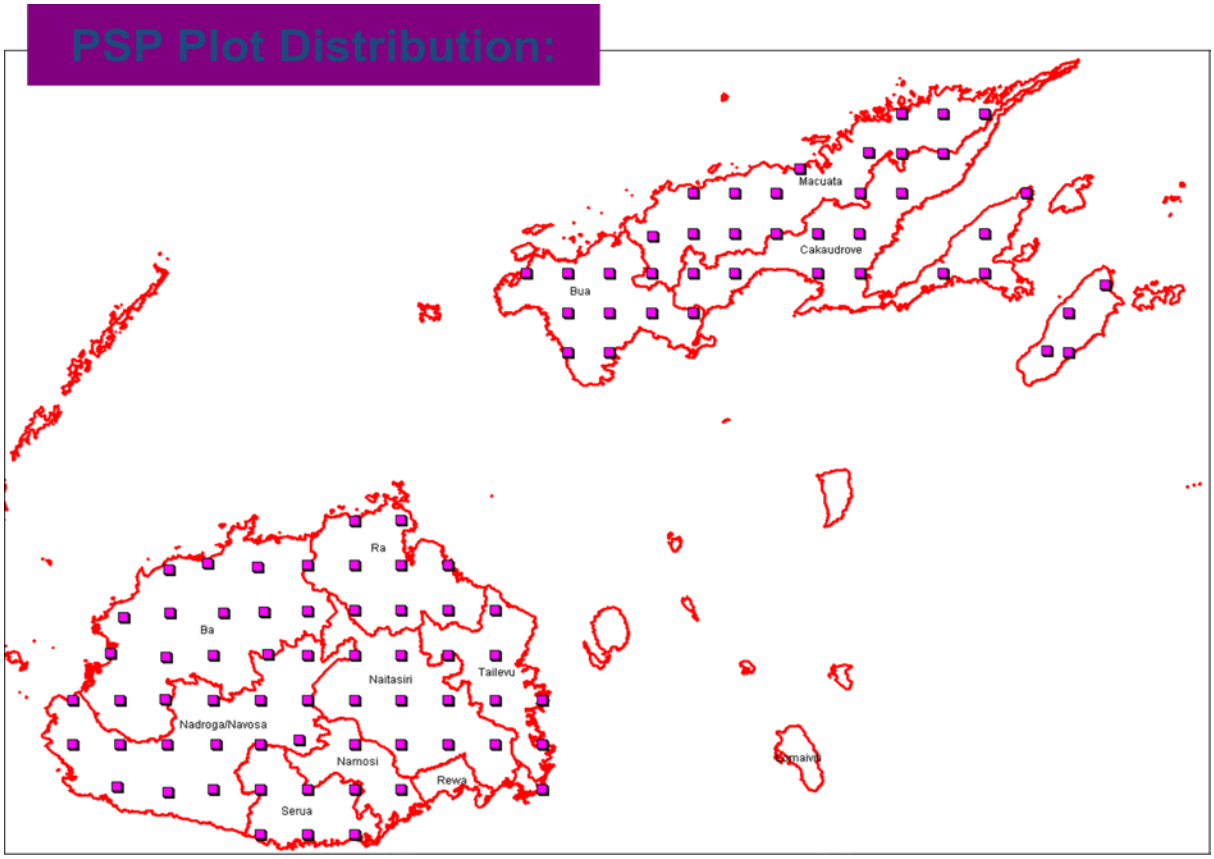
11. Permanent Sample Plots

The main objective is for the establishment of an Annual Allowable Cut (AAC) for Fiji's natural forest, to ensure that harvesting is done at a level which the forest can biologically support.



Above is the plot samples for the measurement that is recorded. There were one hundred (100) sample plots distributed in the two main islands of Viti Levu and Vanua Levu. There is four (4) plots for which the main plot is 50 by 50metre in length and width for which trees greater than 30cm diameter breast height (dbh) were measured and taken into account. This also varies for the other plots of sub plots, circular plot and biomass circular plot.

The biomass circular plot was also included in the sampling to determine the carbon stocking for which no previous record was being kept. The project is into its second (2nd) cycle of which the first set of recording was completed in December 2012. The sampling is set for the next twenty-five (25) years thus to be able to set harvesting quota on each native species that is harvest from Fiji's forests.



Above: A locality map of all the Permanent Sample Plot locations on the two main islands.

ENHANCING FOREST AND WATERSHED CONDITION FOR CLIMATE CHANGE ADAPTATION AND MITIGATION

By Mr. Suhardijono

1. Watershed and forest PROTECTION IN INDONESIA

Climate change becomes an important issue nowadays. It is already having dramatic effects on forest, watershed, natural resources and people's livelihoods. Poor people in developing countries, including Indonesia, are affected to the effect of climate change not least because they are live and work in the very areas where natural disaster most often occur: flood plains, mountainsides and deltas.

Watershed management becomes important part of national development in Indonesia, especially for forestry sector. All of the land in Indonesia is divided into watersheds. It is important to know what the watershed is. . John Wesley Powell, a scientist geographer from the USA defines watershed as follows :

A watershed is "that area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community."

Forest and watershed becomes important natural resources that need to be protected. All of the land in Indonesia is divided into watershed for management unit of forest. The total watershed in Indonesia is 17.088 units, and they are used for the basis of sustainable forest management. Indonesia has about 68.4 % forest out of total land area and it means that forest forms dominant natural resources within the watershed.

The importance of watershed in Indonesia especially for forest management has clearly been stated in Forestry Law No. 41 year 1999. In this law, it is mentioned that the objectives of forestry development are as follows:

- To ensure the adequate existence of forest area scattered through out watersheds or islands
- To optimized all of the forest functions that have been stated
- To increase the welfare of people living surrounding the forest area.
- To increase carrying capacity of watershed to support livelihood of the people
- To guarantee the distribution of forest benefit equally to the whole community

From the objectives of forestry development mentioned above, it is clear that the Government of Indonesia is trying to conserve its forest and at the same time protecting the watershed.

2. Overview of forest MANAGEMENT

Indonesia has vast area of forest resource, counting about 130.68 million hectare or approximately 68.4 % of total land area. Ministry of Forestry implements management of forest resources. There are 5 (five) type of functions namely:

a) Production forest is a forest area that can be exploited to produce forest products such as timber or non timber through selective cutting or clear cutting methods. The area of this forest function is about 32.60 million hectare.

b) Restricted production forest, is a production forest area that has specific fragile conditions such as topography, soil type and rain fall, and the production of timber is limited by minimum timber diameters, depends on species of the forest stand. The area of this forest function is about 24.46 million hectare.

c) Converted production forest, is a production forest area in which its status can be converted into other use of land through releasing or exchanging forest area constituted under Ministry of Forestry. The area of this forest function is about 17.94 million hectare.

d) Conservation forest, is a forest area that has specific features and is intended to conserve biodiversity and ecosystem, including flora and fauna. The area of this forest function is about 26.82 million hectare.

e) Protection forest, is a forest area that has main function for protecting of live support system such as water balance system, avoiding flood and drought, erosion and sediment control, maintenance of soil fertility, protection from sea erosion.

Distribution of forest area is scatted in almost all island and mainly located in five big islands namely : Sumatra, Kalimantan, Sulawesi, Papua and Java islands. The condition and area of forest cover is divided into five categories as follows :

a. Primary or virgin forest about 41.26 million hectare
b. Secondary or log over area about 45.55 million hectar
c. Plantation forest about 2.82 million hectare
d. Degraded forest about 41.05 million hectare

Watershed where degraded forest exists becomes vulnerable, because it can easily cause disaster such as flood, erosion and sedimentation, landslide, etc. This watershed becomes priority to improve and at the same time degraded forest rehabilitation is needed. There is about 41.05 million hectare of degraded forest and it causes the watershed become critical condition.

Forest cover is also found in out side of forest area, and this forest is commonly called as private forest. There are about 8.07 million hectare of private forest in Indonesia and this forest also has important role in wood industry and in supporting the livelihood of people in rural area.

In terms of institutional structure, the management of forest in Indonesia is mainly divided into 3 categories namely:

a. Nature conservation and Forest protection
b. Forest harvesting
c. Forest and land rehabilitation

3. History of forest management

Forestry sector in Indonesia has long historical background, it is started long time ego before this country got independence in 1945. Indonesia was invaded by Netherland over 350 years and it finished in year 1942. During the Netherland invasion, forestry resource management has been built and it became one of the most important business for the Netherland invader in that time.

Forest resource management built by the Netherland was located in Java Island, and the species planted was dominated by teak (Tectona grandis). After the Netherland left this country, the Government of Indonesia is continuing to manage forest resource management in Java by establishing State Forest Enterprise called Perum Perhutanai that is still managing forest area in Java Island.

After the Netherland invasion, Indonesia was invaded by Japan during more than 3 years. During this time, there was no record about forest resource management conducted by Japan, until Indonesia got independence in year 1945. This is maybe because of short period of time Japan invaded Indonesia and they are also concentrated for world war situation.

The next forest resource management period was begun after Indonesia got independence in year 1945. There was no record of forest resource management during period of 1945-mid 1970's, except the continuation of forest resource management in Java island conducted by Perum Perhutani. Starting from mid 1970's, the Government of Indonesia commenced forest resource management in out side of Java Island, and it started in Kalimantan and Sumatera islands. Forest resource management at that time was concentrated in harvesting log or timber in natural forest by implementing mainly selective cutting method. In the era of mid 1970's until late 1990's, forest exploitation which was conducted by private forest concession, was one of the most important government business, resulting in a remarkable foreign exchange earning for the country and a lot of job creation. The exploitation was then spread to other islands such as Sulawesi, Papua, Maluku, and others.

After three decades of forest exploitation, the Government of Indonesia realized that a lot of forest degradation has occurred because of inappropriate implementation of selective cutting method and the weakness of government supervision. As a result, there are many forest destruction resulting in erosion, sedimentation, floods during rainy season, drought during dry season and critical land.

Responding to the situation, in the late 1990's, the government has implemented policy to reduce forest exploitation and increase forest rehabilitation program. At the same time, the government has started watershed management program, which was concentrating not only forest and critical land rehabilitation, but also implementing erosion and sediment control program, establishment of soil conservation structures, community empowerment, promoting of stakeholders participation, etc. This program is continuing until now in which the government is still concentrating to rehabilitate degraded forest and critical land out side of the forest area, and also promoting development of private forest plantation. All of these programs are set up in watershed management planning program.

4. Sustainable forest management policy

The Government of Indonesia has clear commitment on sustainable of forest resource management. It is clearly stated firstly on the national constitution called UUD 1945 in article 33 namely all of the natural resources are managed by government to increase the welfare of people's livelihood. It becomes the basis of all regulation in managing natural resources. Based on this principle, the Law no. 41 year 1999 regarding Forestry then also stated that development of forest resource management is conducted to increase the welfare of people and to rise the quality of watershed condition. The both development commitment are very important especially in establishing policies and regulations regarding forest resource management in Indonesia. Nowadays, watershed management becomes very important forest development approach and it has been used for the basis of forest management planning unit. This is very suitable with the writer that has position as Head of Watershed Management Planning Division.

The other important things underlying the commitment is changing paradigm in managing the forest. Starting from mid 2000's the paradigm in forest management changed from timber management became forest resource management. In one hand, the last paradigm forced the Indonesian government managing the forest to produce mainly timber product. On the other hand, the latest paradigm request the government to manage all natural resources found in the forest to get maximum benefit sustainably, not only timber product, but also non-timber including environmental services.

To implement development programs in all sectors including forestry, the government through the National Planning Bureau has set up mid term development program called Mid Term National Development Planning year 2010-2014. This mid term development planning apply for five years and becomes the development target of every government. Referring to

the Mid Term National Development Planning, every sectors develops their owned mid term planning. Ministry of Forestry has also developed Mid Term Forestry Development Planning Year 2010-2014. There are six main policies in the mid term forestry development planning namely :

a. Strengthening forest boundary and inventory
b. Rehabilitation of degraded forest and strengthening watershed capacity
c. Forest fire prevention
d. Protection of biodiversity
e. Revitalization of forest harvesting and industry
f. Community empowerment surrounding forest area

The next discussion will be focused only on the policy of rehabilitation of degraded forest and land. To implement this policy, a program has been set up called Strengthening Watershed Function and Capacity Based on Community Empowerment Program. Under this program there are some activities namely :

a. Rehabilitation of degraded forest and land including mangrove, coastal forest and peat swamp forest.
b. Establishment of community forestry
c. Development of private forest
d. Development of seed source stand
e. Establishment of village forest
f. Establishment of integrated watershed management planning

To conduct the above program, it has been set up Government Regulation no. 76 year 2008 regarding Forest Rehabilitation and Reclamation. The Government Regulation forms follow up action of Law no. 41 year 1991 concerning Forestry. Finally to conduct each program mentioned above, Ministry of Forestry need to issue Decree. There are some Minister of Forestry Decrees issued to implement the programs namely :

a. Minister of Forestry Decree no. 4 year 2011 regarding Forest Reclamation
b. Minister of Forestry Decree no. 146 year 1999 regarding Forest Reclamation (It has been revised by Minister of Forestry Decree no. 4 year 2011 regarding Forest Reclamation).
c. Minister of Forestry Decree no. 60 year 2009 regarding Evaluation of Forest Reclamation
d. Minister of Forestry Decree no. 39 year 2010 regarding General Plan, Criterial and Standard of Forest Rehabilitation and Reclamation
e. Minister of Forestry Decree no. 70 year 2018 regarding Technical Guidance for Forest and Land Reclamation
f. Minister of Forestry Decree no. 39 year 2009 regarding Guidance for Establishment of Integrated Watershed Management Planning
g. Minister of Forestry Decree no. 32 year 2010 regarding Guidance for Establishment of Technical Plan for Forest and Land Rehabilitation Within Watershed
h. Minister of Forestry Decree no. 38 year 2010 regarding Guidance for Establishment of Management Plan for Forest and Land Rehabilitation
i. Minister of Forestry Decree no. 24 year 2010 regarding Guidance for Establishment of Community Nursery

5. Policy and Strategy on Climate Change Mitigation and Adaptation

The role of forest in climate change mitigation and adaptation is very simple. Basically forest can reduce carbon and increase carbon absorption. The president of the Republic of Indonesia has stated his commitment on climate change mitigation when attended G 20 Conference in Pittsburg and COP 15. By year 2020< Indonesia will reduce carbon emission

up to 46 %, in which it will reduce 26 % through Indonesian effort and 15 % through international support. This policy has been issued in Presidential Decree No. 61 year 2011 regarding National Action Plan on Climate Change Mitigation.

In the National Action Plan there are 5 (five) main sectors involve namely: Forestry and Peat Land, Agriculture, Energy and Transportation, Industry and Waste.

The target of reduction for carbon emission is shown in table below.

SECTOR	**26% (Gton CO2 e)**	**41% (Gton CO2 e)**
Forestry and peat land	0.672	1.039
Agriculture	0.008	0.011
Energy and transportation	0.036	0.056
Industry	0.001	0.005
Waste	0.048	0.078
Total	0.767	1.189

From the table above, it can be seen that forestry sector including peat land has very important role in climate change mitigation and adaptation program in Indonesia. The target for this sector is higher than that of other sector both for scenario reduction of 26% or 41%.

In implementing the Nation Action Plan, especially for forestry and peat land sector, there are some strategies has been set up namely:

a. to reduce deforestation and degradation rate
b. to increase planting to raise carbon absorption
c. to protect forest from fire and illegal logging
d. to manage drainage in peat land area
e. to stabilize water level in drainage system
f. to optimize forest and water resource without conducting deforestation
g. to implement appropriate technology for land and agriculture management with minimum carbon emission.

6. Forest and Land Rehabilitation to Support Climate Change Mitigation

To implement the strategies set up, Ministry of Forestry has set up several regulations.

Based on Government Regulation no. 76 year 2008 regarding Forest Rehabilitation and Reclamation, to constitute forest and land rehabilitation must be commenced by planning. There are three level of plan must be made namely :

a. Technical planning for forest and land rehabilitation within watershed issued by Directorate General of Watershed Management and Social Forestry, Ministry of Forestry or central government (mid term plan for 15 years)
b. Management planning for forest and land rehabilitation, established by district forestry agency (5 year plan)
c. Annual planning for forest and land rehabilitation, established by district forestry agency

The three kinds of planning must be made first before programs implementation, especially for forestry district agency. If the planning s are not prepare, there is a consequence that the budget for the program will not be released by central government. Similarly, Ministry of Forestry must also produced technical planning as mentioned above, and in case of not preparing the plan, there is a consequence ans sanction too,

Another example of law enforcement in forestry is applied for mining companies operating in forest area. Based on Law no 41 year 1999 and Government Regulation no. 76 year 2008, mining companies must get permit from Minister of Forestry before conducting mine operation in forest area. There are several activities must be constituted by mining company such as planning, rehabilitation and reclamation, community empowerment, environmental protection, etc, If the compulsary activities are not properly executed by the company, the Minister of Forestry will cancelled the permit and the company will be fined based on regulation.

The biggest problem of forest resource management in Indonesia if degradation. There are about 41.05 of degraded forest area with degradation rate is about 1.08 million hectare per year. Forest and land rehabilitation program conducted by government every year just counting about 500.000 hectare. There is a deficit between forest degradation and rehabilitation in one hand.

On the other hand, demand of forest area to be used for other purposes is rising from time to time while the deficit still occur. For example, there are a lot of mining companies operating in forest area based on permit from Minister of Forestry. It is a legal operation because it has been regulated in Goverment Regulation no. 76 year 2008 concerning Forest Rehabilitation and Reclamation. The use of forest area for mining activities will benefit forestry sector because there are two activities must be conducted by mining company namely :

a. Forest reclamation in its concession area
b. Compulsory planting for watershed rehabilitation out side of concession area

By implementing the regulation, it seem that the rate of forest rehabilitaion will rise and the community will get more benefit from rehabilitation and plantation program economically and ecologically.

The implementation of forest resouce management program in Indonesia is constituted by Ministry of Forestry that has been set up in six main policies mentioned above. One of the six main policies is rehabilitation of degraded forest and strengthening watershed capacity. This policy has been succesfully implemented in North Sulawesi province by PT Newmont Minahasa Raya. The gold company succeeded to rehabilitate and reclaim degraded forest exploited for gold mining.

The success story may happen because all parties involved were very disciplin in conducting their owned obligation. The main tool used in this case is Minister of Forestry Decrees no. 146 year 1999 regarding Forest Reclamation and Minister of Forestry Decrees no. 60 year 2009 regarding Evaluation of Forest Reclamation. In conducting forest rehabilitation and reclaimation, the company worked together with provincial and district forestry agencies in that area. The lessons learned from this activity is when all parties involved work very hard and seriously participated, the avtivity will be successfull. This story is one of the important experiemces because the Government of Forestry must deal wth private companies which forest area for their activities such as mining, estate, fishery, power plant, etc. All of those companies have obligation task to rehabilitate the degraded forest they use for theier activities.

To support rehabilitation program, Ministry of Forestry has constituted Community Nursery since 2010. Community Nurseries built in 2010 totalled 8,000 units, in which each unit produced 50,000 seeddlings. Each community nurcery is managed by a group of farmer that has members between 10-20 farmers. Total seedling produced in 2010 was 400,000,000 seedilings. All of the seedlings have been planted for private forest development program in year 2011 and the total area is about 400,000 hectare (number of plantation per hectare is about 1,000 trees).

In year 2011 the Government of Indonesia has increased Community Nursery program up to 10,000 unit. The program has been pushed forward because it is very useful and effective to rehabilitate degraded forest and critical land. Total seedling produced during 2011 will be 500,000,000 and it is predicted that the new private forest program will be planted in year 2012 about 500,000 hectare. To implement this program the government provides not only the seedlings but also planting cost as a stimulant for the farmer's group. For the next year 2012 the government is planning to increase up to 15.000 unit of Community Nursery program. It means there will be new private forest planting about 750,000 hectare in year 2013.

To establish community nursery, forestry district office should forms faremer group and each farmer group consists of 10 to 20 members. The farmer group will be trained first how to establish community nursery. After training , the next step of establishing coummunity nursery as follow :

a. Compose of farmer group proposal that will be guided by community nursery field adviser
b. Land preparation for community nursery
c. Preparation of seed materials (seed materials can be seeds or vegetative materials)
d. Establishement of facilities that consists of : information board, nursery shed, net for shading, inspection road, watering facilities.
e. Seedling production
f. Seedling maintenance
g. Transportation of seedling to planting site.

It has been discussed before that to conduct rehabilitation program must refer to the Law and Regulation issued by the Government of Indonesia. The most important Law and Regulation related to rehabilitation is Law no. 41 year 1999 regarding Forestry and Government Regulation no. 76 year 2008 regarding Forest Rehabilitation and Reclaimation. Based on those two legal regulations, it has been issued Minister of Forestry Decree no. 24 year 2010 regarding Guidance for Establishment of Community Nurcery. It is the most important tool for developing community nursery as has been discussed above. So there are two examples of rehabilitation programs elaborated above, one is dealing with private sector, and the other one is dealing with rural community.

In the first example, all of the budget is provided by private sector as a consequence of mining operation, and the latter all of the cost of rehabilitation is provided by the government. Both examples have been successfully implemented based on Minister of Forestry Decree as the legal basis of the program.

To speed up the implementation of rehabilitation of degraded forest and critical land, the government has conducted another massive seedling production method called Permanent Nursery Establishment program. The permanent nursery program was started in 2010 to establish a model of permanent nursery and then continue in 2011 to establish 28 units scattered in 22 provinces. The establishment of permanent nursery program is based on Regulation of Director General of Watershed Management and Social Forestry Development no. P.5 year 2011 concerning Manual for Establishment of Permanent Nurcery

that forms folloe up action of Miniter of Forestry Decree no. P. 12 year 2011 regarding Guidance for Implementation of Forest and Land Rehabilitation.

Establishment of permanent nursery is different with community nursery. Seedling production of one unit of permanent nursery is higher than that of community nursery. One unit of permanent nursery produces 1 (one) or 2 (two) million seedlings, while one unit of community nursery produces only 50,000 seedlings. Therefor establishement of permanent nursery is not conducted by a farmer's group, but it is constituted by a private company though bidding process. So it is compulsary to constitute feasibility study and engineering design before establihment of permanent nursery. Meanwhile establihment of community nursery does not need to make feasibility study and engineering design.

Why the Government of Indonesia pays more attention to the seedling production? It is because one of the most important factor for the success of forest rehabilitation program is the availability of good quality seedlings. The area of degraded forest land is very big totalled about 41.05 million hectare as mentioned above. It means to rehabilitate the degraded forest needs a big number of good quality seedlings.

Forest rehabilitation as one of the Forest resouce management is a very big and complicated program. It consists of many activities and involve a lot of institutions from central, provincial and district governments. There are some challanges or problems faced by the Government of Indonesia in conducting forest rehabilitation namely :

a. Vast area of degraded forest
b. Difficult accessibility
c. Very expensive transportation cost
d. Lack of human resource condition
e. Lack of budget
f. Lack of coordination among the level of government
g. Very small standard cost of implementation
h. A lot of forest encroachment by community, etc.

The implementation of rehabilitation program depends very much on the quality of human resource condition espesially those in district level. All of the budget for forest rehabilitation will be transfered from central government to district government. In this case, district forestry office will act as operational agency. In fact, the quality of human resouce in district forestry office is relatively low. This is one of the big problems for Indonesia in conducting forest rehabilitation program. To overcome this problems, the government conducts training program both for district forestry officials and for farmers.

Indonesia is a big country, which has wide area of forest counting more than 70% of total land. It makes a consequence that the transportation cost to the remote forest area is very expensive in one hand. On the other hand, the availability of budget is very limited. One of the policy to overcome limited budget for forest rehabilitation is establishment of community nursery as much as possible, because this program can produce and distribute seedlings much cheaper than the other methods. More over it can encourage farmer participation in forest rehabilitation program.

Based on challanges and problems mentioned above, the policy of Indonesia in forest resource management in the next five to ten years will be more focus on rehabilitation of degraded forest. There are about 41.05 million hectare of degraded forest land to be rehabilitated. The responsible agency for forest rehabilitation is Directorate General of Watershed Management and Social Forestry Development. Therefor in the mid term planning of Directorate General of Watershed Management and Social Forestry Development year 2010-2014 that focussed on forest and land rehabilitation program, has set up development targets or programs as follow :

a. Rehabilitation of degraded forest and land including mangrove, coastal forest and peat swamp forest about 2.5 million hectare
b. Establishment of community forestry about 2 million hectare
c. Development of private forest about 250.000 hectare
d. Development of seed source stand about 10.000 hectare
e. Establishsement of village forest 500.000 hectare
f. Establihment of integrated watershed management planning targeted for 108 critical watershed.

All of those programs above should be implemented by Directorate General of Watershed Management and Social Forestry Development during five year period from 2010 until 2014. Thera are five directorate under the Directorate General of Watershed Management and Social Forestry Development to implement each program namely :

a. Directorate General Secretariat, responsible for setting up program activites and budgetting.
b. Directorate of Watershed Planning and Evaluation, responsible for providing guide and supervice the Establihment of integrated watershed management planning targeted for 108 critical watershed.
c. Directorate of Forest Seed Development, responsible for development of community and permanent nursery.
d. Directorate of Forest and Land Rehabilitation, responsible for providing guide and supervice rehabilitation of degraded forest and land including mangrove, coastal forest and peat swamp forest.
e. Directorate of Social Forestry Development, responsible for establishement of community forestry, filage forest and private forest.

The success of forest rehabilitation program depends very much also on species selection. It become a key factor because if species selected for this program does not suit farmer's preverence, it is very difficult to grow well because the farmers will not pay attention to the plantation. There for it is important to make plan together with the farmers. Normally there are two kinds of tree species selected by farmers as follow :

a. For wood production, there are some species usually selected by farmer such as: Albizzia falcataria, Swietenia macrophila, Tectona grandis, Acacia mangium, Acacia auriculiformis, etc.
b. For fruit production, there are some species usually selected by farmer such as : Durio zibethinus, Mangifera indica, Nephelium lappaecium, etc.
c. For fire wood production, there are some species usually selected by farmer such as : Leucaena glauca, Leucaena lecocephala, Gliricidea sp, Calliandra sp, etc.

7. Closing

The existence of forest and watershed is very important, In Indonesia forest is an important resource that count about 68.4% of total land. It means forest relatively dominant land cover within the watershed. If the forest is degraded, the watershed will be very critical.

Indonesia has high commitment on climate change mitigation and adaptation. It has been stated by the President of the Republic of Indonesia. The government has also established National Action Plan for Climate Change Mitigation and Adaptation, in which forestry sector becomes an important parts of the program.

REDUCING FOREST DEGRADATION AND EMISSIONS THROUGH SUSTAINABLE FOREST MANAGEMENT (SFM) IN PENINSULAR MALAYSIA

PREPARED BY ISMAIL PARLAN (FRIM)

Summary

With 19.5 million hectare of its land covered with natural forest, Malaysia enjoys one of the highest percentages of forested land among tropical countries. Consequently, the timber and timber products industry are very important and play a significant role in Malaysia's economy. At the same time, there is also an increasing recognition of the protective roles of the forests such as the conservation of biodiversity, protection of soil and water resources and stabilizing the climate. As such, Malaysia has accorded the management of the forests on a sustainable basis a high priority.

Forest management in Malaysia is based on the Selective Management System (SMS) which involves the selection of a management regime to optimize not only the objectives of efficient and economic harvesting and sustained yield but, more importantly, to ensure that forest development is ecologically and environmentally sustainable. However, forest degradation in terms of carbon stocks is occurring in production forests as a result of logging operations. Logging operations in Malaysia in the past have also been reported to be damaging, but of late, significant improvements have been made. The extent of current forest degradation in terms of carbon stocks need to be further studied as it is still not well understood in Malaysia.

Reports have indicated that improved forest management could reduce degradation and reduce carbon emission. However, all these studies are confined to specific areas and with limited information for scaling up activities. Consequently, this project is implemented to assess enhancement of climate change mitigation through reduced emissions from forest degradation in Malaysia. Specifically, the project will determine emissions from forest degradation in logged forests and assess the value of enhancing forest management practices to reduce emissions from forest degradation. Financial evaluations of the improved management practices will be undertaken to provide avenues for assessing payment for ecosystem services.

1. Introduction

All inland production forests in Peninsular Malaysia are currently being managed under the Selective Management System (SMS). The system allows trees to be removed based on a flexible cutting regime where all trees above a prescribed cutting limit are removed. The determination of the cutting limit takes into consideration the existing growing stock, its increment and mortality, as well as a specified future crop at the end of a 30-year cutting cycle. However, there are concerns that the assumptions for the above factors in the implementation of SMS are not being met consistently and thus affecting the productivity of the residual stands. In addition traditional ground based harvesting logging practices have been reported to be damaging to the residual stand and the surrounding environment.

The introduction of Reduced Impact Logging (RIL) systems and practices have indeed reduced the logging damage and improved stand conditions. It is thus opportune that further improvements to the current management practices be implemented to further enhance the productivity of the residual stand and reduce forest degradation in terms of total carbon stocks as well as other ecological factors. However, such sustainable forest management practices may incur significant additional costs both to the logging operators as well as the government. The REDD+ mechanism under the UNFCCC currently being discussed, presents an incentive that may encourage implementation of improved management practices to reduce forest degradation.

The general objective of this project is to utilize Sustainable Forest Management (SFM) as a mitigation tool in combating climate change. As deforestation rate is stable in Malaysia, the emissions to be accounted for REDD mechanism would probably come from the reduction of forest degradation in Peninsular Malaysia.

The specific objective is narrowed down to improve knowledge on reduction of forest degradation and enhance payments for ecosystem services. Assessment of national forest degradation could be done based on identification of drivers and documentation of the forestry data supporting the cause of forest degradation. Guidelines and policy tools could be developed later to monitor and report national forest degradation in the country.

Besides, the project will also study the economic aspect of establishing incentives in reducing forest degradation for carbon and ecosystems services. Opportunity cost for implementing the programme will be evaluated for the purpose, and suitable incentives procedures will be recommended for minimizing forest degradation through sustainable forest management practices.

In addition, a crucial aim of this project is to build capacity amongst stakeholders and communities on the importance of SFM and climate change mitigation. This could be implemented through awareness programmes such as organizing workshops and meetings for policy makers and forest managers. Information on the project's findings could be disseminated as well for better understanding of forest degradation in the country through outreach activities (i.e. publications, seminars, workshops).

2. Key Issues

Malaysia recognises the concerns from various parties, both local and international, on the threats posed by climate change and the contribution of the forestry sector to emissions due to deforestation and forest degradation. In this respect, Malaysia's invaluable forests need to be conserved and managed on a sustainable basis to prevent depletion and degradation of forest resources. In this regard there is a need for a better understanding on the impacts of management policies and practices on the forest ecosystem and to overall emissions of CO_2.

Deforestation is defined as the transition from any forest type to non-forest type which involves a land use change; whereas forest degradation describes the transition from closed forest to open or fragmented forest with no land use change. Malaysia has shown strong commitment in implementing sustainable forest management, where we support global efforts to curb deforestation and forest degradation; as well as to provide incentives for reducing deforestation and forest degradation.

In addition, Malaysia recognizes the relationship of the deforestation and forest degradation with the increase in emissions of greenhouse gasses (GHGs) and the reduction of carbon sequestration potential. Thus Malaysia continues to emphasise the significance of sustainable management of existing sinks and reservoirs, as fulfilling the commitment outlined in the Convention on Biological Diversity (CBD), which is ratified in 1994. Malaysia also developed its own Criteria and Indicators (MC & I) based on ITTO Guidelines for Sustainable Management of Natural Tropical Forests and Criteria for the Measurement for Sustainable Tropical Forest Management in the same year. Currently, Malaysia is implementing the MC & I as part of the measures to reduce emissions and improve sustainability.

Sustainable Forest Management (SFM) is one of the avenues proposed for reducing emissions from tropical deforestation and forest degradation. Under the SFM practices, forest degradation from harvesting activities occurs in permanent production forests is minimized. In this manner, the production forests within the Permanent Reserved Forests

(PRFs) are managed sustainably under the Selective Management System (SMS) based on a 30 year cutting cycle.

However, there is a gap in information pertaining to rates of deforestation and forest degradation at the national level, as well as the drivers of deforestation and forest degradation in the past and present. As such, it is expected that this project will provide a holistic approach with a better assessment of the situation.

The project will be implemented in a pilot area involving a forest management unit such as the state of Pahang. Thus, the implementation of the project will involve the Pahang State Forestry Department. Since the project deals with REDD which is headed at the Federal level by MNRE, the involvement of REDD Unit at the Ministry and the Forestry Department Headquarters Peninsular Malaysia are essential.

3. Data Analysis

The data analysis and modelling application (if any) would be based on expected output of this project as follows:

Output 1: National forest degradation estimated

In addition to deforestation, forest degradation has also been identified as important source of emissions from the forestry sector. Continuous and unabated degradation will lead to deforestation. In most tropical countries including Malaysia, there are concerns that production forests set aside to be managed on a sustainable basis often will experience degradation due to poor management systems and poor logging practices. In this regard, the forest area will experience degradation after each cutting cycle. In many cases the forest will not be fully recovered before the subsequent cut is carried out, thus resulting in a depletion of the carbon stock. In Malaysia, the extent of forest degradation in terms of carbon stocks is still not well defined. In this output research activities would be conducted to ascertain the extent of forest degradation. Baseline information on the level of forest carbon stocks as well other values such species composition and forest structure will be assessed before and after logging under current forest management prescriptions and logging techniques. Assessment of carbon stocks will also be made to assess changes in forest carbon stocks for forest of various temporal categories such second and third cutting cycles. Data on the extent of forest degradation in Peninsular Malaysia will be made available to all major stakeholders.

Output 2: Forest degradation reduced at the forest management unit

Attempts will be made to measure the extent of forest degradation at the selected pilot project forest management unit, which is the state of Pahang. Although forest operations are conducted in the production forests by compartments, often the year after logging will not be sufficient to indicate the degree of forest recovery or the level of forest degradation. Since the logged forest are being managed on a 30-year cutting cycle, measures of degradation will have to take into consideration the age after logging and the ability of forest to recover within the cutting cycle.

In addition, improved protocols would be introduced and tested to enhance carbon retention and reduce degradation in the Pahang one forest management unit. In particular, reduced impact logging systems which reduce the construction of skid trails and maintaining forest structure will be tested to assess its potential in enhancing current management practices towards achieving sustainable forest management and enhancing carbon stocks.

Changes in carbon stocks under the improved forest management prescriptions and logging techniques will be assessed and compared with current practice. Other aspects such

as forest structure and species composition will also be assessed to better understand the value of forest in additions to carbon stocks.

Output 3: Incentives for carbon and ecosystems services established

The success of participation and implementation of projects under the REDD+ in mitigating climate change will depend on the modalities still being negotiated under the UNFCCC as well as the costs involved. It is thus pertinent to understand the costs involved in implementing REDD+ projects. Since additional efforts are being carried out to further reduce degradation and enhance sustainable forest management, the cost involved and opportunity cost foregone by forest owners will have to be accounted. Such information will also be useful for requesting incentives for the protection of ecosystems services. In this output all these costs will be accounted for based on the pilot study area. Enhanced ecosystems services from the forest from improved management will also result in an increase in the benefits rendered to forest dependent communities. An improved residual stand will result in better conservation of flora and fauna as well as improve forest recovery. This will result in added benefit to the forest communities.

A document on the provision of incentives for carbon and services will be developed and presented to key stakeholders including the Pahang State Economic Planning Unit, Pahang State and Federal Forestry Departments as well as relevant Federal Ministries. Based on the feedbacks received, the incentive mechanism will be finalised and submitted to the Pahang State Government for consideration. These documents will made available to the public in the projects website to be developed.

Output 4: Capacity of major stakeholders and communities where relevant is strengthened

As the research project involves exploring new areas in the planning and management of forest in relation to climate change it is expected many new skills and capacity can be built. The input from external experts working together with local experts will be very valuable in the exchange of skills and experience. It is thus important that the project be implemented focusing on this capacity building both via on-the-job training as well as more formal classroom training involving not only FRIM personnel but also relevant people from other agencies and organisations. The project should be undertaken in such a manner that by the end of the project, sufficient skill would have been built locally to enable effective implementation of nation-wide climate change policies and action plans. Trained personnel will also be able to transfer knowledge and technologies to be applied in other parts of the country and the region. This will be achieved by providing training in awareness of REDDES and carbon accounting to at least 120 participants. Trained personnel will also be able to transfer knowledge and technologies to be applied in ASEAN the region through training activities.

All training activities will be documented. Proper evaluations of the training by the participants will also be implemented to ensure continuous improvements. Training reports will be reported to the Project Steering Committee and be available in the project website.

4. Results and Discussion

The project is being executed by the Forest Research Institute of Malaysia (FRIM). Both FRIM and the Forestry Department are under the Ministry of Natural Resources and Environment (NRE) thus providing a direct link between research and policy formulation that is based on existing government structures (thereby increasing sustainability). The REDD Unit under the MNRE will also be involved in the monitoring and implementation of the project. The Federal Forestry Department also provides an institutional avenue to link the

project research activities into the Pahang State forestry planning processes. A Project Steering Committee (PSC) will be established to govern the implementation of the project. The PSC will provide guidance on matters pertaining to the implementation of the project and ensure that the project is directed towards achieving its intended goals. It will enable the coordination of different agencies involved in the project. A national Technical Working Group (TWG) will be established to provide advice on technical issues as well as to provide the linkage with State Forestry Department decision-making processes.

The project will be conducted mainly through the implementation at the forest management Unit Level which is the state of Pahang. Pahang is the largest state in Peninsular Malaysia consisting of about 3.6 million hectare, of which 1.98 million ha or 55% of the land is covered by forests. Forestry sector in Pahang is a very important economic sector and continues to contribute significantly to it socio-economic development. Pahang also has the largest protected areas consisting of national parks and watersheds. There are a significant population of local communities and Orang Asli (aborigines) in the state of Pahang that are dependent on the forest for subsistence. In this respect, the project will consider the impacts of REDDES project on them. They will be consulted in the project planning and implementation and their representatives will be able to participate in the project monitoring through the Project Steering Committee.

5. Looking Ahead

The initiation and subsequent implementation of the activities of the project will be contingent upon the timely provision by GoM through the Implementing Agency, FRIM, of the adequate facilities and services, including secondment of staff, required for the effective operation of the project. The equipment, components and materials acquired for the project will be the responsibility of the Implementing Agency, FRIM, and will be inventoried in a manner that is consistent with FRIM regulations.

FRIM is in a good position to implement the project successfully as it has produced substantial research material and has attracted international research support. FRIM has demonstrated its ability to successfully implement similar research projects in the past and with the support of Malaysian stakeholders such as the federal and state governments, environmental NGOs and forest concessionaires.

Climate Change and Adaptation Measures in Mongolia

1. Introduction

Continuous change in Mongolia's climate has been observed in recent years: between 1940-2007, the air temperature rose by 2.1^0C , by 1.9-2.28^0C in the mountain region and by 1.6^0 -1.7^0 C in the Gobi and steppe regions.

Mongolia's total annual rainfall has decreased by 1.7-12.5% in the Gobi region within the last 68 years, and increased by 3.5-9.3% in the eastern and western regions.

The total forest land area of Mongolia was 18.6 million hectares in 2010 and 18.8 million hectares in 2000, therefore decreased by 20.0 thousand hectare.

Currently, 1190.4 thousand hectares of forests are irreversibly damaged from forest fire, 95.6 thousand hectares of forests have dried out from forest blights, 249.1 thousand hectares has been cleared for lumber, and 0.9 thousand hectares has been damaged by natural disasters. These are the main factors that contributed to forest reserve degradation.

Since 1970, Mongolia has been receiving information and images from the Polar orbit satellite which is an analogue system. Further, not only cloud image, but also analysis of rapidly changing natural resources has been enabled due to the installation of a digital information station in 1987. Since 2007, Mongolia has been receiving satellite images of resolution of 250m from MODIS and geostationary FY2C satellite which have increased monitoring quality significantly.

In 2010, Forest management plan 2011-2015 of Mongolia developed clearly including forest utilization, rehabilitation and protection and funded by Mongolian Government.

In 2011, the draft National Environmental Action Plan (NEAP) of Mongolia has been developed through the initiative of the Ministry of Nature, Environment and Tourism, with the assistance and close coordination of the World Bank within the activity of the "Environmental reform ("NEMO2 /Netherland-Mongolia Trust Fund) project.

2. National Environmental Action Plan of Mongolia

The Action Plan was developed in accordance with the necessity of furthering environmental policy reforms using continuous planning principles. Problem issues were first defined, then the current state of the environment assessed and evaluated, along with the environmental sector administrative and financing systems, strategies, objectives and activities until 2021 and their performances were defined aligning with climate change projections.

Subsequently, the financial, technical and human resource needs and required changes to the current environmental management, administrative and financial systems were analyzed to implement these activities. The scientific group of the Geo Ecological Institute was the lead agency in the development of this Action Plan. The participation of citizens, economic entities and local and central governments was deemed a high priority during the development and discussion of the draft Action Plan.

3. Objective and main direction of NEAP

The Objective of the National Environmental Action Plan is to identify fundamental ways of management and coordination to implement prioritized projects and cross-sectoral activities, and identify courses of action, based on the targets and strategies of the Environmental Policy Reform within the framework of the Comprehensive Policy on National Development (based on the Millennium Development Goals).

Targets, planning indicators and solutions

• Creation of an integrated management system for natural resources and the environment that is capable of supporting ecosystem sustainability, assessing the number, distribution, interdependencies and modifying trends of land, forest, water, plant, animal and mineral resources, and ensuring planning and coordination of environmental projects and programs.

• Development of a cross-sectoral coordination and management system capable of addressing ecological roles and responsibilities, building capacity on sustainable development education based on a "Green Economy", "knowledge and information technology", in harmony with securing a safe and healthy living environment, by limiting negative human activity that is increasingly impacting the environment.

• Influence people's behavior to adopt a culture of ecological protection and develop new approaches for adaptation to further changes in climate.

The NEAP aims to define the necessary actions, their outcomes, and required resources (human, technical, technological and financial) until 2020, as well as clarify how the current administrative system can be improved in order to solve the aforementioned three major issues.

4. Principles applied for producing the NEAP

The following principles were applied in the development of the Action Plan:

• Planning and implementation in accordance with the Comprehensive Policy on National Development, based on the Millennium Development Goals, until 2021 and national programs for their implementation.

• Creating a unified basis for legal and economic coordination ensuring policy integration of the land, forest, water, plant, animal and mineral resources within the objectives and mission of the environmental policy reform.

• Devising effective incentives to increase public roles and responsibilities for ecological sustainability, establishing an efficient cross-sectoral management and coordination system that fully reflects a balanced supply and demand of environmental and social development, specifically in a market economy future.

• Building a natural resource and environmental management system in accordance with the requirements of environmentally friendly and efficient use of mineral resources, and climate change adaptation.

• Improving the current collaboration between soums and aimags with common interests to ensure regional sustainable development, expanding local government rights in environmental protection and rehabilitation.

• Developing partnerships and cooperative relationships between NGOs, foreign countries, international organizations, citizens, and domestic and foreign entities in regard to rational utilization of natural resources, environmental protection, and rehabilitation.

5. The scope and phases of the NEAP

The National Environmental Action Plan is the inter-sectoral planning document aimed at ensuring a balance between environmental and social development and supporting the interdependencies between ecosystem complexities**.** This document covers the following strategies on environmental policy reform and actions to be implemented at the national level:

1) Improving the living environment by reducing environmental pollution and degradation
2) Preventing water scarcity and pollution by accumulating water in storage and using water resources more efficiently

3) Establishing sustainable land use management
4) Creating sustainable management for forest conservation, utilization and rehabilitation
5) Protecting biological diversity, utilizing their resources in a sustainable manner, rehabilitating in case of damage, and preventing their extinction
6) Reducing the negative consequences of desertification and climate change
7) Forming a development path for a "Green Economy"

In order to provide the main requirement of networking for environmental policy, the following need to be taken into consideration:

Quality (benefit):

Insufficient quality in the rehabilitation of degraded areas and low effectiveness of environmental protection activities.

Economic and social benefit of natural resource use is low, not yet using environmentally sound, waste free, complete processing.

Management and monitoring systems for environmental economics that coordinate and reflect natural resource values, ecological and economic assessments, depletion cost accounting, and resource user fee systems into the development policy, national accounting system and state budgeting and taxation system not yet established.

Participation (access):

Weak initiative and participation of economic entities, organizations and citizens on environmental protection and restoration activities, and lack of promoting incentives for their participation.

No adequate political support and social conditions for the fair and even distribution of the benefits from natural resource utilization for the improvement of people's livelihoods.

Lack of rights and unsatisfactory accountability and role of local government on natural resource use and protection.

Insufficient benefits from domestic and foreign partner cooperation in the field related to the mineral resources and land use, in an environmentally sound manner, and weak mechanisms for their monitoring and management.

Insufficient benefit and scope of projects and programs implemented in the environment sector in cooperation with neighbouring and other countries and international organizations, and weak coordination with other economic and social programs and projects.

6. Management:

Slow progress in introducing technologies that are well suited to the environmental capacity and lack of effective incentives from the state to support production and trading of ecologically clean products.

Very weak legal and economic regulation, monitoring, controlling and accountability systems for polluters' responsibility to clean pollution, and rational utilization of natural resources by their possessors and users.

Inadequate reflection of the interrelationships of natural components such as land, water, forest, plants, animals, mineral resources, environmental impact from the economic

activities, and their reflection into the development policy planning, and regular monitoring work for their implementation.

7. Forest Management

J. Tsogtbaatar summarizes the following forest management and strategic measures. The forest management requirements in the Mongolian Law on Forests are the legal mechanism through which Mongolia assesses the current condition of its forests. By law, management shall consist of forest survey and inventory, state of forest stands including forest distribution, composition, quality, silvicultural activities, stand treatment and determination of the justification for forest conservation, proper use and restoration. This Law does not specifically discuss or require forest planning, however, it does require government to prepare various documents.

8. STRATEGIC MEASURES

The most significant forest policy measures at national level have been identified as follows:

Forest Management

• To introduce remote sensing technology and geographical information systems for determination of forest state, to conduct forest inventory in selected areas i.e 20% of total inventory area by using aero-photos with large scale and revising stand indicators in sample plots.

• Supporting forest inventory enterprises of all types of ownership, forest inventory capacity will be increased by 1.5-2.0 times.

• With the purpose of increased tree growth and improvement of wood quality, cleaning of forests will be conducted by jobless people and youth relying on professional institutions and people who own the forest on the basis of contract.

• A prevention of forest fire and forest fire fighting plan must be worked out, fire prevention expenditures shall be budgeted and financed in annual local budget.

• To create forest fire prevention breaks and forest dividing lines in state border zones and some required areas.

• To detect fires and fight hot spots using satellite information and air guard for forest fire monitoring and fire prevention groups.

• To provide natural disaster and fire fighting units with communications means and fire liquidating equipment..

• To fight forest fires with minimal losses by affecting clouds and intentionally causing rain.

• To take measures for prevention and determination of probable forecast of insect and disease distribution and it's multiplication by intensifying research work.

• To modernize laboratory research, laboratory equipment and to provide qualified personnel for fighting harmful insects and disease.

• To promote biological and environmental friendly technology for fighting harmful insects and to organise necessary produce in the country.

Forest harvesting and wood utilization

• To determine annual allowable cutting volume by aimags and sums in connection with forest resource capacity.

• To improve procedure for allocation of forest resources and forest harvesting technology in current condition to assist the forest self generation process.

• A regulation to handover forest resources to an economic entity or organization who are able to combine logging, reforestation and protection of forests will be realized.

• To cease cutting of young and premature trees.

• To protect saxaul forests, firewood needs of some aimags and sums of the Gobi and desert zones will be met from forest zones by cleaning forests. Transport expenses of the above mentioned activity will be allocated from the centralized budget. In the Gobi zones wholesale trade centres of fire wood and timber consumer goods will be established.

• Considering the importance of extension of forest roads for forest protection, silvicultural management and wood utilization, improvement of infra-structure and the development of tourism the Government will support and participate regularly in these activities with the assistance of foreign investment

• To limit export of wood and timber products, to encourage a policy of wood import

• Railway sleepers will be replaced by non-wood alternative materials

• To reduce wastage of logging, and utilize tree tops, branches of trees, sawdust, bark, low quality wood and off-cuts by employing mechanical and chemical treatment to get deep processing by applying foreign and domestic advanced technology will be promoted

• Producing essential oil out of conifers, vitamin powder, medicine extract, pine-tar oil, resin out of larch and pine trees, charcoal out of birch trees and supplying internal and external markets with the above goods will be realized in stages.

• Initiatives to process birches using industrial methods, applying know-how technology of producing birch parquet flooring, construction of wooden parts and timber goods relying on previous wood processing factories will be encouraged and supported.

• Establishment of small and medium sized wood processing factories which are able to compete on the market by modernizing the furniture and timber goods industry will be supported by policy and the assortment and volume of export goods will be increased.

• To create favourable conditions for the establishment of factories to produce particle board and single layer board, plywood, veneer.

• Establishment of small and medium sized wood processing factories combining traditional and modern technology to produce consumer timber goods for countryside herdsmen will be supported.

• The list of usable non-wood products as well as their resources will be determined with their location map and utilization period by regions.

• Instructions, recommendations and a handbook will be compiled and followed to improve use of non-wood products such as pine seeds, berries, mushrooms and medicinal plants

• To support an increase in household income by promoting non-wood product processing and adding to it's assortments.

Forest conservation

• To organize seed collection based on genetic selection evaluation and set up seed harvesting sites in each forest vegetation zone.

• Tree seed analysis laboratories with improved facilities and equipments will be renewed.

• To start establishment of mother seed tree plantations with selection of elite and plus trees.

• To provide financial support to the establishment of tree breeding nurseries for the greening of settlements, reforestation and creation of shelterbelts to combat desertification and soil degradation in pasture and crop land.

• To expand reforestation work annually in 10.0 thousand ha, mobilizing activity of local citizens, youth and the public community in seed collection and breeding of tree seedlings.

• To organize domestic industry to produce simple hand equipment for tree seed collection and seedling breeding.

• To provide portable equipment for forest nursery and reforestation work modernizing technology of tree planting and reforestation.

• To introduce suitable technology in the practice of natural forest regeneration succession and tree plantation activities in accordance with forest vegetation zones and regions.

• To implement regulations for conducting reforestation by project and plan and to develop their monitoring, evaluation and procedure for financing and transferring to state forest land.

• To renew the norms of assessment and expenses of seed collection, seedling breeding and reforestation and standard amount of seeding and seedlings for forest rehabilitation and tree planting in accordance with steppe and Gobi-desert zones.

• The World Environment Protection Day will be celebrated by planting trees for 10 days annually in every aimag and settlement.

• To improve inventory of tree planted areas providing a continuous cycle such as tree planting, tree patching, care for them and transfer to state forest land.

• Actions against desertification, creation of forest strips and small stands to protect crop land and pasture will be supported and encouraged.

• In cases of exception of provision 23 of the second part of the Forest law of Mongolia, a citizen, economic entity or organization are able to own forest planted by themselves.

9. Institutional strengthening

• Renewal of legal environment and implementation and monitoring of legislation by making amendments in the forest legislations will be intensified

• A unit responsible for forest and related issues will be established in every aimag and the capital to coordinate activities of professional organizations

• Local professional organizations of all types of ownership will be set up.

• The system of coordination of activities of forest protection, rational use of forest, reforestation-activities included in the duties of central governmental organization responsible for nature and environment, governors of capital and aimags will be refined, improved and regularized.

• Protection of forest, reforestation which is conducted according to the contract signed by NGOs and central governmental organization, local organizations at their expense or at budget will be increased. NGOs will be involved in activities such as: protecting the interests of domestic manufacturers who are engaged in forestry, to provide them know-how, machinery and business information, to assist in project implementation.

• Protection of forest resources and regeneration activities conducted by a citizen or economic entity, which has voluntarily joined will be supported.

10. Technology transfer and forestry research

• To intensify scientific investigations for the development of modern technology of forest protection, forest utilization, forest regeneration, forest ecosystem sustainability and its change.

• To work out agro-technology and techniques of plantation and selection of species to be used for setting up greenbelts, shelterbelts and small stands to improve agricultural yield productivity as well as protection of pasture and crop land from soil degradation and desertification in steppe and Gobi desert areas.

• To introduce scientific outputs for the development of the special protected area's management, protection of forest biodiversity, conservation of soil and water protection and combating desertification.

• To conduct experimental research in the field of creation of new materials from residuals, deep processing of raw wood materials, production of consumer furniture and development of the forest chemistry industry.

• To take measures to promote the institutional structure of research institutions of the forestry, forest harvesting and wood processing industry.

• Information system of forestry will be set up and it's capacity will be improved.

11. Human resource development

• The significance of forest resources and legislation related to forest will be widely advertised and publicized.

• Local authorities will be trained and educated in the field of forest legislation,, how to conduct forest inventories , forest protection, forest resource use and reforestation.

• Quality of training in National Universities and colleges that train forest specialists will be updated and their activities to educate highly qualified national experts will be supported.

• Trained experts who currently work in forestry will be enrolled in short term and long-term training either in Mongolia or abroad.

• Forest masters and workers with qualifications who are able to run forest industry processing will be trained and re-trained in accordance with a special plan.

• Inter-governmental agreements on fighting and prevention of trans-boundary forest fires will be signed by neighbouring countries.

Mongolian Second National Communication under the United Nations Framework Convention on Climate Changes (UNFCCC) summarizes the measures and actions which have been taken by the Government of Mongolia to meet its commitments and obligations under UNFCCC, government policy and strategies to solve climate change challenges, and key findings results of climate change research and studies conducted in Mongolia.

Policies and measures on adaptation to climate change

Improve forest management

The following major mitigation options have been identified for the forestry sector. 1) Natural regeneration; 2) Plantation forestry; 3) Agro-forestry; 4) Shelter belts; and 5) Bioelectricity;

Reduce emissions from deforestation and forest degradation, improve sustainable management of forests and enhance forest carbon stocks in Mongolian forest sector

There are a certain amount of potential for the reduction of GHG emission from deforestation and forest degradation in Mongolia. Therefore, it is possible to initiate and implement a REDD project in Mongolia through reforestation activities by community based forest management improvement and sustainable use of forest resources.

1. Adaptation strategy and policy

Sector	Strategy	Policy and Measures
Forestry	Ensured sustainability of forest resources	Strengthening forest resources protection and conservation management
		Expanding green areas and trees in urban areas
		Supporting tree-planting initiatives of individuals and organizations, and introduction of advanced technologies
		Increased resources of shrubs and bushes in the Gobi desert area through appropriate solutions of household fire fuels

2. Adaptation measures, needs, challenges and opportunities

Various adaptation options and measures to reduce the adverse impacts of climate change were defined in the National Action Plan on climate change updated in 2010.

Depending on factors such as climate change and harmful human activities, forest ecosystems are being changed though the deterioration of forest resources, epidemic of insects and diseases, and frequent forest fires, etc. However, these changes are not being recorded properly because a systematic monitoring system of forest stock does not exist in Mongolia.

3. Supporting natural ecosystems adaptation

Conservation of the Mongolian ecosystems means protection of rangeland from degradation and the restoration of degraded land at the lowest possible cost. One of the best practices for the protection of ecosystems is to establish a network of protected areas including ecosystems of representative regions that have natural and economic significance.

In 2008, 14% of the total territory, which is 61 areas of 21.9 million hectares were taken under state protection. The Millenium Development Goals aim to have 30% of the total land under protection in the future. Community protection of natural, historical or culturally significant areas has been a way of limiting negative human actions on those lands. In 2008, about 911 areas out of 16.3 million hectare were registered as local protected land. Protection of rangeland requires the following measures:

• An appropriate management system for the development of pasture

• Imposing legislation on pasture leasing, utilization and ownership. It is imperative to preserve pasture land through the investment made by herders themselves by increasing their awareness of the importance of pastureland, because pasture remains under state ownership, while the livestock is private. The investment by herders could be made in 2 ways: a) vegetation of pasture; and b) creation (cultivation) of pasture. The efficiency of both methods depends on how much the herders' sense of ownership of pasture is guaranteed. A promising future can be foreseen if the herders could cooperate in investing in pasture land.

• Comprehensive assessment and mapping of degraded lands at each provincial level

• Ensuring sustainable pasture utilization through improving pasture water availability, re-arrangement of administration units and coordination of otor - temporary pasture during emergencies, etc

• Biological management of insects and rodents inhabiting rangelend

• Strenthening the monitoring and information system of land use and its usage in application and operation.

• Conservation of rare and endangered plants for food and medicines and support for their planting

• Establishment of community ownership of areas in which wild animals are hunted and introd tion of endangered species of animals Cultivation of forage plants and introduction the best soil conservation management Setting up a pastureland irrigation system* Introduction of new varieties of plants, resist to droughts and pests.

4. Adaptation measures in forestry

• The main approach towards the protection of forest resources is to enhance the protected area network. Recently, the Parliament of Mongolia endorsed a new law banning mining activities in forest and water resource areas. The Millenium Development Goals based Comprehensive National Development Strategy stated the importance of sustanable utilization of forest resources through forest protection, restoration and maintaining ecological balances. The strategy can be implemented through the following measures:

• Organizing afforestation activities in at least 12 thousand ha areas in a year and implementation of the Government 'Green Belt' programme on land of at least 200 ha.

• Ensuring tree and bush seed production of at least 5 tons and plant 30 million seedlings per year

• Conducting a forest insects and diseases distribution survey in 1,200 thousand ha and implement actions against harmful forest insects and diseases in 68.5 thousand hectares of land in a year.

• Regulation of the limit of annual logging. Logging areas can be established as 20-30 thousand hectares per year in relation to tree types, their number and capacity.

• Strengthening forest fire prevention and fighting system.

• Introduction of enhanced forestry management methods. Community ownership on 20 percent of the total forest fund by local communities and forestry groups should be established in order to ensure forest protection restoration and proper utilization of forest resources, etc.

Recommendations

To develop and implement existing forest policy and legislation in Mongolia, it is necessary to review the policy and to identify the underlying causes of policy failures. It is suggested in this connection that forest policy is to be approached in a comprehensive manner covering institutional, social, economic and environmental needs.

In this regard, the following recommendations are required in respect of the following issues:

• To restructure and strength forestry institutions at central and local level (The feasibility of establishing an autonomous forestry board, and how it can be established and structured, is a matter for consideration).

• To formulate an appropriately phased and structured long term National Forestry Program for Mongolia to guide the sustainable forestry development of the country.

• To consider the linkage of policy, legislation, programs and their implementing mechanisms.

• The present system of forestland use should be reviewed in connection with forest conservation and protection in the country and to establish effective and efficient participation of local community organizations in forestry development, through rational resource allocation and appropriate arrangements.

• To establish an appropriately developed, structured and balanced enterprise system, financial system, social protection system and environmental protection system.

• To enhance the country's capability in the field of forestry development, including the need to strengthen and restructure institutions engaged in forestry research and the need to improve facilities for forestry education and training.

Data Aanalysis and Modeling of Biomass Study

I would like to report the results of biomass study of forest steppe in Western Mongolia that with growing concern about predicted global warming, increasing attention is being paid to biomass of forest stand and their role in the carbon cycle. Mongol Altai mountain ranges located at 440-500N, 880-960E, 1000-1800kms from capital city of Ulaanbaatar. Mongol Altai mountainous stretches from north-west to south-east approximately 800km long.

The forests distributed in Mongol-Altai mountain ranges represent the south-western boundary of Mongolian forest distribution and are located far from the massive forest of Northern Mongolia. The forests are distributed patchily within in limited areas and grow slowly under sub-boreal, sub-arid and strongly continental climates. They are commonly referred to as "relict forest".

Siberian larch (*Larix sibirica* Ledeb.) is Mongolia's dominant tree species, which covers 80 % of the forested area of the country (Tsogtbaatar 2004). Forests in Mongolia are not systematically managed with a methodology that would ensure sustainability. Rather, logging is largely driven by the demand for construction timber and fuelwood, for which permits are sold by the government. The logging itself is not carried out by foresters, but local stakeholders, including pastoral nomads and wood traders (Lkhagvadorj et al. 2013). A considerable part of wood is harvested illegally (Erdenechuluun 2006).

The selection of allometric regression models for estimating the above-ground biomass y (in kg dry weight) of larch from DBH D (in cm) and tree height H (in m) followed Hosoda & Iehara (2010), who modeled the above-ground biomass in *Larix kaempferi* and two further species of coniferous trees:

$$y = aD^b \quad (1)$$
$$y = a(D^2 H)^b \quad (2)$$
$$y = aD^b H^c \quad (3)$$
$$y = (D^2 H)/(a+bD) \quad (4)$$

Three-quarters (76±2%) of the total above-ground biomass was allocated in the trunk, whereas the branches accounted for 19±1% and the foliage 5±0%.

Biomass functions were established to estimate above-ground biomass of Siberian larch (*Larix sibirica*) in the Altai Mountains of Mongolia. The functions are based on biomass sampling of trees from 18 different sites, which represent the driest locations within the natural range of *L. sibirica*. The best performing regression model was found for the

equations $y = (D^2 H)/(a+bD)$ for stem biomass, $y = aD^b$ for branch biomass, and $y=aD^b H^c$ for needle biomass, where D is the stem diameter at breast height and H is the tree height. The robustness of the biomass functions is assessed by comparison with equations which had been previously published from a plantation in Iceland. There, $y=aD^b H^c$ was found to be the most significant model for stem and total above-ground biomasses.

Applying the equations from Iceland for estimating the above-ground biomass of trees from Mongolia resulted in the underestimation of the biomass in large-diameter trees and the overestimation of the biomass in thin trees. The underestimation of thick-stemmed trees is probably attributable to the higher wood density, which has to be expected under the ultra continental climate of Mongolia compared to the oceanic climate of Iceland. The overestimation of the biomass in trees with low stem diameter is probably due to the high density of young growth in the not systematically managed forests of the Mongolian Altai Mountains, which inhibits branching, whereas the plantations in Iceland are likely to have been planted in lower densities.

Study on: Assessment of Regional Climate Models and Selection of Appropriate Model Suitable for Mountainous Region of Nepal

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Acronyms

ADB	Asian Development Bank
APN	Asia Pacific Network
COP	Conference of Party
DHM	Department of Hydrology and meteorology
DSSAT	Decision Support system for Agro technology Transfer
GLOF	Glacier lake Outburst Floods
ICIMOD	International Centre for Integrated Mountain Development
IFC	International Finance Cooperation
IPCC	Intergovernmental Panel on Climate Chang
MOPE	Ministry of Population and Environment
NAPA	National Adaptation Program for Action
NARC	Nepal Agriculture Research Council
NDRI	Nepal Development Research institute
OECD	Organization for Economic Cooperation Development
PRCIS	Providing Regional Climate for Impact Studies
RCM	Regional Climate Model
RRI	Rainfall Runoff Inundation
SNC	Second National Communication
UNDP	United Nation Development program
UNEP	United Nation Environment Program
UNFCC	United Nation Framework Convention on Climate Change
WFP	World Food Program

Executive summary

The Second National Communication Project is preparing a report on the research and systematic observation through consulting services. One of components of this SNC is to prepare a report on research and systematic observation as its part and one of its activities is to prepare a report on “Assessment of Regional Climate Models and Selection of Appropriate Model Suitable for Mountainous Region". The primary objective of this task is to prepare a detailed and representative description of Assessment of Regional Climate Models and Selection of Appropriate Model Suitable for Mountainous Region” for research and systematic observation in Nepal that will be included in the SNC report. The study started with a detailed review of available articles, discussion with experts and related organizations related to climate modeling. It has found a few numbers of studies on climate modeling in Nepal.

It is found from the literature review that different types of models are used in Nepal regarding climate change. Global Climate Model was used by (McSweeney et al, 2011) showing trends in annual mean temperature. Empirical (statistical) downscaling was done by the University of Cape Town archive (A2 scenario for the 2040-2060 time period, UCT, 2012) considering around 9 models, downscaled to individual met stations for determining Monthly daily maximum temperature and monthly rainfall for the mid-century projections (A2) for

different sites in the country. An analysis was done by the Nepal Agriculture Research Council (Gautam, 2008) using simulation models (DSSAT)for major crops such as rice, wheat and maize. The Water Balance Model was first used in Nepal for the Koshi Basin. MOPE used the same model for the Karnali, Narayani, Koshi and Bagmati Rivers in Nepal in order to assess the vulnerability of climate change to water resources. It was also used by Chaulagain, 2006 in Chovar in the Bagmati basin (rain-fed) and Kyangjing in the Langtang basin. NDRI/ICHARM (2012) used a Rainfall Runoff Inundation (RRI) model. Naito et al. (2000, p. 245) applied Empirical Glacier Mass Balance Model model in the Eastern Himalayas for a numerical simulation of shrinkage of the Khumbu glacier and predicted the likelihood of formation and succeeding enlargement of a glacier lake in the lower ablation area of the glacier. Similarly, Naito et al (2001, p. 315) used the same model for estimating sensitivities of some other glaciers in the Nepal Himalayas in relation to climate change. With respect to Regional Climate Models, there have been several families of models applied in Nepal. As an example, the DHM study projects warming in all seasons in the mid-21st century (2039-2069). A new set of regional climate model runs have recently been produced as part of the DHM climate portal and the 2nd National Communication, which again has a RCM output for the A1B scenario. In 2010 the ICIMOD conducted one research on climate change impact on eastern Himalayan region of Nepal through PRECIS model on RCM framework. The study focuses mainly on analysis of contemporary trends in temperature and precipitation in the region and on analysing the scenarios of future climate change.

From th study and analysis it is found that the appropriate climate models suitable for Nepal are DSSAT crop models, BIOME 3, PRECIS RCM, Empirical Glacier Mass Balance Model and Water Balance model.

Assessment of Regional Climate Models and Selection of Appropriate Model Suitable for Mountainous Region of Nepal

1. Introduction

Climate change is a phenomenon due to emissions of greenhouse gases from fuel combustion, deforestation, urbanization and industrialization (Upreti, 1999) resulting variations in solar energy, temperature and precipitation. Climate has changed considerably throughout the history of the earth due to change in its forcig components, whether natural or anthropogenic. The rate of global climate change during the 20th century was greater than before (IPCC, 2001a, p.45). For example, average global temperature increased by approximately 0.6±0.20C during the 20th century, which was greater than in any other century in the last 1,000 years (IPCC, 2001a, p.45). The warming rate became even more pronounced during the second half of the last century, which was predominantly due to the increase in anthropogenic greenhouse gas concentrations in the atmosphere (IPCC, 2001a, p. 51; Graedel and Crutzen, 1993, p. 5). Many analyses show that the temperature increase in the twentieth century has been greater than in any other century during the past 1000 years (ibid). The 1990s was the warmest decade of the millennium and 1998 was the warmest year on record (IPCC, 2001a, p.173). If no action at a global level is taken to curb the rising trend, then scientists predict that the average global temperature will increase by 1.4 to 5.8ºC over the next hundred years, which may lead to consequences more drastic over the last 100,000 years (NRCS, 1995). The global average surface temperature has increased by about 0.6ºC during the twentieth century (IPCC, 2001a, p 152).

Studies show that developing countries are more vulnerable to climate change and are expected to suffer more from the adverse climatic impacts than the developed countries (IPCC, 2001a, p. 287). In a humid climate like that of Nepal, there will be changes in the spatial and temporal distribution of temperature and precipitation due

to climate change, which in turn will increase both the intensity and frequency of extreme events like droughts and floods (Mahtab, 1992, p.37). Observed changes in temperature trend in recent studies shows that the temperature of Nepal is increasing. For instance, Shrestha et al. (1999) in his study for the period 1977 to 1994 indicated a consistent and continuous warming in the period at an annual rate of 0.06o C. Similarly, a study conducted by Practical Action (2009), using data for the period 1996-2005, indicated a consistent and continuous warming in maximum temperatures at an annual rate of 0.04o C. The studies also indicate that the observed warming trend in the country is spatially variable.

There are indirect effects of climate change such as sea level rise, soil moisture changes, changes in land and water conditions, changes in the frequency of fire and changes in the distribution of vector-borne diseases (ibid, p.245). Global warming is causing the melting of glaciers in the Himalayas. Changes in the snowfall pattern have been observed in the Himalayas in the past decades (IPCC, 2001b, p.553). Almost 67% of the glaciers in the Himalayas have retreated in the past decade (IPCC, 2001b, p.553). Throughout Asia one billion people could face water shortage leading to drought and land degradation by the 2050s (Christensen et al. 2007, Cruz et al. 2007). Fifteen Glacial Lake Outburst Floods (GLOF) events have been documented in Nepal (Ives, 1986, Yamada, 1998. In Asia, the principal impacts of climate change on health will be on epidemics of malaria, dengue, and other vector-borne diseases (Martens et al. 1999). Climate change will have a significant impact on agriculture in many parts of the world (IPCC, 1998, p.397). Increases in temperature result in a reduced growing season and a decline in productivity, particularly in South Asia (Pachauri, 1992, p.82). Mountain agriculture, practiced close to the margins of viable production, could be highly sensitive to climate change (Carter and Pary, 1994, p.420). Risk levels of climate change often increase exponentially with altitude, therefore, small changes in the mean climate can induce large changes in agricultural risks in mountain areas (ibid, p.421). The recently observed extreme severe weather events between 2006-09 including droughts and floods have significantly affected food production in Nepal (WFP, 2009). In addition, it has been suggested that warming of more than 2.5°C could reduce global food supplies and contribute to higher food prices (UNEP & UNFCCC, 2002). International Food Policy Research Institute assessed impacts of climate change on global cereal production and concluded that the negative impact of climate change on world cereal production may vary from 0.6% to 0.9%, but in the case of South Asia, the impact could be as high as 18.2% to 22.1% (Von Braun, J., 2007). Within South Asia, the impacts are more pronounced in mountain areas than in the plain areas. It means, the impacts of the climate change are high in Nepal (Joshi et al. 2011).

Nepal signed the United Nations Framework Convention on Climate Change (UNFCCC) on 12 June 1992; it was ratified on 2 May 1994 and entered into force on 31 July 1994. As a Party to the Convention, Nepal took initiatives to identify the effects of climate change and areas that require immediate attention and assistance. Nepal had prepared the Initial National Communication with UNEP's support and shared with Parties to the UNFCCC in August 2004 as required by Article 12 of the Convention. The Initial National Communication sets out Nepal's obligatory contribution to international efforts to address Climate Change issues as a Non-Annex-I Party. It provides an overview of National Circumstances that influence Nepal's capacity to respond to the problem, and describes the Greenhouse Gas Emissions Inventory and Mitigation Options. This Communication deals on four major subjects: these are i) National Circumstances, ii) National Greenhouse Gas Emissions Inventory, iii) GHG Mitigation Options and iv) Vulnerability/Impact and Adaptations. With the continuation of step towards further implementation of the UNFCCC at a national level, the Ministry of Environment has implemented Second National Communication (SNC) project of Nepal. The project enables Nepal to present the information in a consistent, transparent, and comparable as well as flexible manner, taking into account specific national circumstances. In brief, the project aims to: a) Assist Nepal

with enabling activities; necessary to undertake an improved national greenhouse gas (GHG) inventory; b) Plan for actions for the mitigation of climate change and adaptation to its potential impacts of climate change; and Prepare the country's Second National Communication (SNC) to the Conference of the Parties (COP) of the UN Framework Convention on Climate Change (UNFCCC).

2. Objective of the study

The primary objective of this task is to prepare a detailed and representative description of Assessment of Regional Climate Models and Selection of Appropriate Model Suitable for Mountainous Region" for research and systematic observation in Nepal that will be included in the SNC report.

3. Rationale of the study

Climate change is a serious and urgent issue and climate change is not going to be resolved in the near future. It is a real threat to the lives in the world that largely affects water resources, agriculture, coastal regions, freshwater habitats, vegetation and forests, snow cover and melting and geological processes such as landslide, desertification and floods, and has long-term effects on food security as well as in human health. It is therefore essential to comprehend the future possible scenario of climate change in terms of global warming. It is required to project the future climate change to aid policy makers in making decisions. Climate models are considered as the main tools available for developing projections of climate change in the future. In order to apply appropriate and better options for mitigation and adaptation to climate change climate modeling in various sectors like temperature, agriculture, water, glacier etc is very crucial. Different climate models in various sectors are used in Nepal by government organizations, NGOs, academic sectors or students from different parts of the world. Nepal lacks a proper documentation of the study that has been performed on various sectors of Nepal in climate model and projections. So it is crucial to document the studies on climate modeling. With the proper documentation of the various models used in Nepal and with reference to IPCC suggested models we then can suggest the better climate model suitable for Nepal. And most of all is one of the components of Second National Communication is to prepare a report on research and systematic observation as its part and one of its activity is to prepare a report on "Assessment of Regional Climate Models and Selection of Appropriate Model Suitable for Mountainous Region". So this study is highly required.

4. Scope of the study

The scope of the study includes the following:

a. Review of the available documents related to climate models;
b. Assess the climate models that are used in Nepal to assess the climatic scenario;
c. Suggest the appropriate climate model suitable for mountainous region of Nepal; and
d. Based on the gathered information, prepare a final report on regional climate models and selection of appropriate model suitable for mountainous region.

5. Methodology

This study was based on literature review and consultation with climate change experts and related stakeholder like research institutions, GOs, Bilateral and multilateral agencies like ADB, IFC, WB Group, INGOs and NGOs. The articles and journals were collected in electronic as well as hard copy from internet and library. The secondary information was also collected by discussion with climate change modeling experts.

6. Current Climate Vulnerability in Nepal

6. 1 Current climate

The climate of Nepal (and particularly the temperature) significantly varies across the country, due to the strong elevation gradients, from the hot Terai plains (a few hundred meters above sea level) to the cold high mountains, shown below. The highest temperatures occur during the pre-monsoon period. The lowland regions of Nepal have a warm and humid sub‐tropical climate, while the high mountainous regions are cold, and remaining well below zero in the winter (PAC, 2009).

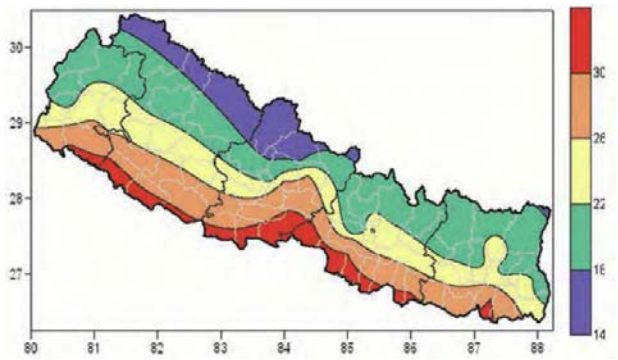

Figure 1. Spatial variation of mean maximum temperature. Source PAC, 2009.

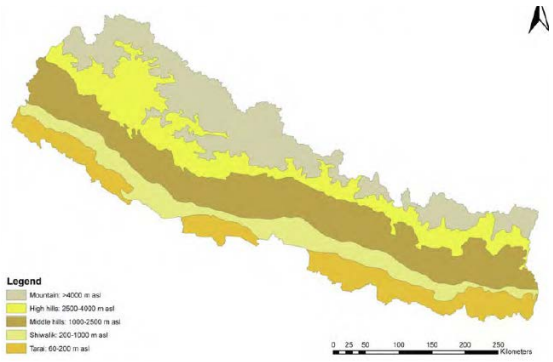

Figure 2. Elevation. Source PAC

The mean annual rainfall in Nepal varies dramatically, by area, and perhaps more importantly, by season. The terrain and topography – notably the large mountain systems – have a major impact on rainfall patterns. Average annual rainfall is approximately 1800 mm (GON, 2010), but rainfall is dominated by the monsoon rains, from June to August/September. The monsoon rain is most abundant in the east and gradually declines as it moves towards the west (GON, 2010: PAC, 2009). High extreme rainfall is a major source of floods and landslides, as well as soil erosion and sedimentation transfer. Importantly, there is high variability in annual and seasonal rainfall between years (Baidya et al 2007; PAC, 2009).

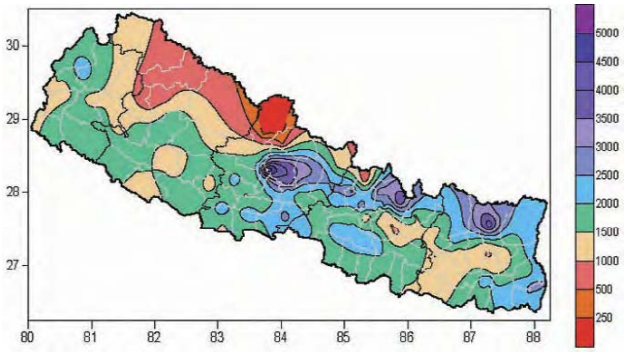

Figure 3. Annual mean rainfall. Source PAC, 2009

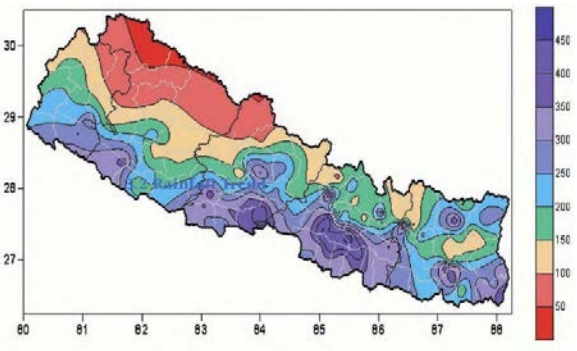

Figure 4. 24 hours highest rainfall (mm). Source PAC (2009)

6.2 Emerging Climate Trends

The study has reviewed the recent trends looking at observational data (including recent trend reviews; Shrestha et. al. 1999; McSweeney et al. Baidya et al 2007; Saraju et. al 2008; PAC, 2009; GoN, 2010).

The NAPA (GON, 2010) reported a trend of observed warming for Nepal (though with regional differences). More recent detailed analysis performed by Practical Action, 2009 looking over a period of 30 years (1976-2005) reported that maximum and mean temperatures are rising. Further increases in temperature are anticipated over the next decade or so, potentially accelerating as climate change signals strongly emerge, though these increases have to be seen against the existing (and dominant) temperature gradients from altitude.

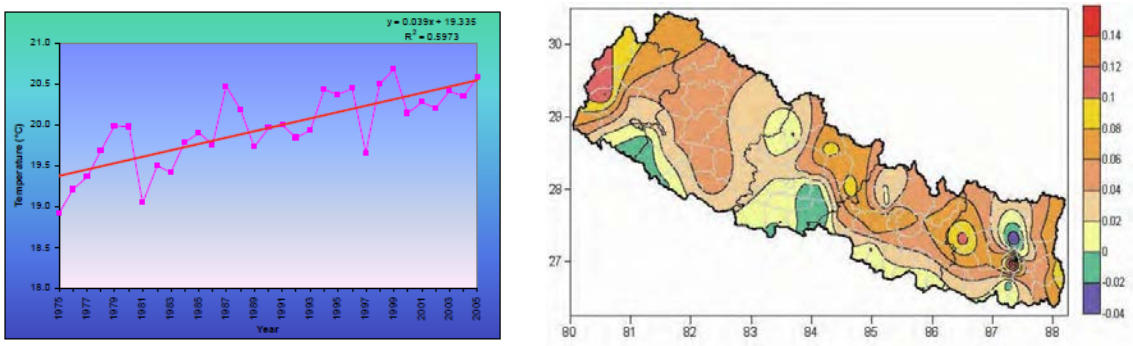

Figure 5. Annual mean temperature trend Nepal (Baidya et al (2007) and spatial pattern (PAC, 2009)

For rainfall, the situation is more unclear, and there is uncertainty. The NAPA reported that precipitation data does not show any general nationwide trends (though the UNDP country profile (McSweeney et al) reported a trend of decreasing annual precipitation). However there are number of regional precipitation trends and the NAPA reports that annual precipitation data show a general decline in pre-monsoon precipitation in far- and mid-western Nepal, with a few pockets of declining rainfall in the western, central and eastern regions. Other studies (Baidya et al 2007; Practical Action, 2009) report a change in precipitation over time during the different seasons with some regions show increases and others show decreases. Saraju et. al. (2008) found an increasing trend in the number of extreme precipitation days at the majority of the stations (but particularly for stations below 1500 metres) and highlighted the implications for landslides, flash floods and inundation.

7. Climate Model Data and Projections for Nepal (Based on Literature review)

The analysis of the future impacts and economic costs of climate change requires projections of future climate change, which is produced from climate models. These models use future scenarios (of socio-economic and emissions) to make projections of future changes in temperature, precipitation and other meteorological (and hydro-meteorological) variables over time. The projections are made using global climate models that operate at a high level of aggregation. However, these can be downscaled to regional levels either with statistical downscaling or with regional climate models. The review has considered the available climate model projections for Nepal. Importantly, there is a significant range of temperature across different scenarios and from different models, which cautions against the use of central trends (or reporting, e.g. with mean values). This can be seen in the figure below, which captures the range of future temperatures across different SRES scenarios and across models – showing that some models project an increase in average temperature in excess of 5 °C by 2080 (Figure 7).

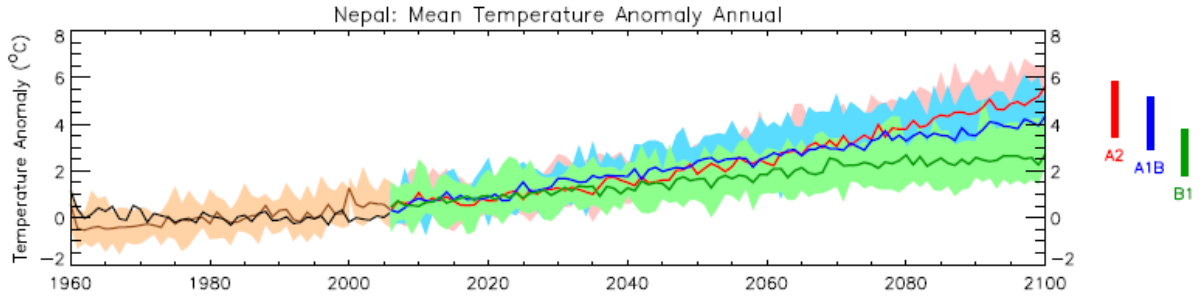

Figure 7. Trends in annual mean temperature for the recent past and projected future simulated by 15 models for each emissions scenario (McSweeney et al)

Some models project a likely increase in annual precipitation over the country, though considerable caution is needed in interpreting this finding. The increase in rainfall is primarily associated with increased rainfall during the monsoon season, and further, the models indicate increases in the proportion of total rainfall that falls in 'heavy' events. McSweeney et al (2011) report a similar variation across scenarios and model projections, indicating changes between -30% and + 100% (Figure 8).

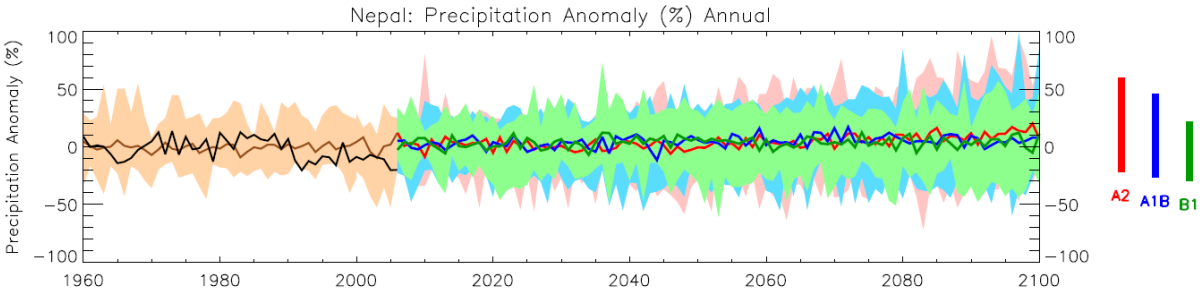

Figure 8. Trends in annual mean rainfall for the recent past and projected future simulated by 15 models for each emissions scenario % anomaly (McSweeney et al)

This is a critical finding for the study. There are a range of future emission profiles, ranging from low to high levels, and many climate models available. These give very different results, even for variables such as average temperature. For precipitation, the difference is often even in the sign of change (+/-). An important part of the review has therefore been to consider the breadth of available projections, and interpret the information, rather than reporting examples from one or two models. These differences caution against the use of Global Climate Model data, especially given the elevation and climatic zones across Nepal. However, similar differences emerge with downscaled projections.

7.1 Downscaled Projections

The study has considered two alternative approaches for producing downscaled data - empirical (statistical) downscaling and Regional Climate Model (RCM) outputs. An analysis of statistically downscaled data (derived from using station meteorological data) is presented below, from the University of Cape Town archive (A2 scenario for the 2040-2060 time period, UCT, 2012). This considers around 9 models, downscaled to individual met stations (Figure 9). The climate change projections for Kathmandu are shown in the box below (for 2040-2060 periods for the A2 scenario). These show broadly consistent trends for temperature, but very complex and uncertain projections for precipitation. The downscaled data shows even greater variation when the wide range of climatic zones in Nepal is considered. This is shown in Figure 18, which plots downscaled mid-century projections for different stations across Nepal, noting that each has a very different existing climate.

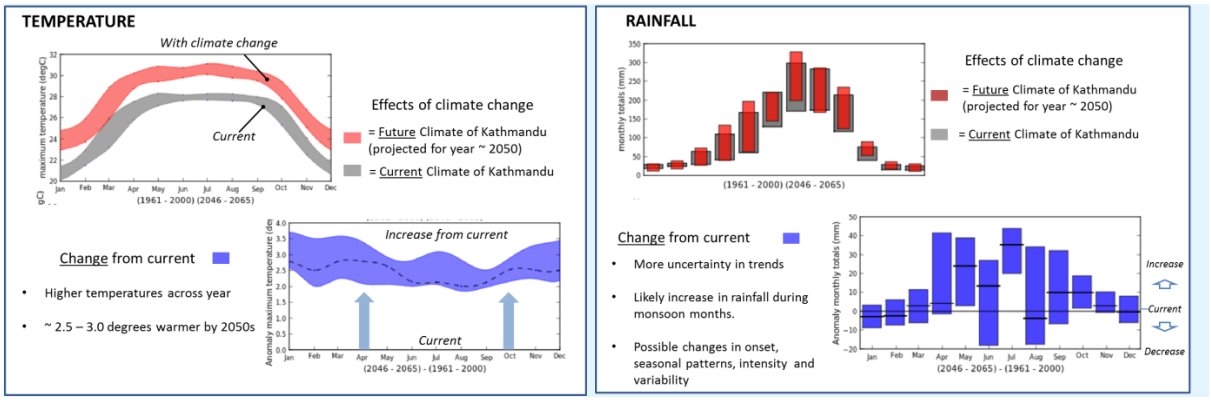

Figure 9. Temperature and Precipitation Projections for Kathmandu (A2, 2050)

Source of data: Climate Systems Analysis Group (CSAG), University of Cape Town, UCT (2012)

Figure 10 shows the monthly daily maximum temperature and monthly rainfall for the mid-century projections (A2) – for both current and future (top figures) and relative to current (bottom figures), for temperature and precipitations. While the relative changes in temperature are similar across areas, these arise on top of very different baseline climates, and will therefore have very different impacts. The changes in rainfall vary significantly by location, which leads to strong differences in the patterns of seasonal and monthly rainfall, with different precipitation trends in different parts of the country, and different levels of changes, though there is a common theme of uncertainty.

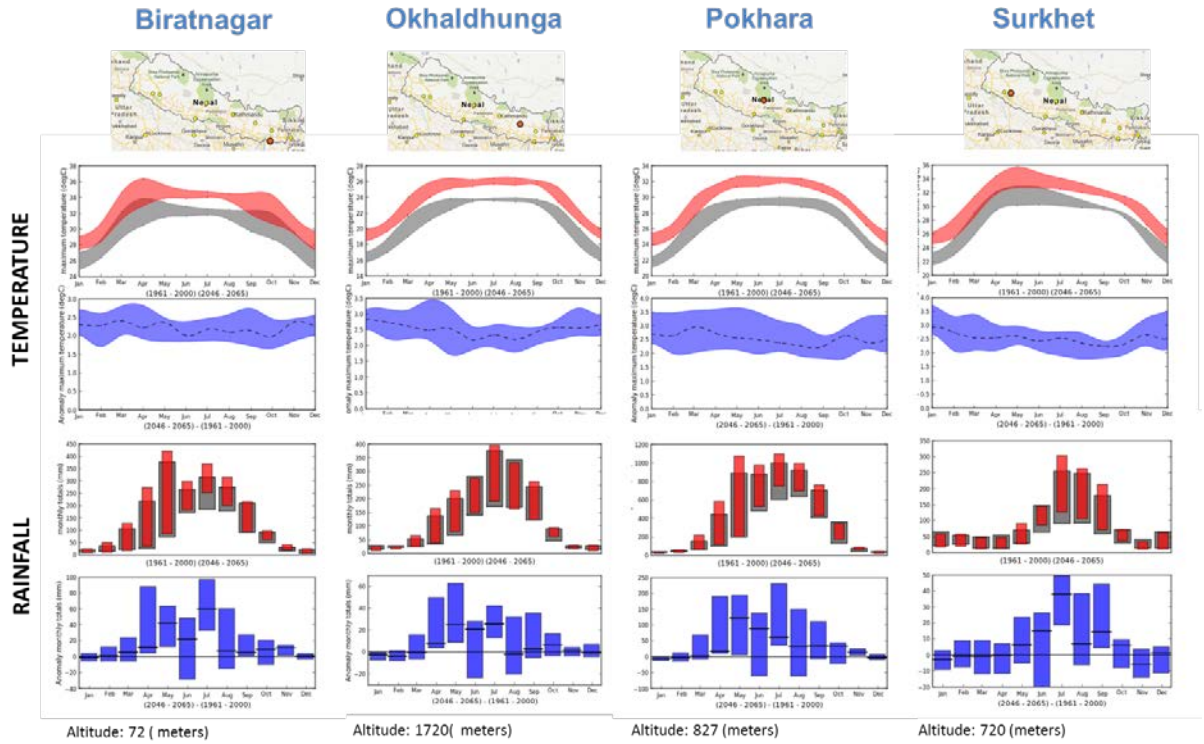

Figure 10. Monthly daily maximum temperature and monthly rainfall for the mid-century projections (A2) for different sites in the country (Source: Climate Systems Analysis Group (CSAG), University of Cape Town, UCT, 2012)

With respect to Regional Climate Models, there have been several families of models applied in Nepal (NCVST, 2009: Karmacharya et al., 2007; GCISC et al. 2009). As an example, the DHM study (Karmacharya et al., 2007) projects warming in all seasons in the mid-21st century (2039-2069) with the warming in the northern part over the high Himalayas being higher than that in the southern part, and highest in the winter and lowest in the pre-monsoon season in both the east and west Nepal. The annual mean temperature was projected to rise in the range of 1.7oC in the southern region of the country to 2.5oC in the northern region. It also projected a decrease in annual precipitation in large parts of the country, mainly in the eastern and southern Nepal (by up to -30%) but no change in precipitation over north central and north-west Nepal, and with varied seasonal changes. A new set of regional climate model runs have recently been produced as part of the DHM climate portal (which has three regional climate model outputs for the A1B scenario) and the 2nd National Communication, which again has a RCM output for the A1B scenario.

While these regional applications are very promising, it is important to highlight that while regional models may start to address the complexities of the local climate, the use of a small number of regional models does not capture model variation, i.e. it is not a substitute for multi-model ensemble analysis – indeed, it can even be counter-productive by giving apparent confidence without capturing the underlying model bias, e.g. whether the model is warmer, wetter, drier, etc..

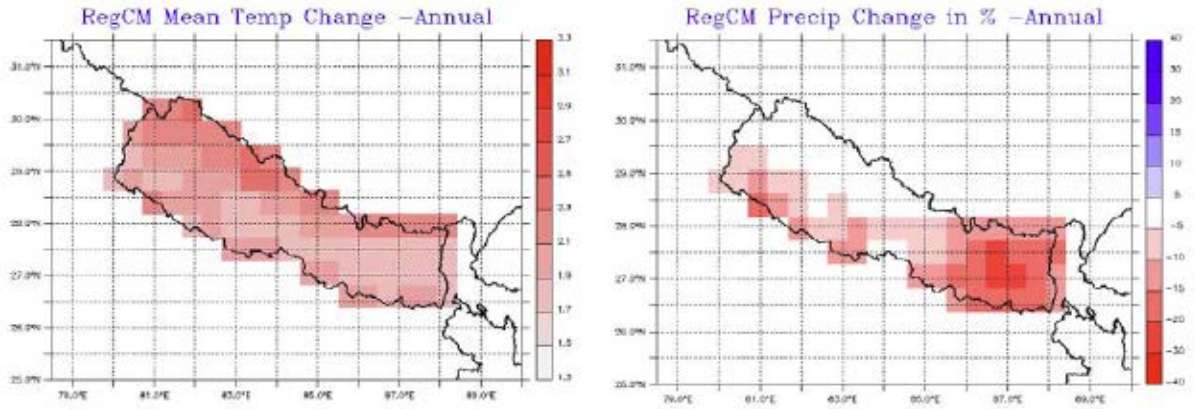

Fig. 12a: Mean annual temperature change (°C)

Fig. 12b: Mean annual precipitation change (%)

Figure 11. RCM output for Nepal. Source: Karmacharya et al., 2007

Furthermore, due to the complex topography, local variations in response to global and regional climate change, particularly for precipitation, are likely to be large and many areas may vary from the regional trend – as highlighted by McSweeney et al, there is a lack of consistency between models in representing monsoon processes. This will contribute to uncertainty in estimates of future precipitation.

Finally, there is the potential for major changes in the longer-term with the monsoon patterns of the region, with the transformation of the monsoon highlighted as one of a number of potential global tipping points (more recently referred to as tipping elements).

Overall, the projections indicate that there is high uncertainty for future rainfall, and even more so for the changes in variability and extremes, and thus broadly for water related impacts and water resources.

The review clearly highlights that for rainfall, variability and extreme events (e.g. floods and droughts), the results from the models differ significantly and there is a need to consider the outputs of a range of models, rather than a single central projection. Indeed, even if new

RCM runs emerge, these will not solve the issue of future model projections, because of the range of emission scenarios and range of models, let alone the underlying evidence on some of the more complex effects of climate change on the regional climate from changes in the high mountains. It is essential to recognize this uncertainty, rather than ignoring it, and to plan robust strategies to prepare for uncertain futures, rather than using uncertainty as a reason for inaction.

In the study conducted by OECD in 2003 shows that mean annual temperature increase by an average of 1.2 C by 2030, 1.7 C by 2050 and 3 C by 2100 compared to a pre-2000 baseline. Similarly NCVST (2009) study projects the mean annual temperature to increase by 1.4o C by 2030, 2.8o C by 2060 and 4.7C by 2090. Both the studies show higher temperature increment projections for winter compared to the monsoon season. In terms of spatial distribution, the NCVST (2009) study shows a higher increment in temperature over western and central Nepal as compared to eastern Nepal for the year 2030, 2060 and 2090 with projections for western Nepal being greatest. Similar trends are projected for the frequency of hot days and nights for 2060 and 2090 (in MoE, 2010).). For precipitation GCMs project a wide range of changes, especially in monsoon: -14 to 40 % by the 2030s increasing -52 to +135 % by the 2090s (NCVST, 2009).This projection suggests that Nepal's agriculture will face many challenges over the coming decades due to climate related variability.

There are studies on the potential effects of climate change and agriculture in Nepal (Sherchand et al, 2007; Malla, 2008; Rai et al; Pokhrel and Pandey, 2011; Nayava et al 2011; Thapa and Joshi, 2010; Pant, 2011; Lama and Devkota, 2009; Bastakoti et al 2011). An analysis done by the Nepal Agriculture Research Council (Gautam, 2008) using simulation models for major crops such as rice, wheat and maize suggested that rice yields might increase under elevated CO2 and 4°C increase in the Terai (lowland)(3.4%), hills (17.9%) and mountains (36.1%). Similarly, wheat production might increase by 41.5% in the Terai, 24.4% in the hills and 21.2% in the mountains under elevated CO2, but there would be a significant decrease in production with a 4°C rise. Maize yields were expected to increase in the hills and mountains, but decreased in the Terai with 4°C rise (Sherchand et al., 2007 cit ed in Malla, 2008; Gautam, 2008). The main quantified focus to date has been on crop production and two main approaches have been used in the agricultural sector to assess future impacts (and economic costs): crop models and ricardian (econometric) analysis.

There is a significant literature that has applied crop models (agronomic models) to assess the soil-plant-atmosphere components relevant for plant growth and yield, and also look at the effects of future climate change on crop productivity (GON, 2004: Sherchand et al, 2007; Rai et al). These have found mixed results for Nepal, often with a mix of positive and negative effects depending on the degree of change, and the geographical areas considered. Many studies report an increase in crop productivity, especially at modest levels of temperature change (and especially when CO2 fertilization effects are factored in). As an example, early DSSAT modeling in the National Communication (GON, 2004) reports that temperature rise might increase wheat output in the western region of Nepal but could lead to a decline in other regions. Rice yields were also generally anticipated to increase up to a certain temperature level. However, potential decreases in yield were reported for maize (a temperature sensitive crop) particularly in the Terai. Overall, effects have been strongly influenced by future CO2 concentrations and CO2 fertilization effects. Moreover, the studies and other literature highlight that the changes in productivity vary not just on temperature but on future precipitation and water availability.

The DHM/APN (Sherchand et al, 2007) study also applied DSSAT. It reports that CO2 concentration increases (in the absence of other effects) would increase crop production (due to fertilization effects). However, varied effects were found across the three crop types and three physiographic regions (Terai, Hill and Mountain) when temperature and rainfall

trends were factored into the analysis. For rice, there were broad increases in yields projected across the temperature and rainfall changes, though with a lower relative increase with higher temperature changes in the Terai. For wheat, yields were more varied, with some reductions in yield in the Terai when temperature was factored into account, but favorable changes reported in the mountains. For maize, projected yields declined in the Terai and Hill regions with higher temperatures (though led to positive effects in the Mountains). However, it also highlighted that many of the crops are particularly vulnerable to variability and droughts in key stages of development (particularly pre-monsoon). Overall, the projections were reported to show that Nepal could move from a nation of marginal surplus under a baseline normal scenario to a case where supply and demand only just balanced under the climatic change scenario (assuming no adaptation). Rai et al, using the DSSAT model, looked at rice in Nepal and reported that modest temperature increases (minimum temperature) have positive effects, but above 2°C negative impacts start to arise.

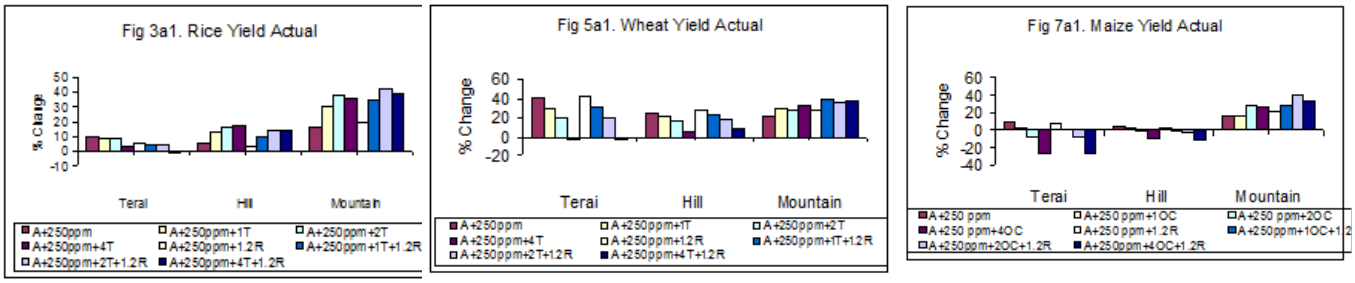

Figure 22. Rice, wheat and maize yield at different altitude regimes as influenced by climatic variability.Source Sherchand et al (2007)

There have also been some Ricardian modeling studies, which consider the long-term productivity of land, and consider different influences on land value or farm net revenues, including climatic differences, using cross-sectional data. These can look at how future climate conditions affect these land values or farm net revenues. Thapa and Joshi (2010) apply such a Ricardian approach to Nepal. This identifies existing relationships between net farm income and climate variables. The findings show that these variables have significant impacts on the net farm value per hectare.

There is relatively less information available on the potential effects of climate change on livestock. The studies and reviews available (Pokhrel and Pandey, 2011, Sherpa, et al. 2009) indicative a combination of possible effects, either from direct impacts (heat stress) or from indirect effects associated with vector borne disease, impacts on pasture or forage production, climate variability and water availability or hazards risks, and highlight potential increases in production costs and/or declining productivity. The studies identify that yaks might be particularly vulnerable to climate change, due to the fact they are acclimatized to colder temperature, and are sensitive to high temperatures, with effects potentially exacerbated by herding practices.

7.2 The Water Balance Model

WatBal model was developed by Yates (1994, p.1) for climate impact assessment of river basin runoff. It was first used in Nepal within the US country study programme for the Koshi Basin (Gurung, 1997, p.33). MOPE (2004, p.98) used the same model for the Karnali, Narayani, Koshi and Bagmati Rivers in Nepal in order to assess the vulnerability of climate change to water resources. Potential evapo-transpiration was calculated separately using the Penman-Monteith equation (Allen et al., 1998, p.65) and applied as input data in the model. In order to assess the climate change impacts on river runoff, (Chaulagain, 2006) the model was calibrated and validated for two hydrological stations 1. Chovar in the Bagmati

basin (rain-fed) and 2. Kyangjing in the Langtang basin (snow-fed). This was sdone in order to estimate the sensitivity of river runoff to temperature and precipitation changes. The result showed that the runoff had a negative correlation with temperature change but a positive correlation with precipitation change. There will be a 7.5% decrease in annual runoff with a 5ºC rise in the temperature assuming no change in precipitation. Similarly, a 10% decrease in the precipitation and a 5ºC rise in the temperature may result in a 17.4% decrease in the river runoff of the Bagmati River at Chovar. He also performed the runoff modelling with WatBal model for the glacier-fed Langtang Khola. A sensitivity analysis for the Langtang Khola was carried out for the temperature changes from +10C to +50C and the precipitation changes from -10% to +10%. The result showed a 0.6% decrease in annual runoff with a 5ºC rise in the temperature assuming no change in the precipitation. Similarly, a 10% increase in the precipitation and a 5ºC rise in the temperature may result in only a 1.9% increase in the annual runoff of the Langtang Khola. The runoff of the Langtang Khola was less sensitive to temperature rise than that of the Bagmati River (see Table 5.4). This was because of the existence of the melt-water component in the runoff of the Langtang Khola, which masks the effect of decreasing runoff due to warming by providing additional runoff from glacier-melt.

In terms of rainfall and river discharge, in line with the climate models, there are strong differences by season and high uncertainty across the models that translate into projections of water availability. These are further exacerbated due to the complexity of the Nepalese monsoon (thus even downscaled models have high uncertainty of future trends). Some studies (e.g. GoN, 2004) report potential increases in river discharge associated with increased monsoon rainfall, also noting that the increase in extreme precipitation would be a factor in increasing flood risks. NDRI/ICHARM (2012), using a Rainfall Runoff Inundation (RRI) model, project that precipitation frequency will increase in the near future due to climate change, with an increase in intensity that will increase extreme (flood) events in the lower West Rapti River Basin, leading to increased household damage and agricultural losses. Importantly, they identified that the most affected villages from increased risks are also the areas which are most socio-economically disadvantaged.

Sharma and Shakya (2006) assessed potential changes from emerging climate change trends in the Bagmati River basin, which is interesting due to the current water supply deficit. The study reported a trend of reduced mean yearly flow and monsoon season flow in the Bagmati River, and highlighted the effects of continued trends on hydro-power production. The study also reported that the magnitude of floods is decreasing but the frequency and duration are increasing. There are also possible issues of increasing demand and reduced supply water (e.g. Downing et al, 2012) between India and Nepal, and that given underlying demand trends, any changes from future climate change could be important. Such studies show the importance of local information and conditions, and analysis really needs to be undertaken at the catchment level, and to consider subsequent impacts and economic costs, this needs to extend to the analysis of demand as well as supply and availability, though previous applications of water management models (e.g. in the Tinau) have found the variability in the mountain context makes such assessments very uncertain.

Empirical Glacier Mass Balance Model was originally developed by Y. Ageta in 1983 using the observational data in 1978 and 1979 to calculate the mass balance of Glacier AX010 in the Nepal Himalayas (Kadota and Ageta, 1992, p.2). The general assumptions for the model application are as follow (Ageta and Kadota, 1992, p.90):

1. A rise in temperature does not affect precipitation and other climatic factors.
2. The amount of precipitation on the glaciers is independent of altitude and uniform for the whole glacier area under study.

3. The temperature changes with an adiabatic lapse rate of -0.6°C per 100 m of altitude.

This model received a wide acceptance to estimate the glacier mass balance in the Nepal Himalayas. Naito et al. (2000, p. 245) applied this model in the Eastern Himalayas for a numerical simulation of shrinkage of the Khumbu glacier and predicted the likelihood of formation and succeeding enlargement of a glacier lake in the lower ablation area of the glacier. Similarly, Naito et al.(2001, p. 315) used the same model for estimating sensitivities of some other glaciers in the Nepal Himalayas in relation to climate change. This analysis has revealed that the glaciers in the Nepal Himalayas, which are mostly summer-accumulation type, are more sensitive to temperature change than other glaciers in the world. Likewise, Kadota et al. (1997, p. 246) used this model to monitor and predict the shrinkage of a small glacier in the Nepal Himalayas and concluded that the shrinkage would accelerate in the years to come.

Dam breach model

A dam breach model developed by the National Weather Services (NWS-BREACH) was used to simulate the outburst hydrographs of Lake Imja Tsho. The inputs required by this model include the geometry and some geotechnical parameters of the moraine dam, the lake area, and the lake depth information. The geometric data of the Dig Tsho moraine dam were taken from the DEM. Since geotechnical parameters for the lakes were not available, parameters from the Tsho Rolpa were used (DHM 1996). This substitution is justified because of the many similarities between the two cases. Geometric data of the moraine dam of Lake Imja Tsho was based on information from a detailed survey conducted by Japanese scientists (Watanabe 1995) and the lake area-depth information was based on the bathymetric data of the lake (GEN 2001). After the GLOF hydrograph was derived from the NWS-BREACH model, the nature of flood propagation in the downstream was derived from hydrodynamic modelling. For this, the geometric and hydraulic data from HEC GeoRAS was exported to HEC-RAS, a single dimensional hydrodynamic model developed by the US Army Corps of Engineers, Hydrologic Engineering Center (HEC) (USACE 2004). A flow hydrograph, derived from NWS-BREACH, was given as the upstream boundary. The attenuation of Lake Imja Tsho GLOF is much dampened. The peak discharge of 5400 m3s–1 at the outlet of the lake is sustained for a considerable distance. Many closely spaced peaks are found throughout the river reaches. Higher flooding depths occur at the narrower river sections. Such narrow sections can be found at the gorges downstream of Tengboche and upstream of Namche Bazar, and at the confluence of the Dudh Koshi and Bhote Koshi. The spatial distribution of the flood was analysed by preparing inundation maps for the high flood level along the river. The inundation maps reveal the spatial extent of the flooding as well as the depth of the flooding along the river reach (Table 4.3). This table helps estimate the arrival time of the flood – information that can be useful in preparing to reduce the GLOF risk.

7.3 Regional Climate Model

A regional climate model (RCM) is a high resolution climate model that covers a limited area of the globe, typically 5,000 km x 5,000 km, with a typical horizontal resolution of 50 km. RCMs are based on physical laws represented by mathematical equations that are solved using a three-dimensional grid. Hence RCMs are comprehensive physical models, usually including the atmosphere and land surface components of the climate system, and containing representations of the important processes within the climate system (e.g., cloud, radiation, rainfall, soil hydrology). Many of these physical processes take place on much smaller spatial scales than the model grid and cannot be modeled and resolved explicitly. Their effects are taken into account using parameterizations, by which the process is

represented by relationships between the area or time averaged effect of such sub-grid scale processes and the large scale flow.

Given that RCMs are limited area models they need to be driven at their boundaries by time-dependent larges cale fields (e.g., wind, temperature, water vapour and surface pressure). These fields are provided either by analyses of observations or by GCM integrations in a buffer area that is not considered when analysing the results of the RCM (Jones et al.,1995).

7.4 PRECIS Model

PRECIS is a regional modeling system that can be run over any area of the globe on a relatively inexpensive, fast PC to provide regional climate information for impacts studies. The idea of constructing a flexible regional modeling system originated from the growing demand of many countries for regional-scale climate projections. Only a few modeling centers in the world have been developing RCMs and using them to generate projections over specific areas as this task required a considerable amount of effort from an experienced climate modeler and large computing power. Both these factors effectively excluded many developing countries from producing climate change projections and scenarios. The Hadley Centre has configured the third-generation Hadley Centre RCM so that it is easy to set up. This, along with software to allow display and processing of the data produced by the RCM, forms PRECIS.

7.5 Use PRECIS RCM model in Nepal

In 2010 the ICIMOD conducted one research on climate change impact on eastern Himalayan region of Nepal through PRECIS model on RCM framework. The study focuses mainly on analysis of contemporary trends in temperature and precipitation in the region and on analysing the scenarios of future climate change. The Climate Research Unit's Times Series' (CRU TS 2.0) data (New et al. 2002) were used to analyse temperature and precipitation trends. The eastern Himalayas were divided into three elevation zones: below 1,000, 1,000 to 4,000; and above 4,000 metres and area-averaged trends were derived for these regions for the period from 1970-2000. The period from 1970-2000 was chosen because after the 1970s the global and regional temperature records show monotonous rising trends, whereas before this period the trends generally descend (Jones and Mann 2004; Shrestha et al.1999). The spatial distribution of trends in annual and seasonal temperature is illustrated in Figure 2: it is clear that major parts of the region are undergoing warming trends. Annual mean temperature is increasing at the rate of 0.01°C/yr or more. In general, for annual and seasonal trends there is a diagonal zone with a southwest to northeast trend with relatively less (0 to 0.02°C/yr) or no warming. This zone encompasses the Yunnan Province of China, part of the Kachin State of Myanmar, and the northeastern states of India and Assam. The area to the upper left of this zone, which includes eastern Nepal and eastern Tibet, shows relatively greater warming trends (>0.02°C/yr). The warming in the winter (December, January and February; DJF) is much greater, about 0.015°C/yr more than the annual trends and more widespread by comparison. The diagonal zone of less warming is significantly small and limited to Yunnan and Arunachal Pradesh.

8. Conclusion

It is found from the literature review that different types of models are used in Nepal regarding climate change. Global Climate Model was used by (McSweeney et al, 2011) showing trends in annual mean temperature for the recent past and projected future simulated by 15 models for each emissions scenario (%) anomaly and trends in annual

mean rainfall for the recent past and projected future simulated by 15 models for each emissions scenario % anomaly.

Empirical (statistical) downscaling (An analysis of statistically downscaled data derived from using station meteorological data) was done by the University of Cape Town archive (A2 scenario for the 2040-2060 time period, UCT, 2012) considering around 9 models, downscaled to individual met stations for determining Monthly daily maximum temperature and monthly rainfall for the mid-century projections (A2) for different sites in the country.

With respect to Regional Climate Models, there have been several families of models applied in Nepal (NCVST, 2009: Karmacharya et al., 2007; GCISC et al. 2009). As an example, the DHM study (Karmacharya et al., 2007) projects warming in all seasons in the mid-21st century (2039-2069). A new set of regional climate model runs have recently been produced as part of the DHM climate portal (which has three regional climate model outputs for the A1B scenario) and the 2nd National Communication, which again has a RCM output for the A1B scenario. In 2010 the ICIMOD also conducted a research on climate change impact on eastern Himalayan region of Nepal through PRECIS model on RCM framework. The study focuses mainly on analysis of contemporary trends in temperature and precipitation in the region and on analysing the scenarios of future climate change.

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The Water Balance Model – WatBal was first used in Nepal within the US country study programme for the Koshi Basin (Gurung, 1997, p.33). MOPE (2004, p.98) used the same model for the Karnali, Narayani, Koshi and Bagmati Rivers in Nepal in order to assess the vulnerability of climate change to water resources. It was also used by Chaulagain, 2006 in Chovar in the Bagmati basin (rain-fed) and Kyangjing in the Langtang basin.

NDRI/ICHARM (2012) used a Rainfall Runoff Inundation (RRI) model, which projected that precipitation frequency will increase in the near future due to climate change, with an increase in intensity that will increase extreme (flood) events in the lower West Rapti River Basin, leading to increased household damage and agricultural losses.

Naito et al. (2000, p. 245) applied Empirical Glacier Mass Balance Model model in the Eastern Himalayas for a numerical simulation of shrinkage of the Khumbu glacier and predicted the likelihood of formation and succeeding enlargement of a glacier lake in the lower ablation area of the glacier. Similarly, Naito et al (2001, p. 315) used the same model for estimating sensitivities of some other glaciers in the Nepal Himalayas in relation to climate change.

The conclusion of ICIMOD research shows that the area-averaged seasonal and annual biases and sensitivities of the HadRM2 and PRECIS simulated mean temperatures over the Eastern Himalayan region. Both models indicate cooler climates than those of the observed data during all seasons and annual periods. Further, both models show the greatest bias during winter (DJF) and the least during pre-monsoon (March, April and May; MAM) over the region. Comparing Tables 2 and 3, the biases in the PRECIS simulation are greater than those in the HadRM2 simulation by 0.8°C in DJF and 0.1°C in MAM. Whereas, the biases in the HadRM2 simulation are greater than those in the PRECIS simulations by

0.5°C in summer (JJA) and 0.7°C in the post-monsoon (September, October and November; SON) period. It may thus be concluded, in general, that over the Eastern Himalayan region the performance of HadRM2 is better during winter and that of PRECIS is better during the summer and post- monsoon (SON) seasons. During the pre-monsoon (MAM) and annual periods, both models perform more or less uniformly.(Devkota l. et. Al, ICIMOD, 2010).

Recommendation

Due to complex geographical structure, data availability and based on literature review the PRECIS model with RCM framework is suitable for climate change impact study in Nepal. The PRECIS model is suitable because it can be run on a personal computer (PC) and can be applied to any area of the globe to generate detailed climate change projections. PRECIS has a horizontal resolution of 0.4425° latitude by 0.4425° longitude with 19 levels in the atmosphere and four levels in the soil. The present version of PRECIS has an option to downscale to a horizontal resolution of 25 km with A1B scenario. And other appropriate models that are suggested for Nepal

- In Agriculture DSSAT crop models (agronomic models) to assess the soil-plant-atmosphere components relevant for plant growth and yield, and the effects of future climate change on crop productivity.
- There are models (BIOME 3, FAO) to project the extent and nature of future ecosystem changes in the geographical distribution of species, and these models can be effective partially to quantify effects of climate change in a country like Nepal where adequate data are not available.
- Empirical Glacier Mass Balance Model to calculate the mass balance
- Water Balance model for climate impact assessment of river basin runoff

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OUTLINE OF PARTICIPANT PAPER
CASE STUDY OF FOREST ADAPTATION - PAPUA NEW GUINEA

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Abstract

Forest management in Papua New Guinea (PNG) is by PNG Forest Authority, as mandated by the government. Total landmass of PNG is 46.3 million ha, of which 62.6% (29.437m ha) is forested. All forestry operations by PNGFA are governed by specific policies and guidelines. The foundation for the forestry policies is the 4th goal of the National Constitution which is, "…to ensure that the forest resources of the country are used and replenished for collective benefit of all Papua New Guineans now and future generations." Forest Adaptation initiatives due to climate extremities are governed by a policy framework for action for 2009 to 2015. Impacts due to climate change on forest ecosystems, social and economical values are very obvious and are here to stay. Efforts are taken to assess vulnerabilities of identified impacts of climate extremities. Likewise adaptation measures are initiated by local communities and other key stakeholders.

Key words:

Forest management, PNG Forest Authority, climate change, climate extremities, vulnerability, adaptation

INTRODUCTION OF FOREST MANAGEMENT IN YOUR REGION AND FOREST POLICIES/ ACTION PLANS FOR CLIMATE CHANGE ADAPTATION

1. Outline of Forest Management in Papua New Guinea

The vast tropical forests and forest resources of Papua New Guinea (PNG) is managed by PNG Forest Authority (PNGFA) as mandated by the government. PNGFA's mission statement is in harmony with the country's constitution and aims to: *"Promote the management and wise utilization of the forest resources of Papua New Guinea as a renewable asset for the wellbeing of present and future generations."* As the custodian of the forests and forest resources, PNGFA is responsible for managing and developing the nation's tropical natural forest and state-owned forest plantations and for negotiation of timber industries activities as well as other forest related activities in the country.

1.1 Forests and forest resources of PNG

The total landmass of PNG is 46.3 million hectares (ha), of which 62.6% (29.0 million ha) is forested area as of 2010[1]. This is a decrease in forest area coverage by around 3.0 million ha from 32.0 million ha estimated 20 years ago (1990). Forest resource of PNG is unique and very diverse in terms of flora and fauna, some of which are found nowhere else on earth.

The landmass of PNG is broadly classified as follows[2];

[1] UN-REDD National Programme Document, FAO FRA 2010, National Report

[2] http://www.forestry.gov.pg/site/page.php?id=11

Total Land Area – 46.284 million ha
Forest Cover[3] – 29.437 million ha
Other wooded Lands – 4.474 million ha
Grassland & savannah – 3.241 million ha
Inland water bodies – 0.998 million ha
Other Land – 8.134 million ha

PNG's vegetation is classified based on the structural formation of the vegetation. Six broad classes have been distinguished as follow; Forests, Woodland, Savannah, Scrub, Grassland, Mangroves. Within these 6 structural formations, 59 vegetation classes have been differentiated. About 15 million ha of the forested area is classified as the productive forest, rich with some of the world's high quality tropical hard woods and other forest products that are of major revenue source for the country[4].

Geographically, the independent state of PNG is located on the eastern end of the Island of New Guinea and lies between 141.0° and 154.9° eastern longitudes and between 2.2° and 11.7° south latitudes. PNG has a population of about 6.1 million people with over 800 distinct languages and over 1000 ethnic tribal groups. Moreover, over 85% of the country's population live in rural areas and depend on the forests for their sources of food, medicine, clothing, shelter, water and for almost all their daily needs.

Fig. 1: Map of New Guinea showing part of West Papua (Indonesia) to the west and the Independent state of Papua New Guinea to the east.

1.2 Forest Policies of Papua New Guinea

PNGFA is the government's mandated body to manage acquired forest resources of the country. Its operations are governed by the following policies and guidelines; National Forest Policy 1991, Forestry Act 1991 (as amended), PNG Forest Authority Corporate Plan, The National Forest Development Guidelines 2009, Forest Regulations, National Forest Plans (19 Provincial Forest Plans)[5], PNG Logging Code of Practice, 24 Key Standards, and the Forestry and Climate Change Framework for Action 2009-2015.

The main policy target [i.e. National Forest Policy 1991] was approved in 1990 and gazetted in 1991. There are two main objectives of this Policy; (i) Management and protection of the nation's forest resources as a renewable natural asset, and (ii) Utilization of

[3] Production forest = 15m ha; Reserved forest = 13.2 m ha, and Protection forest = 1.2m ha

[4] PNG FA 2007 – 2012 Corporate Plan

[5] National Forest Plan comprises following documents: Development Guidelines for Forestry Sub-Sector; Forest Classification in each Province; Allowable cut by Province; Schedule for forest development in each province; National Forest Development Programme.

the nation's forest resources to achieve economic growth, employment creation, greater Papua New Guinean participation in industry and increased viable onshore processing. There are four other supportive objectives of 1991 Forestry Policy and are consistent with the government's strategies, especially in the sustainable development framework (e.g. MTDS[6]; LTDS[7] and PNG Vision 2050). The foundation for the forestry policies is the fourth goal of the Constitution and that is, *"to ensure that the forest resources of the country are used and replenished for the collective benefit of all Papua New Guineans now and for future generation."*

1.3 Framework of Planning System

The National Forest Plan provides a detailed statement on how the government intends to manage, develop and utilize the national forest resources. The forestry plan outlines a program of forest acquisition and the identification of areas that are considered to be suitable for commercial logging. The areas that are suitable for logging are acquired by the State under a Forest Management Agreement (FMA) signed between the landowner's representative identified under an Incorporated Land Group (ILG) and the PNG Forest Authority. Operations of all major timber concession areas are processed and operated in accordance with the National Forest Plan and the respective Provincial Forest Plans and regulated by the Forestry Act.

Forest resource development is undertaken in accordance with the National Forest Plan, Provincial Forest Plan and the National Forestry Development Guidelines. Timber harvesting operations are guided by the 'PNG Logging Code of Practice' and the '24 Key Standards'

1.4 Environmental Protection System

Environmental management is one of the eleven listed strategies under the Forest Management Policy. According to the forestry policy, all forest resource developers are required to submit an environmental plan for each approved projects. This environmental plan will be consistent with the Environmental Planning Act and with environmental plan and guidelines specific to forestry projects are regulated and issued by Department of Environment and Conservation. Areas approved for conservation are restricted from any forms of developments, except where specific permission is given by the Minister for Environment and Conservation under relevant clause of the Environmental legislation[8]. The Environmental Key Standards and Logging Code of Practice are supportive documents that provide guidance to ensuring compliance and effective monitoring of the logging operation and the environment.

1.5 ACTION PLAN FOR CLIMATE CHANGE ADAPTATION

"Forestry and Climate Change Framework for Acton for 2009-2015"

PNG Forest Authority recognizes its commitment to sustainable development and as a national government agency, it also realized that it cannot achieve such a task, but needs other relevant agencies and development partner support[9]. Within this context, this framework for action outlines the broad priorities for the Government. The framework provides a strategic platform not only for use by policy and decision makers, but also for the

[6] Medium Term Development Strategy

[7] Long Term Development Strategy

[8] National Forest Policy, Ministry of Forest, September 1991

[9] Forestry and Climate Change Framework for Action: 2009-2015

development and strengthening of partners for implementation of national, provincial and community initiatives. The framework is consistent with the timeframes of PNG's national development strategies[10] and other international obligations[11]. Significantly it addresses the issues of forestry and climate change that requires a national multi-stakeholder approach. Hence the framework intends to promote links with, but in no way supersede national and provincial instruments and plans across specific sectors that link to weather and climate including water, agriculture, energy, fisheries, mining and petroleum landuse, health, coastal zone management, forest soil management, marine ecosystem, ocean management, tourism and transport.

Vision

That Papua New Guinean people, their forests, environment and livelihoods are resilient to the risks and impacts of climate change.

Goal

To ensure that Papua New Guinea people build their capacity to be resilient to the risks and impacts of climate change through implementing adaptation measures; contributing to mitigation of greenhouse gas (GHG) emissions; improving decision making and good governance; improving understanding of climate change and its effects; promoting education and awareness; and developing and strengthening partnerships and cooperation.

There are seven underlying principles of this framework addressing important issues of concern to forestry as a sector due to the impacts of climate change now being experienced in communities and nation as a whole. Principle two (2) directly focuses on Adaptation and implementation of strategies to address the impacts of climate change;

Principle 2: Implementing Adaptation Measures

Building resilience through adaptation to climate change including climate variability and climate extremes has been identified as the key priority for all provinces and communities. The government has agreed with the FAR of the IPCC that they are already witnessing the adverse effects of climate change. New Guinea Islands, highlands and coastal areas of the country, in particular believe their very survival is threatened.

The ecological fragility, economic vulnerability and the remoteness of PNG makes recovery from extreme weather and climatic events very difficult. National adaptation policies and measures reflecting the whole of country approach need to be integrated into national sustainable development strategies and plans. PNG will encourage adaptation measures based on the precautionary approach and principles of risk management with a focus on improving the livelihoods of its people. Such an approach will require the implementation of resilience building measures that have multiple benefits including disaster risk reduction.

Expected Outcomes by 2015

1) Adaptation measures to climate change developed and implemented at all levels.
2) ARCDM and REDD^{+} projects on forestry initiatives facilitated and developed with adaptation funds or from Government and donor funding.
3) Highly vulnerable forestry priority areas identified through site-specific baseline data, collection and interpretation and adaptive actions developed.

[10] E.g. Medium Term Development Strategies (MTDS) and Millennium Development Goals (MDGs)

[11] E.g. Kyoto Protocol, the Johannesburg Plan of Implementation and subsequent work program of the UN Commission on Sustainable Development.

4) Integrated approaches to adaptation embedded in national sustainable development plans and budgeting process.
5) Research and development into forest types and climate impacts.
6) Restoration and rehabilitation: forest enrichment and plantation development with soil protecting species in highly degraded areas.
7) Main streaming of climate change into Forest Management Plans and policies.
8) Methodologies and research initiatives incorporated and streamlined into school curriculum.
9) Integrated food and wood production (agroforestry) for environmental, economic and social services that improve local communities' capacity to cope with adverse climatic events.
10) Improved and effective coastal mangrove and littoral forest management to minimize effects of heavy storms and rising sea level on coastal communities.
11) Improved and effective urban forestry management to maintain and improve shade cover to keep towns and cities in PNG cooler.

Implementing Strategy

PNGFA recognizes that the implementation of this framework, its forestry policy, MTDS, LTDS, the PNG MDGs Strategy, and the PNG Vision 2050 are mutually reinforcing. This will require more focused and substantially increased efforts, both by PNGFA and the PNG Government and by the rest of the international community, based on the recognition that PNG has primary responsibility for its own development strategies and cannot be over emphasized, taking into account the Rio principles, including *inter alia,* the principle of common but differentiated responsibilities as set out in principle 7 of the Rio Declaration on Environment and Development.

PNGFA with the necessary support from its donor partners and the international community, including facilitation and improvement of access to the existing resources and, where appropriate, through allocation of dedicated financial resources, will seek to implement actions identified in the framework nationally with the support of the landowners and their communities, as necessary. Harmonized implementation of this five-year framework is essential.

Monitoring the Framework

Evaluating progress against the vision, goal, principles, outcomes and priority activities of this framework will be undertaken regularly at all levels, following establishment of an appropriate baseline and mechanism. UN organizations, NGOs and the private sector will, where necessary, provide support and coordinating role, for regional and international reporting.

Targets and indicators will be established within the action plan linked to the framework and set at the appropriate levels. Mid-term review of the framework is now being carried out this year 2013 (now currently being done) to determine its overall success.

Key stakeholders will meet biennially to review progress on the implementation of this framework and its action plan. This will require PNGFA, Office of Climate Change and Development (OCCD), the Government, local communities, and NGOs to identify progress towards achieving and implementing the principles contained in this framework, and to identify emerging gaps requiring priority action and adjustment of priorities in the future.

KEY ISSUES/ CHANGES TO BE RESOLVED, MAIN CHALLENGES FROM CLIMATE CHANGE AND WHAT SHOULD BE DONE TO PROTECT OUR FOREST AND ENHANCE ITS SOCIAL, ECONOMIC AND ENVIRONMENTAL VALUES.

1. Background

It is anticipated that surface temperatures will increase by 2-4 °C (IPCC, 2007), while decreases in precipitation will likely lead to a significant reduction of rainfall causing increases in the frequencies and intensities of extreme climatic events, e.g. El Nino and La Nina. The IPCC Fourth Assessment Report (FAR) provides and reaffirms strong evidence that global, regional and national changes due to climate change, variability and sea level rise are caused by human and natural activities (IPCC, 2007[12]). Climate change in PNG is real and its impacts on terrestrial ecosystems are becoming more evident, especially with *increasing surface and air temperatures, changes in distribution and intensity of rainfalls, alteration of hydrological regimes, changes in wind patterns and intensity, altering fire frequencies and intensities, flooding and erosion regimes and changes in frequency and intensity of extreme weather events* (Saulei, S., *et al.* 2011).

2. Impacts of Climate Change

Impacts of climate change in PNG are very obvious. The consequences of incidences of extreme climatic conditions, especially in the forestry sector as experience in PNG results in the following;

- Prolonged and intense droughts and increase fire frequency and intensities: e.g. in 1997-98 PNG experienced severe droughts; resulted in extensive forest fires and loss of big areas of both natural and plantation forests.
- Increase temperatures leading to reduction in soil moisture, changed soil physical structures, increased seedling mortality: (e.g. Bulolo forest plantation – reduction in tree growth and termite attack as being reported[13]).
- Changes in the phenology, seed quality and physiology of trees due to increased temperatures.
- Invasive weeds: Occurrence of weeds and invasives such as exotic plants and animals which are not known to occur in the area before.
- Insects and pathogens: e.g. increase termite attack on trees as in Bulolo plantation, termite attacks were found to be related to the vulnerability of trees exposed to increasing temperatures and changed soil physical conditions (Saulei *et al, 2011)*.
- Natural forest mortality: e.g. Asengseng Consolidated FMA[14] in West New Britain Province - Trees died at altitude 250-550m due to injuries caused during harvesting and also due to 'edge effect[15]'- lead to decrease productivity in terms of timber volume per ha. The impact on socio-economic of the developer (Timber Company), landowners (in terms of royalties) and the state, will be enormous. Impacts on the forest ecosystem (e.g. inhibitors inter-relationships) and other subsequent effects that are like to occur such as pests and diseases are of increasing concerns. Similar incidences of forest mortality were also reported in other locations e.g. in high altitude forest of Pomio of East New Britain province.

[12] IPCC, (2007c) Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the IPCC. Parry, ML, Canziani, OF and Hanson, CE (eds.), Cambridge University Press, Cambridge, UK.

[13] Saulei, S., Kuroh, B., Kawanamo, M., Senart, S. and Masbong,S. 2011. Vulnerability Assessment of Bulolo Plantations.PNG Forest Research Institute, Lae.

[14] Saulei, S., *et al (unpl.).* Vulnerability and Adaptation assessment of Asengseng Consolidated FMA, West New Britain Province

[15] *Edge effect* - is a phenomenon found common amongst trees which have not experienced any exposures to extreme environmental conditions than to what they have been adapted to inhabit (i.e. in an intact forest environment). In this case, many of these trees have not experienced any exposures to high and direct effects of increased sunlight, temperature, wind, high direct precipitation, low humidity, dry and low soil moisture.

- Increase incidences of pests and diseases: trees that are stressed due to injuries sustain during logging are more vulnerable to any form of insect and pathogenic attacks. Exposure to new extreme micro-climatic conditions e.g. as observed at Asengseng, (Saulei *et al* .unpl.) may only promote pest and diseases and thus tree mortality.

- Flooding, landslips and erosion: Increase precipitation resulting in flooding, soil erosion, landslips and increased seedling mortality (esp. in plantation).

- Sea level rise –Trees are dying along low lying coastal areas and on low lying atolls, e.g. along an inlet at Jacquinot Bay, Pomio, resulting from the effects of rising sea level or subsiding land enabling the sea to submerse the area. Mangroves are also dying in some areas (e.g. Aromot Island) due to lack of substrate which have been eroded over past years[16]. Hence, islanders plant more mangroves to protect their islands behind constructed sea walls following mangrove zonal arrangements along the coastline.

- Food and freshwater security: Rise in sea level has allowed sea water to move inland through surface wash and intrusion through the soil thus affecting freshwater sources and food crop yields e.g. Siasi Island, Duke of York Islands (Saulei, et al., 2010; Saulei & Nagari, 1998[17]) and outlying islands and atolls.

Table 1 below provides a summary of elements of climatic vulnerability and their impacts

Exposure & Sensitivity	**Impacts**
Increase temperature	Changes to soil physical characteristics including moisture holding capacity; increase vulnerability of plant matter susceptible to fire; change in phenological behavior of trees.
Increase in extreme events	Droughts, floods; landslips, soil erosion, soil compaction due to flushing out actions of flowing water
Increases in forest fires	Reduction in wood supplies; follow up infestations by insects and pathogens
Increases in insect, fungal, etc outbreaks	Reduction in wood supply both in terms of quantity and quality
Changes in forest productivity	Changes to wood supply and carbon sequestration
Shifts in species composition	Changes to technology and markets; changes to other values
Genetic erosion through selection and breeding especially for species selected for seed orchards	Reduction of resilience or adaptation mechanisms to impacts of climate change

Source: Saulei, S. et al. 2011

3. What should be done to protect forest and enhance its social, economic and environmental values

[16] Saulei, S., *et al (2010).* Vulnerability and Adaptation assessment in Siasi Island, Morobe Province, PNG Forest Research Institute, Lae

[17] Saulei, S & Nagari, T,. 1998. The Sea level rise assessment of the Duke of York Islands, East New Britain Province, Office of Environment & Conservation, PNG

Table 2: Impacts of climatic changes and what needs to be done in PNG

Key Issues /Main Challenges from Climate Change	***What should be done to protect forest and enhance its social, economic and environmental values***
Droughts/ forest fires	Reduce non-climatic threats to forest ecosystem & its biodiversity such as timber harvesting, hunting, burning, gardening. Set up climate (weather) monitoring systems at strategic locations e.g. near forest plantation, and warning signs or fire indicator to warn people to be wary and not ignite fire; Improve capacity to combat fires (fire fighting)/ impose tough penalties on arsonists.
Natural forest mortality	Conserve intact ecosystems, avoid habitat fragmentation and create biological corridors; rehabilitation of affected areas; determine cause of mortality through research; weigh out adaptation options & implementation (Action Plan).
Plantation mortality	Follow strict nursery practices, improve seedling handling and planting techniques, and management during early stages after planting. Conserve and promote genetically diverse tree populations with genetic potential to acclimatize to climate change; *ex situ* conservation or relocation of vulnerable plantation tree species. Maintain natural processes (e.g., migration, predation, pollination, seed dispersal) in the plantations which are necessary for ecosystem function;
Reduced tree growth	Assessment of potential genetic erosion within species of plantation trees be addressed so that work on characteristic selection be considered and make way for possible backcrossing to be conducted (Saulei, S,. *et al.* unpl.)
Increase incidences of pests and diseases/ invasive species	Determine the species, their points of entry and population size of major insect and pathogenic infestations causing forest trees mortality and establish strategies for eradicating and monitoring them over a period of time (Saulei, S,. *et al.* unpl.)
Degradation of areas	Rehabilitation of degraded and exposed areas by planting trees that would meet the set objectives, e.g. SRC[18] trees for firewood/ posts/ charcoal production or commercial timber trees for timber/ post; Carbon sequestration, etc.
Sea level rise	Building sea walls; Protection of shoreline by planting mangroves and other non-mangal trees where mangroves cannot grow.
Freshwater security	Enhance water storage and conservation; improve management of forest watershed areas & water-use efficiency.
Food security	Promote Agroforestry (MPTS[19]) through inter-planting of food crops with trees.
Capacity building	Build capacity for research, planning and implementation of adaptive measure. Conduct awareness to villages so they are able to make inform decisions.

[18] SRC–Short Rotation Coppicing trees

[19] MPTS-Multi-Purpose Tree Species

TOOLS AND METHODS

4. Data analysis and modeling application

Forestry inventory data and other non-climatic data including socio-economic data collated for vulnerability and adaptation baseline studies on impacts of climate change are analyze by PNGFA. Modeling application using baseline data for climate change impacts is rare. Climatic data analysis and modeling application used by PNGFA are sourced from IPCC's Assessment Reports and other sources (e.g. PNG National Weather Service).

5. Data sources

Models depend on a lot of quality data and information. PNGFA conduct vulnerability and adaptation assessments, including other forestry research and inventories to collate useful baseline data and information. The Authority is also building capacity on GIS & Remote Sensing which is a very useful tool to provide up to date forest data/ information as well as other useful monitoring data and information. Climatic data for PNG and Pacific region are still scarce and there is a need for better modeling for future projections is essential (Saulei, 2011). Climate data and information is collated by PNG National Weather Service and PNG Maritime Authority, but there are more data and information that can be sourced from published reports by IPCC (e.g. FAR4, IPCC 2007).

In order to implement effective adaptation policies, plans and programmes, climatic and non-climatic information and data is required, in and across sectors at local, regional, national and global scales, supported by 'local knowledge and experience'[20].

6. Tools use in your region

Tool is a means or instrument by which a specific task is accomplished[21]. Examples include:

RCMs, impact models, decision tools (cost-benefit analysis, MCA[22], TEAM[23], ADM[24], etc), **stakeholder tools** (vulnerability indexes, Livelihood Sensitivity Exercise, etc.).

A method is a set of steps or tasks that can be implemented through using a number of tools, i.e. means or instrument used for accomplishing a specific task (UNFCCC 2005b).

Forest adaptation and vulnerability assessment on climatic extremities is quite a new area of research for the PNGFA. Availability of different tools and methods to use is not a limitation. There are many tools and methods available (UNFCCC, 2005). PNGFA uses tools that are suitable to achieve set goals and objectives of a particular assessment and also based on its capabilities to use them. Generic methods and tools used in recent vulnerability and adaptation assessments in PNG include; cognitive mapping and expert judgment (see

[20] UNFCCC United Nations Framework Convention on Climate Change: Adaptation assessment, planning and practice: an overview from the Nairobi work programme on impacts, vulnerability and adaptation to climate change

[21] UNFCCC. 2005. Compendium on methods and tools to evaluate impacts of, and vulnerability and adaptation to, climate change

[22] MCA-MultiCriteria Analysis

[23] TEAM-Tools for Environmental Assessment and Management

[24] ADM-Adaptation Decision Matrix

Giupponi et al, 2008[25] and Locatelli, B., *et al.,* 2008[26]) and Rapid Vulnerability & Adaptation Assessment methods (Santoso, 2007[27]).

These three methods are detailed briefly as follows:

Cognitive mapping (or concept mapping or mental model) - is a structured process that enables researchers to produce a map of the concepts or ideas behind a topic of discussions and to describe how these ideas are interrelated. It assists the researchers to define problems and structure their mental model. For the vulnerability and adaptation (V&A) assessment, cognitive mapping can start with identifying the different elements relating to vulnerability. The second step involves clustering of the identified elements into groups or initiating events, intermediate events, outcome and consequences. The third step aims at representing casual links between the elements and the last step consists of explanations of these links.

Expert judgment – a method used for eliciting informed opinions from experts of a specific topic (see Meyer and Booker, 1991). It is a useful method when resources are limited for conducting an in-depth analysis of scientific literature, collecting data or modeling.

Rapid Vulnerability & Adaptation Assessment – a method for designing national strategies and plans of adaptation to climate change and climate variability. In respect to the V&A assessments, a number of coastal and small island communities in PNG were assessed using the rapid assessment method designed for use in Indonesia (Santoso, 2007) with particular emphasis on the following parameters: *Exposure; Sensitivity*, and the *Adaptation* capacity in regard to transport, communication, finance, manpower and health for the island communities (Saulei, S,. 2011). For this exercise, the PNGFA V&A Assessment team used both the national and sectoral development goals against potential short and long-term impacts of varying climate change scenarios (especially for issues relating to exposures and sensitivity). Of particular sectoral importance are agriculture, health and social services. While for adaptation capacity, the assessment was based on observations and discussions with local authorities and communities on the islands.

New techniques learned from previous trainings and their application

There has been no training attended in the past specifically focusing on vulnerability and adaptation in light of climate change. However, PNGFA does conduct workshops on climate change issues and through such workshops, issues of vulnerability and adaptation have been extensively discussed and new ideas are shared. Further, there are volumes of literature available that provide information on climate change and related subjects that are easily accessible via the internet.

Forest adaptation strategies under different potential climate change scenarios and forests management scenarios.

National adaptation policies and measures reflecting the whole of country approach need to be mainstreamed into national sustainable development strategies and plans. A national plan of adaptation needs to be prepared in order to reduce the adverse effects of climate change (Santosa, H. 2007[28]). The plan is best to be mainstreamed and incorporated

[25] Giupponi,C.,Mysiak, J.and Sobbi, A. 2008. Participatory modeling and decision support for natural resources management in climate change research. The Fondazione Eni Enrico Mattei, Note di Lavoro 13/208, Milan, Italy.

[26] Locatelli, B., *et al.* 2008. Methods and Tools for Assessing the Vulnerability of Forests and People to Climate Change: An Introduction, Working Paper NO. 43, CIFOR, Bogor, Indonesia.

[27] Santosa, H,. 2007. A rapid vulnerability assessment method for designing national strategies and plans of adaptation to climate change and climate variability, CIFOR, Bogor, Malaysia.

[28] Santoso, H. 2007. A rapid vulnerability assessment method for designing national strategies and plans of adaptation to climate change and climate variability. Bogor, Indonesia.

into national long-term development strategy (Prabowo, 2006). Forest adaptation strategies should be tailored to address identified site-specific potential climate change scenarios and to suit specific forest management scenarios, taking into consideration existing forest policies and forest development plans of the country (PNG).

The extent of vulnerability to climate change and climate variability of forests ecosystems in PNG is not fully understood. There are few vulnerability and adaptation baseline assessments done in PNG (e.g. Saulei, S & Nagari, T., 1998; Saulei, S., *et al*. 2010; Saulei, S., *et al.* 2011). Currently, adaptation strategies resulting from thorough vulnerability assessments are very few, and much less at the national level. Some reasons for the lack of vulnerability assessments are due to the fact that research on Vulnerability and Adaptation (V&A) started only recently after restructuring of PNGFA and establishment of the REDD and Climate Change Branch and Species Vulnerability & Adaptation Unit of PNGFA in 2009. Capacity to undertake such activities is also of concern.

RESULTS AND DISCUSSION

1. Modeling

Modeling of impacts of climate change on forests and other ecosystems for vulnerability and adaptation is very limited in PNG. Much of what has been done by PNGFA are mainly depend on site-specific baseline studies and assessments to determining impacts of climate change and vulnerability issues and determining adaptation options.

What is being discussed below are information that is generated from modeling by IPCC and others on climate change and its potential impacts.

1.1 Climate Change

There is very little being done in the area of climate models in PNG and the region, but this is needed to improve our understanding of climate change, variability and sea level rise (Saulei, *et al.* 2011). The improved scientific understanding of climate change and natural variability has challenged all to appreciate the contributions, especially the impacts of climate change as a global, regional and national issue:

- The observed increase in global average temperature since the mid 20th century is likely due to the observed increase in anthropogenic GHG concentrations. This information (i.e. FAR, IPCC 2007) is more advanced than that of IPCC third Assessment Report (2001).
- Discernible human influence now extends to other aspects of climate, ocean warming, extreme temperatures and wind patterns.
- It has been concluded that increase GHG concentrations alone could cause more warming than that observed because volcanic and anthropogenic aerosols have offset some warming.
- Warming of the climate system has been detected in the changes on surface and atmospheric temperatures, temperatures in the upper several hundred meter of the oceans and its contribution to sea level rise;
- It is understood that anthropogenic forcing is likely to have contributed to changes in wind patterns, affecting extra-tropical storm tracks and temperature patterns in both hemispheres.
- Climate models coupled with observations/research has enable one to assess the likely range for climate sensitivity for the first time and provide increased confidence in the understanding of the climate system's response to radiative forcing.

1.2 Climate Impacts on PNG

It's now a challenge for PNG and the rest of the world to seriously reduce their levels of emissions by developing and applying national climate change and mitigation policies:

- The impacts of climate change is extended to oceans, extreme temperatures and wind patterns,
- Volcanoes and its aerosols in PNG continually contribute to offsetting some warming,
- PNG GHG levels/concentrations continue to increase due to the Petroleum, Gas and Mining activities, Forestry, waste, energy and technology contributions,
- Risk assessment and monitoring on climate change, variability and extreme events in PNG should be a priority.

1.3 Projections of Future Changes in Climate

The models used in the FAR have suggested that in the next two decades a warming of about 0.2^{o} C per decade is projected for the emission scenarios. If the concentrations of all greenhouse gases and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1^{o}C per decade could be expected:

- Advancement in models for GHG emission at or above current rates would cause further warming and induce many changes in global climate system during the 21^{st} century and that could likely be larger than those presently observed.
- The models for temperature changes compare very well with the sea level rise measurements at global level.
- Most models do not include uncertainties in climate-carbon cycle feedback nor do they include the full effects of changes in ice sheet flow due to lack of data.
- Increase in atmospheric carbon dioxide concentrations leads to increasing acidification of the ocean. Average global pH level in the oceans was recorded to be between 0.14 and 0.35 units over the 21^{st} century
- Both past and future anthropogenic carbon dioxide emissions will continue to contribute to warming and sea level rise for more than a millennium, even if steps are taken now to greatly reduce or stop all emissions due to the timescales required to removal of this gas from the atmosphere.
- There is now higher confidence in projected patterns of warming and other regional-scale features, including changes in wind patterns, precipitation and some aspects of extremes and melting of the ice. Warming is expected to be greatest over land and at high altitudes and northern latitudes and at least over southern oceans.
- The range of models have indicated that there is likely future tropical cyclones will become more intense, with large wind speed and more heavy precipitation with ongoing increases of tropical Sea Surface Temperature.
- With confidence in modeling temperatures are likely to increase by approximately 5^{o}C by 2100
- Anthropogenic warming and sea level rise would continue for centuries due to the timescales associated with climate processes and feedback, even if the GHG concentrations were to be stabilized in 2100.

1.4 Potential Impacts on PNG

The following are important potential projections in the climate change; variability and sea level rise in the PNG and includes:

- The level of GHG in the atmosphere will continue to increase in the next 100 years as developing countries like PNG will contribute to meet its economic and social aspirations through the development of its natural resources of oil/gas, forest and land change;
- Melting of ice cap and thermal expansion of the oceans are the main resources contributing to the sea level rise in PNG and the pacific region. Provinces such as Bougainville, Manus, East Sepik, Milne Bay, Central, Gulf, Western, East New Britain and others with their outlying small islands are now being impacted;
- Climatic data for PNG and pacific region are still scarce and there is an urgent need for better modeling for future projections is essential;
- The range of models have indicated that there is likely future tropical cyclones will become more intense, with large wind speed and more heavy precipitation with ongoing increases of tropical Sea Surface Temperature in the country and neighbors.
- The climate change and variability will impact the whole country but will be heavily felt by New Guinea Islands, Milne Bay, Gulf, Central, Sepik Provinces, and Fly provinces.

Base on such information, PNG or PNGFA for that matter can be in a better position to make informed decisions regarding forest adaptation issues relating to forest management and development due to climate change.

2. Scenarios

2.1 Potential Impacts to PNG

The following are some results of some recent assessments of potential climate change impacts:

- In the last 10-15 years, there is strong evidence of increase in temperature of the atmosphere and oceans, sea level rise in PNG provinces and the Pacific;
- The major contributions to sea level changes will be thermal expansion of oceans and ice caps melting and hence will adversely affect the atoll islands in New Guinea Islands, Milne Bay, Fly and Gulf Provinces, Momase regions and low lying coastal areas of the country;
- EL Nino and La Nina signals will continue to increase its frequency and intensity and its impacts on the entire country especially on food and freshwater security.
- There will be major climatic influences in the country and the region and will greatly have an impact on economic, social and environmental sectors of the densely populated parts of the country, especially the vulnerable remote and isolated communities.
- More intense and longer droughts in PNG
- The frequency and intensity of cyclones, heat waves, flooding and extreme climatic conditions will be experienced;
- Highland provinces will be impacted severely in light of long and short term droughts especially for populated areas and malaria/health will be a challenge.

3. Policies and strategies for climate change adaptation

- There is need for climate change, variability and sea level rise policy as it is important for the country.
- There is a need for a review of the current National Action Plan for Adaptation of vulnerable forest ecosystems for PNG to compliment the broad framework 2009-2015.

LOOKING AHEAD

a) Challenges:

- Capacity: in terms of personals and financial resources to vigorously pursue vulnerability and adaptation baseline studies and initiatives, especially in vulnerable ecosystems. Capacity is still needed to enable developing countries such as PNG to develop adaptation programmes and strategies.
- Uncertainties in institutional arrangements in terms of infrastructure, capacity building, policy and new practices to carry out Vulnerability and Adaptation (V&A) initiatives.

b) Opportunities:

- Policies and measures are currently in place.
- There is strong leadership and coordination of V&A related activities.

"Adaptation is an essential pillar of any comprehensive policy response to climate change. Learning by doing can enhance our understanding of the adaptation process and build the knowledge base to facilitate effective adaptation actions." - UNFCCC

Case Study of Forest Management and Biodiversity Conservation under a Changing Climate

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1. Introduction

As the result of the increase in greenhouse gas concentrations in the atmosphere, it is concluded that the temperature of the earth will increase by several degrees over the next century (Houghton et al. 1992). If the atmospheric concentrations of greenhouse gases continue to rise, climate change is highly likely. Then, the sea level will rise, agricultural production will change, runoff and water supply will change, and the location of forests and other terrestrial vegetation will shift poleward and to higher altitudes" (Tegart et al. 1990; Smith et al. 1995). There are many countries vulnerable to adverse effects of climate change such as sea-level rise, the persistence of droughts, and forest fires. In Thailand, for example, the temperatures have increased by 0.10 °C to 0.18 °C per decade over five decades of observation. Its rainfall has been decreasing over the past three to five decades. It is predicted that extreme events, including prolonged floods and drought, landslides, and strong storm surges will become more frequent and more damaging. The changes in rainfall patterns and the frequency and intensity of rainfall have affected the quantity and quality of water resources of several watersheds. It is reported that rainfall patterns are highly irregular and the dry season have grown longer and hotter (Jesdapipat 2008). FAO (2012) also states that climate change has posed challenges for forests and forest-dependent people. It is a dynamic and complex issue that increases uncertainty about what future forests will look like (CCFM 2012). Therefore, it is significant to seek innovative ways to adapt sustainable forest management policies and practices for a changing climate.

This report briefly presents the introduction of forest management in Thailand and summarizes the issue of forest policies available to address the adverse effects of climate change. It also suggests changes to be resolved main challenges from climate change and key issues in protecting forests from these threats in sustainable manner. Moreover, a case study of biodiversity conservation under a changing climate, including data analysis and modeling for climate change adaptation will be examined in this report. Additionally, challenges and opportunities will be presented in the last section.

2. Forest Management in Thailand

Land area and forest cover

Thailand has a total land area of approximately 53 million hectares. In 1961, the total forest area of the country was about 27 million hectares covering over 53.3 percent of the country. As a result of the forestland encroachment, the forest area declined to 25.3 percent in 1998. Since 2000 onwards the annual rate of deforestation has been about 63,000 hectares per year. Subsequently, in 2006, the country has 16.8 million hectares of forests, representing 33 percent of the country's area. With regard to the 1985 National Forest Policy, 40 percent of the country area shall be kept under forest: 25 percent of the country area for protected forest and 15 percent of the country area for production forest. Since the government banned all logging in natural forests in 1989 the area of existing forests reported in 2010 was 33.09 percent. Therefore, about 7 million hectares of forests is needed to achieve the nation target (FAO 2001; FAO 2009).

Policy framework for forest management

Since the establishment of the RFD in 1896, Thailand enacted several forest policies. These include the National Economic and Social Development Plan, the National Forest Policy, and the Constitution.

The National Economic and Social Development Plan (NESDP)

The 1961 First National Economic and Social Development Plan (NESDP) aimed to protect 50 percent of Thailand's areas as forests. The second NESDP (1967) reduced the area to be protected to 40 percent. Finally, the first formal National Forest Policy was "announced" in 1985, - emphasizing economic or production forests and conservation or protected forests. It divided the 40 percent of land under forests into 25 percent for economic forests and 15 percent for conservation forests. The seventh NESDP (1992-1996), following the imposition of the logging ban, reversed the allocations to 25 percent of conservation forests and 15 percent of economic forests to emphasize conservation objective (FAO 2001). At present, Thailand is implementing the 11th Plan (2012-2016) with reflects the importance of the environment to production and consumption patterns, and its important mission in cooperating in the management of natural resources and biodiversity to ensure their richness.

The National Forest Policy

In 1985 the National Forest Policy was proposed with a target of keeping 40 percent of the country area as forested areas, 25 percent of the country area for protected forest and 15 percent of the country area for production forest. The Policy also identifies the need for partnerships between the public and private sectors. The RDF was directed to encourage local community participation and to cooperate closely with the private sector. However, the Policy was silent about the root causes of deforestation and poverty reduction in forest areas and it did not involve rural people (FAO 2009).

The Constitution

It is believed that the 1997 Constitution has been the most important political development in Thailand. The Constitution recognizes the right and roles of Thai people to participate in national policy formulation regarding resources and environmental development and conservation, has been the most significant recent political development in Thailand. The Constitution clearly notes the right of societies in managing natural resources (FA0 2009).

Legal framework for forest management

The Government of Thailand has established **laws** toward the protection and conservation of forest areas. The five main Forestry Acts formulated regarding to forest protection and conservation include (FAO 2009):

1) Forest Act, B.E. 2448 (1941) concerns logging operations and non-wood forest product collection, transportation of timber and non-timber products and sawnwood production as well as forest clearing.
2) National Park Act, B.E. 2504 (1961) covers the determination of National Park land, the National Park Committee, and protection and maintenance of National Parks.
3) National Forest Reserve Act, B.E. 2507 (1964) includes the determination of National Reserved Forest, control and maintenance of the National Reserved Forests.
4) Wildlife Conservation and Protection Act, B.E. 2535 (1992) establishes provisions for national wildlife preservation, establishment of a Protection Committee and identification of 15 species of reserved wildlife.

5) Forest Plantation Act, B.E. 2535 (1941) covers the determination of reforestation and land registration of private reforestation rights, ownership and exemption from royalty on forest products from reforested areas.

Forest Management Responsibility and Strategies

In the part the ownership and control of all forests belonged to the Royal Forest Department (RFD). From 2002, these responsibilities were transferred to three departments, which are: the Royal Forest Department (RFD) who is responsible for forests outside protected areas; the National Park, Wildlife and Plant Conservation (DNP), being responsible for forests assigned as protected areas; and the Department of Marine and Coastal Resources and Environment (MNRE), managing coastal flora and fauna, including mangrove forests.

The present forest management approach has had three main interventions: expansion of designated protected areas, expansion of the forest resource base by plantation to substitute wood supplies from natural forest, and development of community forestry.

Expansion of designated protected areas

Thailand has set a target to have 25 percent of the country's total land area as protected areas. Since the enactment of the National Park Act in 1961 the areas under legal protection have expanded rapidly and they presently cover about 17 percent of the total nation area. The protected area system consists of national parks, wildlife sancturairs or local government-controlled forest parks, no-hunting areas, botanical gardens and arboretums. They are under the control of the DNP. National forest reserve managed by the RFD is also part of the system. The forest reserves have obviously less strict rules than sites with protected area status. In 2009, there were 1,221 National Forest Reserves spreading over 23.4 million hectares. However, most protected areas and national forest reserves have people living in them and all have people living nearby who harvest timber and non-wood forest products. Resource harvesting in protected areas is not allowed under current legislation except by permission of the Director General. Therefore, Thailand still needs to develop a more efficient natural resource and environmental management mechanisms such as integrated management of protected areas and conflict management, based on a system for good governance.

Expansion of the forest resource base by plantation

Although reforestation in Thailand started in 1906, the reforestation programme gradually expanded after 1961. Native teak has been the most favored species for commercial plantation. During 1994-1996 an area of about 800,000 hectares was planted with forest trees. From 1994 to 2001, the government had launched farm forestry programme in responding to the deteriorated wood supply situation. However, the planted area only covered only 169,400 hectares. The total extend of planted forests in 2000 was estimated at 2.81 million hectares (FAO 2009).

Community forestry

Community forestry is a significant tool for forest management in Thailand. In order to address the country's rampant deforestation, the Thai government officially recognized community forestry as a tool for sustainable forest management. In 1991, the government began drafting a Community Forest Bill to guide the formalization of community engagement in forest management. Since then several versions have been drafted but approval has been on hold due to difficulty in reaching a consensus among politicians and stakeholders. Unfortunately, for two decades the bill has been debated, it has been rejected, and then

rescinded. The major point of contention has been over local people's forest use rights within protected areas. Although Thailand's Constitution, which guides the country's laws and policies, clearly empowers communities to actively engage in natural resource management, protection and use, the National Park Act of 1961, which prohibits use of timber and non-timber forest products, works against community forestry. Thus, support for community forestry varies even within the Ministry of Natural Resources and Environment. The evidence of this is that the RFD, responsible for all forests outside protected area, has long supported community forest whereas the DNP, responsible for protected-area forests, has largely worked to prevent community forestry in protected areas. However, community forestry proponents-including the RFD, NGOs, and Thailand's emerging community forestry networks-continue to make progress. As of 2010, the RFD had formally recognized and registered about 7,000 community forests, all outside of protected areas, and it is actively seeking to register more. A major recent initiative has been the development of community forestry networks with a range of members, from the subdistrict administrative unit and district levels through to the Community Assembly, which operates nationally. These networks are proving to be an important vehicle in which to share lessons learned and practical experience for setting up and managing sits. The emerging issue of climate chang mitigation is also gaining the attention of the community forestry movement in Thailand (RECOFTC 2011).

3. Forest Policies/Action Plans for Climate Change Adaptation

Since 2000, research work on the impacts of climate change in Thailand has been conducted. The research has provided a broad picture of the effects of climate change in Thailand. It is shown that rainfall all across the regions in the country has a potential to increase by about 10-20 percent. The rainy season will not change much, although the weather will tend to be warmer due to an increase in maximum and minimum temperatures by 2 degrees Celsius. Moreover, natural disasters, especially droughts and floods, have become increasingly common in the country (Ministry of Natural Resources and Environment 2011).

In Thailand, the process of understanding vulnerability and adaptation resulting from climate change has begun from conducting the Initial National Communication (INC) and submitted to United Nations Framework Convention on Climate Change (UNFCCC) in 2000. Subsequently, the proposal for Second National Communication (SNC) had been prepared in 2005 and it had been received and approval in 2006. Furthermore, Thailand's National Strategy on Climate Change, 2008-2012, gives top priority to climate change impact, vulnerability and adaptation. It can be said that over the past decade, Thailand has made substantial efforts to expand technical knowledge concerning climate change and to integrate the results into the process of sustainable national development. As commitments under the UNFCCC and the Kyoto Protocol, Thailand has continuously promoted energy conservation and implemented measures to accelerate use of alternative fuels to support GHG reduction efforts. Expanded forest areas as well as protected existing natural conserved forests have also been implemented to enhance the GHG sink. Since 2000, substantial efforts to expand forest areas have been carried out in the form of conserved forests, reforestation and rehabilitation of deforest areas, and expansion of community forest and commercial forest. Reforested areas have increased by more than 64,000 hectares (Ministry of Natural Resources and Environment 2011).

4. Key Issues/ Changes to be Resolved Main Challenges from Climate Change

It is believed that climate change poses enormous challenges for forests and people who depend on forest resources. Mitigation and adaptation are the two main responses to climate change, mitigation seeking to address climate change causes and adaptation aiming

to reduce its impacts. In the forest sector, mitigation strategies include: reducing emission from deforestation; reducing emissions from forest degradation; and increasing the role of forest as carbon sinks (FAO 2012). CCFM (2012) also states that adaptation can reduce the vulnerabilities and risks associated with climate change. Smith and Lenhart (1996) suggested a number of adaptation strategies for managing forests. These involve:

- Enhance methods to protect biodiversity off-site. Threatened or endangered species may be saved off-site, which protects diversity. These methods must be in place before climate changes to avoid the irreversible loss of species extinction. Off-site protection may be very important in preventing irreversible loss of biodiversity.
- Enhance forest seed banks. Seed collections should represent the variety of genotypes that exist for each species.
- Encourage diverse management practices. The planting of trees with greater resistance to heat and drought on the southern range of managed forest boundaries if the trees can survive in the current climate. The mix of different timber-harvesting strategies may be used to promote forest diversity.
- Establish flexible criteria for intervention. Policies that establish flexible criteria for the use of existing forest intervention management practices should be in place. The use of management practices such as salvage harvests, silvicultureal management, insect and fire control, and restoration activities should be allowed to change as conditions change. Such policies apply to current forest management but should also consider how the structure of the forest might change because of climate change.

Reduce habitat fragmentation and promote development of migration corridors. Geographic fragmentation may threaten the ability of forests and forest species to migrate or adapt to changing climate. Currently, the health of many forests is stressed by existing fragmentation. Forest fragmentation may be reduced through incentive programmes for multiple-use management that balances preservation and use within a single parcel or through the negotiation of conservation easements that protect geographically important land parcels from development.

In addition, implementing adaptation in Sustainable Forest Management or SFM, which is “based on the principle of maintaining and enhancing the long-term health of forest ecosystems while providing environmental, economic, social, and cultural opportunities for current and future generations” (CCFM 2008: 1) should be priority in the country. Since 1961, Thailand’s five-year national economic and social development plans have provided a framework for sustainable management. At present, Thailand is implementing the 11th Plan (2012-2016) with reflects the importance of the environment to production and consumption patterns, and its important mission in cooperating in the management of natural resources and biodiversity to ensure their richness. The Enhancement and Promotion of the National Environment Quality Act (B.E. 2535) has also been promulgated in order to ensure the country’s economic cum environmental development process. Some issues that need to be addressed to ensure the sustainability of forests and community resilience in the face of changing climatic conditions are:

- Although local communities have a long and tradition and strong interest in sustainable forest management, poverty makes it difficult for communities to resist alternative land uses. Thus, financial incentives, for example, from REDD+, could provide critical support for communities to manage forest sustainably.
- Support is required to develop environmentally and socially sustainable strategies. This includes technical guidance and financial support for initiatives which can help reduce pressure on forests.

5. Biodiversity Conservation under a Changing Climate

Biodiversity and Climate Change

Habitat loss and fragmentation are well understood as significant threats to biodiversity. In recent years, it is substantially understood that climate change has the potential to dramatically affect biodiversity. Although there is considerable uncertainty in how species and ecosystem will respond to climate changes, global climate change is already having significant effect on biodiversity (Commonwealth of Massachusetts 2010). There are two types of action need to be taken to address the challenge of climate change and biodiversity conservation. The first is mitigation that is controlling and reducing emissions of greenhouse gases, the root cause of climate change. The second type of action is adaptation, which means increasing the ability of natural systems to absorb and respond to change. To mitigate climate change it is important to limit the increase in concentration of green house gases in the atmosphere. Ecosystems and their biodiversity have a role to pay in securing the substantial carbon stocks held within the earth's atmosphere. It is also important to find ways to increase the ecosystems and their biodiversity resistance to current and future climate change (UNEP 2013).

A Case study: Biodiversity Conservation under a Changing Climate in Ban Sam Kla, Lumpang Province, Thailand

Background Information

Ban Samkha Village is located in Mae Jang National Forest Reserve in Lumpang Province, one of the northern provinces of Thailand. Multiple gradient plains surrounded by hills and Mae Jang National Forest Reserve dominates the landscape of Ban Samkha village. The village's 152 households engage in traditional rotational rice production, located two to four kilometers outside the village. Villagers have longstanding practices of community forest and recognize livelihood dependence on surrounding natural resources.

Role of the community in climate change mitigation and adaptation

Some mitigation and adaptation actions that the community has used to conserve biological diversity in Mae Chang Forest Reserve, with the collaboration of the RFD and NGOs, will be presented as follows.

Mitigation actions

- Reforestation and rehabilitation of deforested areas. The community has participated in reforestation and forest rehabilitation for several years. The community, the RFD, private sectors, and NGOs have been working in collaboration to promote biodiversity conservation by using the strategy of community forest management and or social forestry which is an approach based on people's participation in forest management.
- Reduce crop residue burning. It is noted that the reduction of burning crop residue provides environmental benefits, not only for mitigating greenhouse gas but also preventing road accidents and undesirable health effects.

Adaptation actions

- The community participation in water management and wildfire prevention. These actions include the construction of check dams, fire break, usage of the applied technology. The risk of wild fire has been reduced through controlled burns and thinning (e.g., removal of excessive vegetation and dead fuels through thinning).

- The community participation in developing biodiversity data bases systems which can been served as tools for planning and management.
- Collaborating across Mae Jang Forest Reserve areas to create habitat linkages. This allows species migration between areas.

6. Challenges and Opportunities

Climate change poses a number of challenges to SFM in the country, especially in terms of deciding how best to plan and adapt for an uncertain future. New approaches to SFM are being developed, and forest managers are seeking innovative tools to support decision-making in a changing climate. Well managed forests can also contribute to combating climate change through: sequestering carbon through new forests; substituting energy derived from fossil fuels; avoiding emissions from forest loss and degradation. These strategies include: multi-purpose resource management, minimizing conflict to building partnerships, public participation and international collaboration. Moreover, it is important to evaluate the long-term impacts of climate change and determine what the community might do now and in the future to respond to the effect of climate change on forests. In addition, research and development related to climate change, by the interorganizational collaboration and cooperation will strengthen the capacity of the forest sector to adapt to climate change. Finally, it is vital to promote good governance in national administration at all levels in order to achieve development that is sustainable. Community forestry is one of the relevant measures to achieve forest governance that has 8 major characteristics: participatory, consensus oriented, accountable, transparent, responsive, effective and efficient, equitable and inclusive and follows the rule of law.

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1.Bangladesh：Climate Change Adaptation

Climate Change Adaptation: A case Study of Bangladesh

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Introduction To Bangladesh

- Himalayan-Hindukush landscapes with Tibet plateau as the topmost headwaters comprising glaciers and lakes, mega watersheds of Bangladesh.
- Bangladesh is a country of about 160 million people with the highest population density of the world.
- Bangladesh is one of the most climate vulnerable countries in the world and become more affected as a result of climate change.
- Floods, tropical cyclones, storm surges and droughts are likely to become more frequent and severe in the coming days.

Forest Management of Bangladesh

- According to Forest Resource Assessment(FRA): 11% of the country's land mass is under forest cover (FAO 2010)
- 90% of the people living in villages depend on natural resources (both wetlands and forests).
- Bangladesh lost its forest cover on an average 0.17% per year between 1990 and 2010 (FAO, 2010).
- Deforestation is caused due to .....

  -Rapid urbanization

  -Industrialization

  -Agriculture expansion

  -Shifting cultivation

  -Lack of effective implementation of forest policy and laws in the forest land and resource management, etc.

Climate Change Adaptation Initiatives in Bangladesh

- Bangladesh government has developed Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009.
- The country established Climate Change Trust Fund from its own revenue budget to implement the BCCSAP.
- Main objective of the fund is to increase capacity of local people and reduce vulnerability through implementation of projects.
- Following laws, guidelines and policies are in place for proper management of the fund.
- Climate Change Trust Act, 2010

Climate Change Adaptation Initiatives in Bangladesh

- Climate Change Trust Fund Policy
- Guideline for preparing project proposal, approval, amendment, implementation, fund release and fund use of the Climate Change Trust Fund
- Guidelines for selection of NGO and project implementation under the Climate Change Trust Fund
- Bangladesh Climate Change Trust (BCCT) Governing Rules, 2013
- Bangladesh Climate Change Trust (BCCT) Employees Service Rules, 2013

Climate Change Adaptation Initiatives in Bangladesh

- From 2009-2010 to 2012-2013 Bangladesh government has allocated taka 2,500 crore each year against Bangladesh Climate Change Trust Fund.
- Climate Change Trust Act 2010 the Trustee Board is authorized to approve 66 % of the fund for project implementation while rest 34 % is to be deposited in banks for future emergencies.
- Tk. 1155 crore has been deposited in banks to meet the mandate of Trust Act 2010.
- A total of 194 Projects (131 government and 63 NGO projects) have been funded with committed expenditure of taka 1513.59 crore from the BCCTF.
- 19 projects have already been successfully completed.

Climate Change Adaptation Initiatives in Bangladesh

- In GHG emission Bangladesh emits only 0.3% of global emission, still we have shown our voluntary commitment through undertaking mitigation and adaptation projects.
- Adaptation has given the highest priority in the selection and funding of projects under BCCTF.
- Among the projects funded by BCCTF, 77% are adaptation based while 23% projects are contributing to the mitigation of greenhouse gas (GHG) emission.

Community based Adaptation to Climate Change through Coastal Afforestation(CBACC-CF): A Case Study

- Community based Adaptation to Climate Change through Coastal Afforestation (CBACC-CF) is a joint initiative by the Government of Bangladesh (GOB) and United Nations Development programme (UNDP).
- $5.823 million project is implemented by UNDP under Least Developed Countries Fund (LDCF) of the Global Environment Facilities (GEF).
- Project implementing in four coastal districts of Bangladesh-Barguna, Bhola, Noakhali & Chittagong & its duration is from July, 2009 to November, 2013.
- The project enhanced adaptive capacity of 20,027 households(hh) through livelihood diversification and training measures.

Resilience of Protective Ecosystems

- 13,743 coastal people benefited from cash for work programme.
- The project empowered coastal communities with particular ownership rights for landless groups. To date, 400 coastal people get accessed in govt. lands(8hh/ha) for recurrent resource and income generation practice in the triple F model. Additional ownership arrangement for accommodating 496 hhs in govt. land is under process.
- Coastal afforestation in 6,300 ha contributes to sustain protective ecosystem and global mitigation by absorbing 630,0ooton carbon annually.
- It has improved land stabilization capacity which is important for maintaining protective green coverage in the coastal areas as well as securing the lives and livelihood of local communities.

Community based Adaptation to Climate Change through Coastal Afforestation (CBACC-CF)

- Existing coastal forests are monoculture plantation
- There is lower regeneration trend & the new species diversity is well-deserving and potential to highly dynamic bio-physical characters of coastal areas.
- 95 ha model plantation raised and involved 143 households living around coastal areas.
- Model plantation with introducing 10 new mangrove species in the existing gaps of coastal forests ensured

Mangrove afforestation in newly accreted coastal lands & Mound Plantation

Mangrove afforestation in newly accreted coastal lands

Model Plantation

Mound Plantation

Community based Adaptation to Climate Change through Coastal Afforestation (CBACC-CF)

- The ditch and dyke Plantation system is benefiting 400 coastal families and more 496 HHs are now underway to be involved through Forest, Fish and Fruit (FFF-Triple F) model.
- Each family is producing different vegetables on their dykes in two seasons which secures their household food and income generating up to BDT 20,000-25,000 annually from selling of vegetables.
- Fish cultivation in ditch system is providing household protein sources and income for poor.
- The rainwater harvesting creates freshwater fish cultivation and irrigation for extended fish culture throughout the year.

Community based Adaptation to Climate Change through Coastal Afforestation (CBACC-CF)

Multi-level resource generation practices

Salt tolerant rice variety

High yielding fruit variety improves household food security and nutrition

Community based Adaptation to Climate Change through Coastal Afforestation(CBACC-CF)

- In CBACC-CF project, Guava and BAU Kul practiced for homestead horticulture.
- Fallow lands and dykes around homesteads used for fruit cultivation which providing seasonal food and income to poor families.
- The fruit varieties are new of those sites which have been found highly demanding for household food consumption and local market.
- With the support of Department of Agriculture Extension Services, beneficiary households started harvesting of the fruit varieties two times in a year.

Community based Adaptation to Climate Change through Coastal Afforestation(CBACC-CF)

- Each beneficiary generates BDT 10,000-15,000 annually from selling of the fruit varieties.
- The HYV quality and size of the Guava has raised.
- The beneficiary estimates that each Guava fruit weighs 600 gm and total production to 8-10 kg per plant which is higher than local variety.
- Guava serves as substitute of apple locally known as poor man's fruit

Community based Adaptation to Climate Change through Coastal Afforestation(CBACC-CF)

- Each family is producing 400-500 kg of fishes annually from own ditch which secures their household protein and additional income after consumption.
- Within only six (6) months of project supports, a family generates at least BDT 20,000-30,000 from selling of fish
- Each family also generated incomes from poultry rearing with improved duck varieties.
- Currently, each family is getting 900 eggs from 5 ducks annually supported by the project which is generating BDT 4000-9000 from duck rearing which increased household income of the beneficiaries.

Capacity building and strengthening community-institutional linkage

Capacity building of local govt. institutions

Mainstreaming women's role in adaptation

- CBACC-CF project focused on involvement & roles of women in local adaptation decision making, resource planning and implementation process.
- Women beneficiaries participated in training measures for addressing climate change related risks in household livelihood security and identified required for empowering in the long-run.
- The project involved 6,389 women in forest, agriculture, aquaculture and livestock based training, demonstration and income generating activities.
- Women beneficiaries learned nursery preparation and plantation, diversification of homesteads crop cultivation and maintenance activities including pest control, use of compost and weeding.

Community based Adaptation to Climate Change through Coastal Afforestation(CBACC-CF)

- We have introduced through the project improved livestock including poultry. 470 families received training on cow and poultry rearing and input support.
- Livestock Department provided technical support and capacity building training. The participant beneficiaries developed their skills on improved livestock rearing with additional measures for increasing production, precaution on seasonal disease management and eventually contributing to household income generation.

Improved Agricultural Practices

- Salt tolerant and high yielding rice variety
- Salt tolerant (BR 47) rice demonstration under CBACC-CF project has been found as a potential crop for coastal areas.
- In 2010, it started with 8 ha of lands were cultivated with the variety and subsequently rice production increased in 50 ha in 2011. In 2012, it has increased in 500 ha of lands with the salt tolerant varieties.

Capacity building and strengthening community-institutional linkage

- A database of government officials working at upazila and district level developed on Proper understanding on climate change risks, impacts and CBA measures .
- 993 govt. officials received training on coastal afforestation & livelihood diversification.
- Co Management Committees (CMC) is representing different implementing government partners, local community, elected members and civil society in implementing project sites.
- CMC took the initiatives to coordinate activities and draw feedback of different implementing institutions; take necessary actions in response to effective service delivery of the govt. departments.

Empowering women through improving their resource generation capacity

Women have direct access to land rights and resource generation practices

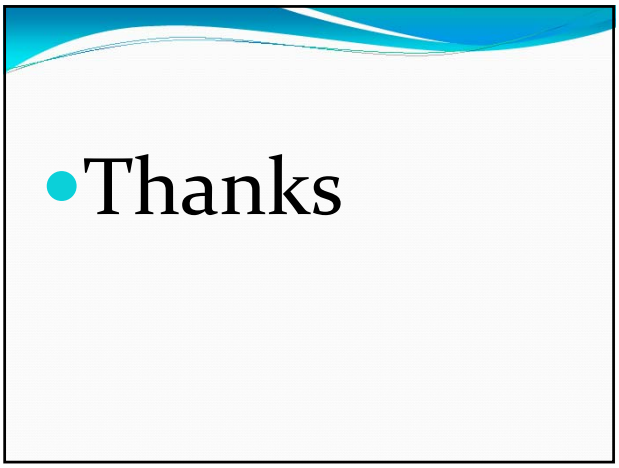
Diversification of household income

Key Achievements of the project

- The project received "Earth Care Awards 2012" on 14th September, 2012 sponsored by "the JSW- the Times of India" at New Delhi for "innovative Fish, Forest and Fruit (FFF-Triple F) model and providing access to government lands for the landless in coastal districts of Bangladesh ".
- The project was selected as one of the two best adaptation projects from asia-pacific region for showcasing in GEF Side event on Adaptation practitioner day of COP 18 on 1st december.2012 held at Doha.

Looking Ahead

- Coastal land use policy is currently under review to delineate land ownership and incorporate climate change related in dynamic coastal zone management.
- The innovative livelihoods with mangrove afforestation through restoration of fallow lands and providing ownership of landless households have eventually got momentum across local, national and international stakeholders.
- The grant money from the Swiss Agency for Development and Cooperation (SDC) and the Embassy of the Kingdom of the Netherlands (EKN) has been incorporated in the revised project document to extend the project activities.


Thanks

2.Fiji：Sustainable Forest Management for Fiji

Sustainable Forest Management for Fiji

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Forestry Department
Ministry of Fisheries and Forests

Overview

- Roles
- Policy
- Vision
- Milestones

Case Study: National Forest Inventory
- Permanent Sample Plots
- REDD+ Activities

Roles

- Formulation and implementation of policy initiative
- Administration of the regulatory framework to facilitate Sustainable Forest Management (SFM) in all types of forest.
- The vision of the department; **Our future generation inherits a prosperous & enhanced Forest sector, this is to enhance the improving livelihood through SMART policies on sustainable forest resources.**

SMART policies:
S – Simple
M - Measureable
A – Achievable
R – Realistic
T – Timely.

Policy

- The first Fiji Forest Policy for Fiji was approved by the Legislative Assembly in 1950.
- Forest Act was endorsed in 1953 to give legal effect to this policy.
- In 1988, the Government of Fiji initiated a Forest Sector Review with a comprehensive analysis of the sector and reformulated sectoral objectives, strategies and development programmes as a basis for the development of the forest sector. Although the Review did not result in the formulation of a new forest policy, it initiated changes in the forestry legislation.
- The Forest Act was reviewed in early 1990, and in 1992 replaced by the Forest Decree, which simplifies, clarifies and updates its preceding legislation taking into account the need for sustainable forest management and changes in the policy environment.

Vision

- A permanent forest cover, including a protected forest area network, that provides the full range of ecological, economic and social functions for the local, national and global level;
- Forest management practices that provide high value goods and services by effective planning and utilization techniques while soil erosion and siltation in vulnerable watersheds are substantially reduced, balanced water supply is ensured, pollution avoided, and valuable biodiversity preserved;
- A thriving forest industry that provides stable employment and contributes significantly to national economic development by value-added processing and exports of quality products;
- Greatly improved rural livelihoods by substantial involvement of landowners and communities in sustainable management of their forest land and in forest -based industries
- An institutional framework that encourages investment in sustainable forest management and forest industries with a forest administration that delivers high quality services that are widely sought and paid for by its clients.
- To achieve this vision, the nation is obliged to address the following **broad strategies** (*cf* Rural Land Use Policy):
  - Protecting the integrity of ecological systems and biodiversity
  - Reducing the rates and areas of land degradation
  - Maintaining and extending natural forest and forest plantations cover
  - Rehabilitating areas of degraded natural forest remnants
  - Preventing and controlling pollution
  - Promoting sustainable forestry and agroforestry systems
  - Fostering the involvement of landowners in the management and utilization of their own forests
  - Implementing international environmental accords to which Fiji is signatory

Milestones

By 2020, the following **milestones** should be achieved:

- Overall national land use planning controls natural and plantation forest areas and protects them against degradation or uncontrolled conversion.
- The clearing of forested land is regulated under the Rural Land Use Policy to ensure the area of permanent natural forest cover in Fiji exceeds 40% of the total land mass including a substantial part set aside for conservation and protection.
- A comprehensive national system of nature reserves, parks and protections forests, including mangroves, is established and managed.
- At least 3 Management Plans for natural forest areas are in place for trial implementation.
- Unsustainable forestry practices have ceased.
- The Fiji Forest Harvesting Code of Practice is universally applied and enforced, and a revised National Harvesting Code of Practice incorporating silvicultural prescriptions and reduced impact logging measures drafted and placed under trial.
- Plantation areas harvested for timber production are completely reforested, with a projected productivity and economic value no less than the current level.
- Effective basic requirements established for the proper management of a forestry business by landowners, including advice on procurement of finance and the management of funds.
- Fiji will have established an industrial structure and infrastructure that can deliver forest products to stringent export quality standards with strong value-added element from timber processing for high end-value niche markets.
- Mechanisms for financing forest conservation activities in operation.
- Appropriate elements of the Forestry Department are commercialized with increasing generation of revenue to assist fund the cost of forestry activities.

Case Study

- National Forest Inventory
- Permanent Sample Plots
- REDD plus activities (and Policy)

Fiji's National Forest Inventory

Objective

To assess the quantity and quality of Fiji's remaining native forest through:

- **The identification and mapping of commercial forest areas**
- **The identification and mapping of non commercial forest areas**
- **The calculation of the remaining timber volumes in both forest types**
- **Determining the annual allowable cut**
- **Setting up of a Forest Monitoring System**

Methodology

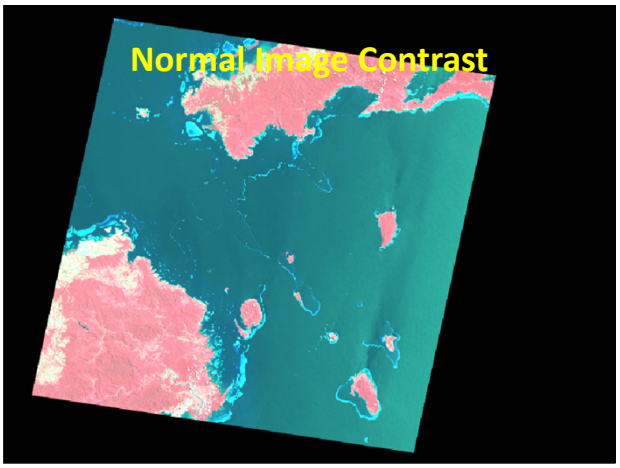
- First stage: remote sensing and mapping of forest types, functions
- Second stage: field sampling in selected forest types
- Outputs: forest maps 1:50,000, stand and stock tables for sampled strata, area and volume statistics

Mapping of Forest Types

- Image data analysis
- Area calculation and map production
- Visual Interpretation

Image Data Source

- Landsat 7
- 25m resolution -> 1:50,000
- About 30 scenes 2000, 2001, 2002
- 5 bands available: blue, green, red, near IR, short wave IR
- Most scene pre-corrected to UTM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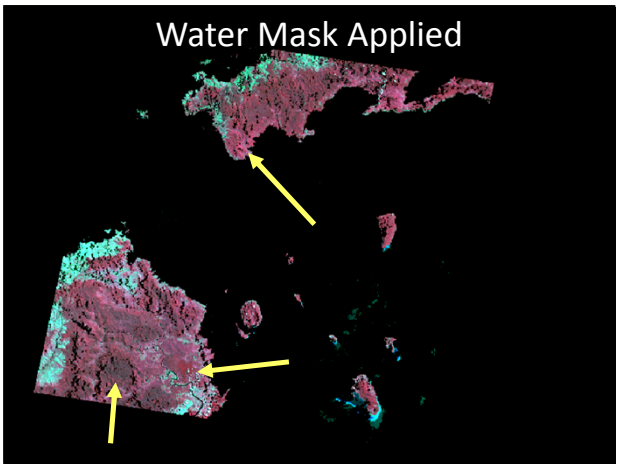
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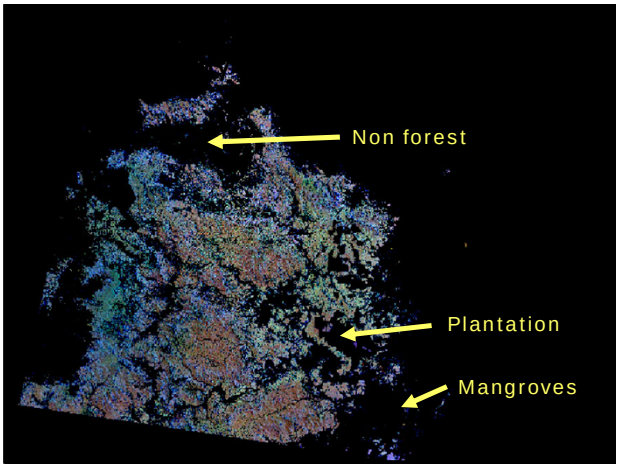
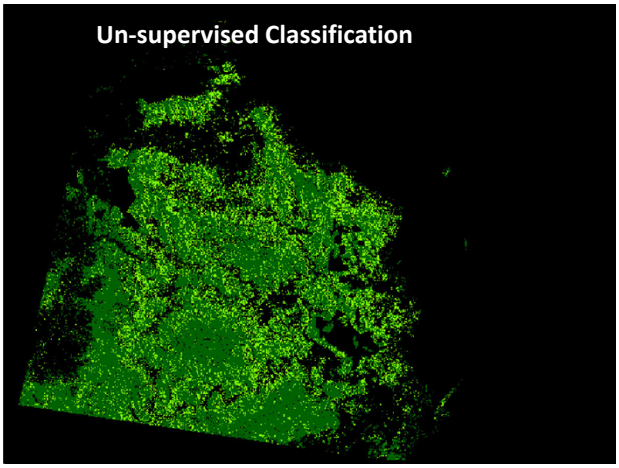
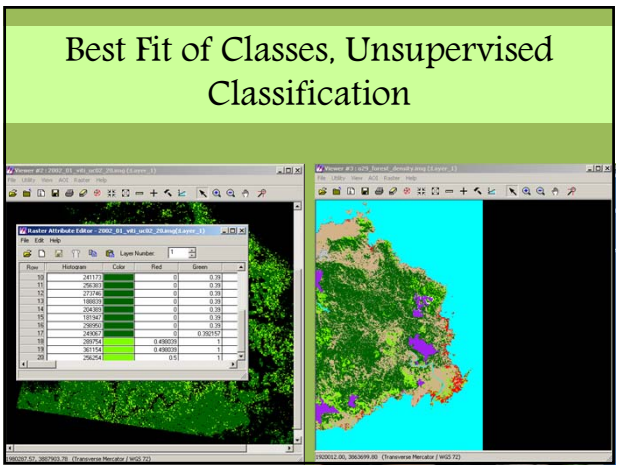
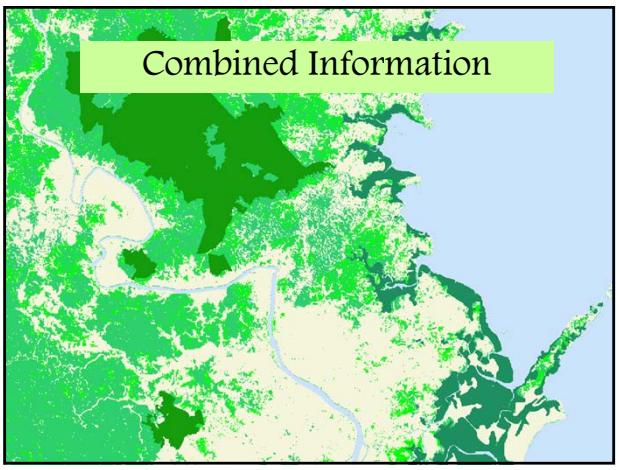
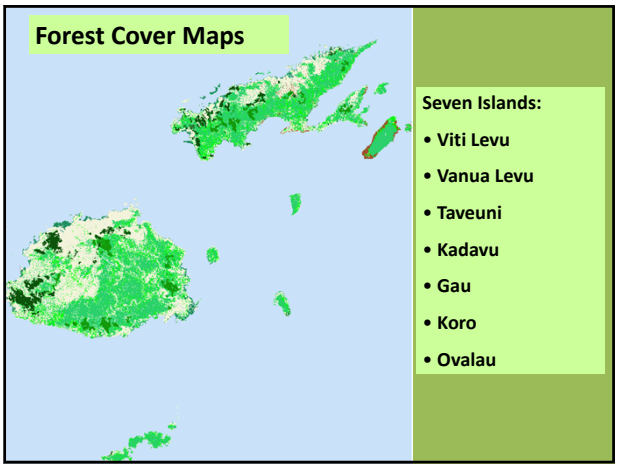
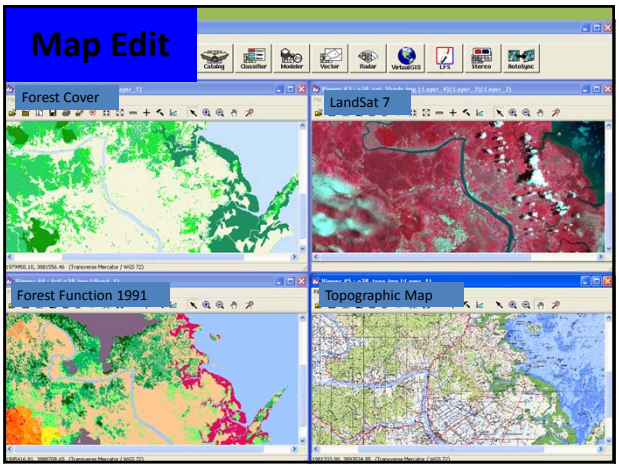

Non forest
Plantation
Mangroves

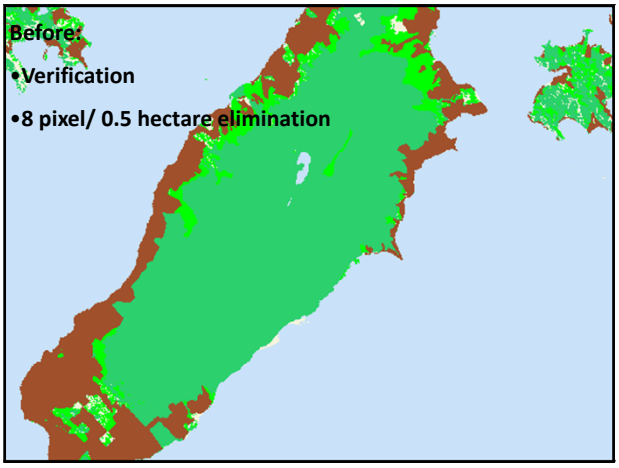

Un-supervised Classification

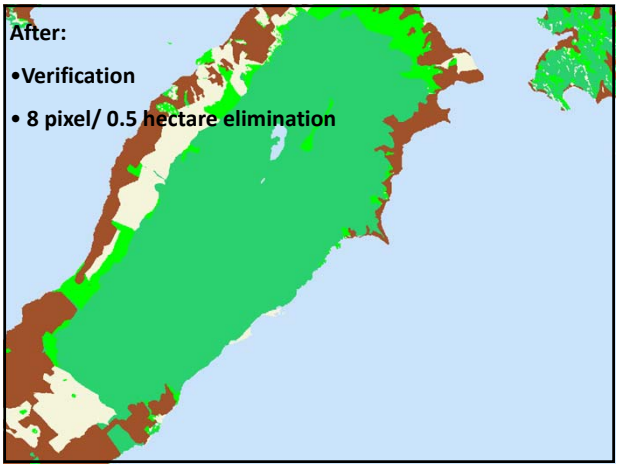

Best Fit of Classes, Unsupervised Classification

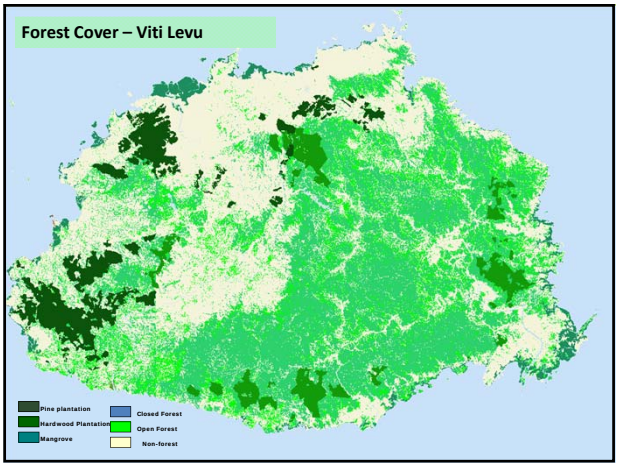

Combined Information

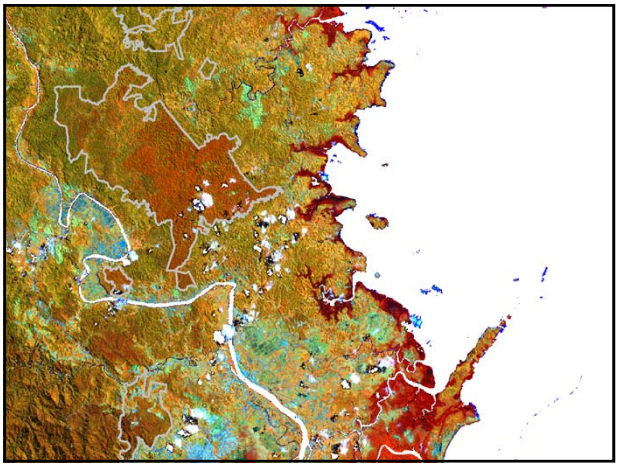

Forest Cover Maps
Seven Islands:
• Viti Levu
• Vanua Levu
• Taveuni
• Kadavu
• Gau
• Koro
• Ovalau

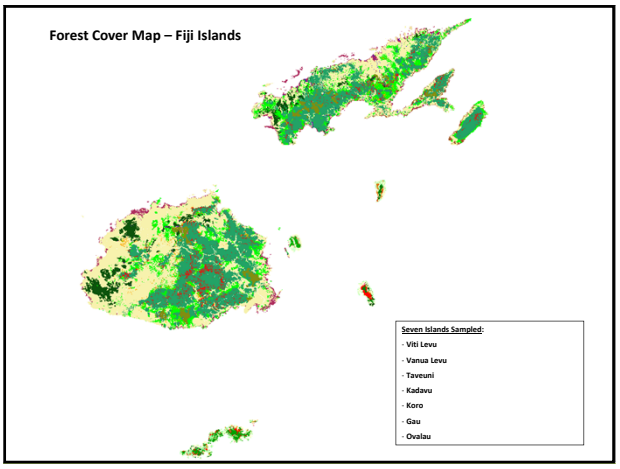

Map Edit
Forest Cover
LandSat 7
Forest Function 1991
Topographic Map


Before:
•Verification
•8 pixel/ 0.5 hectare elimination


After:
•Verification
• 8 pixel/ 0.5 hectare elimination

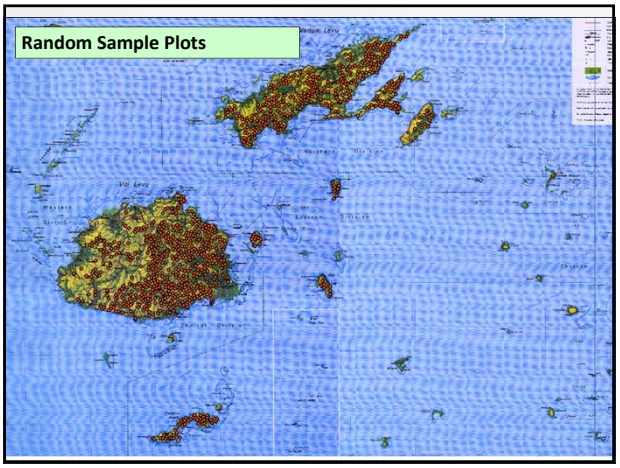

Forest Cover – Viti Levu
Pine plantation
Hardwood Plantation
Mangrove
Closed Forest
Open Forest
Non-forest

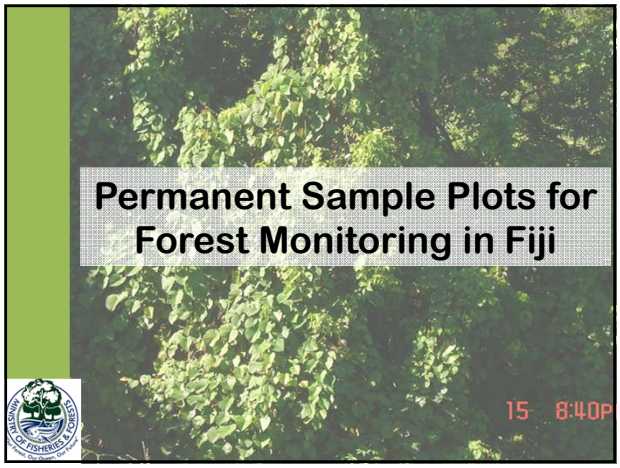




Field Sampling

Islands	Plots
Viti Levu	563
Vanua Levu	380
Taveuni	15
Kadavu	44
Ovalau	9
Gau	7
Koro	4
TOTAL PLOTS	1,022





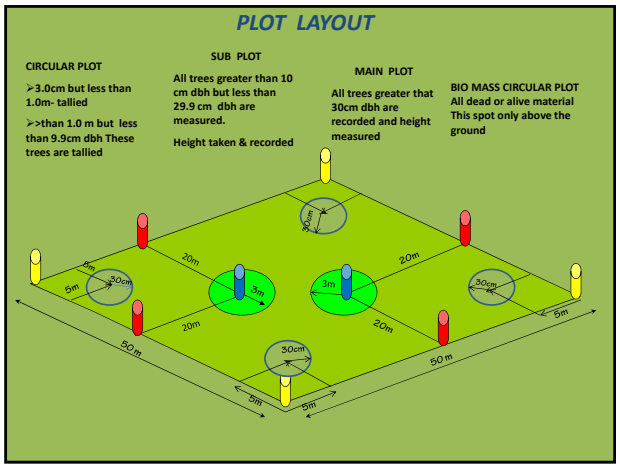
Objective

Establishment of an Annual Allowable Cut (AAC) for Fiji's natural forest, to ensure that harvesting is done at a level which the forest can biologically support.

Permanent Sample Plots

- Awareness are done to Resource Owners first from Administrative Level and Provincial Level.
- Awareness also conducted to Mataqali Heads where the plots are located.
- Establishment of Sample Plots

Plot Layout



Main Plot

- 50m by 50m
- Measure all trees with diameter **GREATER THAN 30 cm** in diameter using a diameter tape and recorded in the field recording form. The trees are identified, numbered using yellow paint and recorded in the field recording form.
- Tree heights measure using Height Pole.
- Record if the trees bear fruits or seeds during the time of assessment
- Record if there is any dead trees standing or alive within the plot.

Subplots

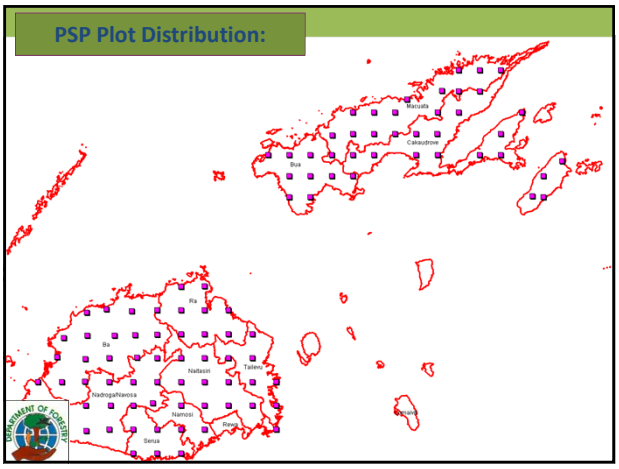
- 20m by 20m
- All regeneration trees which are **GREATER THAN EQUAL TO 10cm** diameter but **LESS THAN EQUAL TO 29.9 cm**
- The trees are identified, numbered using red paint and recorded.
- The tree heights are measured using a Height pole.
- Record if the trees bear fruits or seeds during the time of assessment
- Record if there is any dead trees standing or alive within the plot.

Circular Plot

- All regeneration trees **LESS THAN ONE METER** are identified, tallied on to the field form.
- Also for those trees which are **GREATER THAN or EQUAL TO ONE METER** height and **LESS THAN** 3cm DBH.
- Measure trees **GREATER THAN EQUAL TO 3cm DBH** but **LESS THAN EQUAL TO** 9.9cm. The color that is being used is blue paint.
- Three meters stick stress out to the circumference of the circular plot. Fishing line or ribbons at the end to locate the circumference of the plot. Clockwise identify the tree species and count the trees making sure not miss a single tree or recount an existing tree.

Biomass Circular Plot

- The 4 corner of the 50 x 50m plot (5m by 5m from main plot)
- All the dead organic matters found on the spots are collected and stored in a plastic bags
- Wet weight are recorded on a digital scale and then dried-up on a oven and then weigh again to record the dry weight.



REDD + Activities

REDD+ Policy

- *The Fiji REDD-Plus Policy is implemented within the framework of the National Forest Policy 2007 and contributes to the national Forest Sector goal: 'Sustainable management of Fiji's forests to maintain their natural potential and to achieve greater social, economic and environmental benefits for current and future generations'.*
- *In supporting the National Forest Policy, the Fiji REDD-Plus policy will: 'contribute towards the development of a national carbon trading policy' (Section 5.1, National Forest Policy) and 'strengthen the capacities to facilitate access to international financing mechanisms such as opportunities in the context of the UNFCCC' (Policy field 6.6, National Forest Policy).*
- *The Fiji REDD-Plus Policy is aligned to the objectives of the Fiji Sustainable Economic and Empowerment Development Strategy (SEEDS) and will strive to contribute to the overall sustainable development of the Fiji Islands, including poverty reduction.*

PILOT PROJECTS

- The Fiji REDD-Plus Programme will benefit from 'learning-by-doing' and will therefore include pilot projects designed to assist in building capability in the design and implementation of REDD-Plus activities.
- Thus the identification of the Pilot Site of the Mataqali Emalu

(*mataqali – communal land owning unit)*

SUMMARY 2012

- 3 weeks of field work - 9th – 27th July
- 4 Teams (5 – 8 person per team)
  - Forestry Dept
  - Drawa Landowners
  - Forest Technician
  - Emalu Landowners
- Measured 25 plots

SUMMARY 2013

- 3 weeks of field work - 11th – 28th Feb
- 4 Teams (5 – 8 person per team)
  - Forestry Dept
  - Drawa Landowners
  - Forest Technician
  - Emalu Landowners
- Measured 29 plots

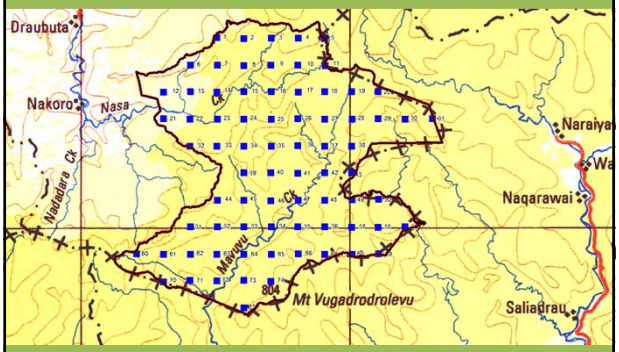
SAMPLING METHOD

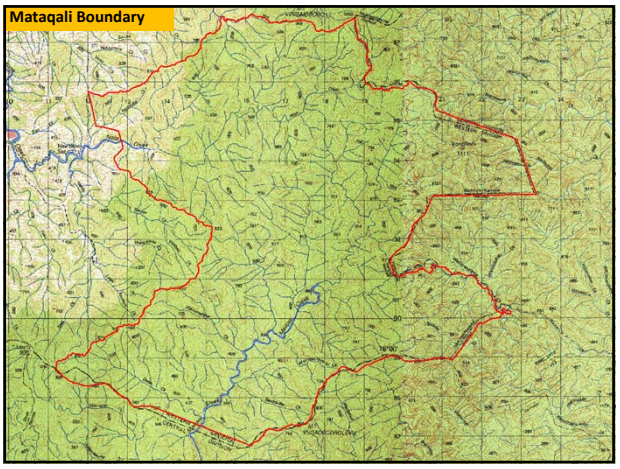
FROM SYSTEMATIC SAMPLING.. TO RANDOM

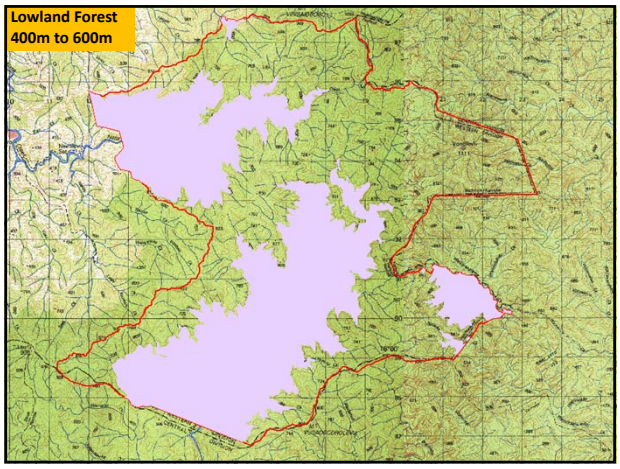
STRATIFY BY VEGETATION TYPE

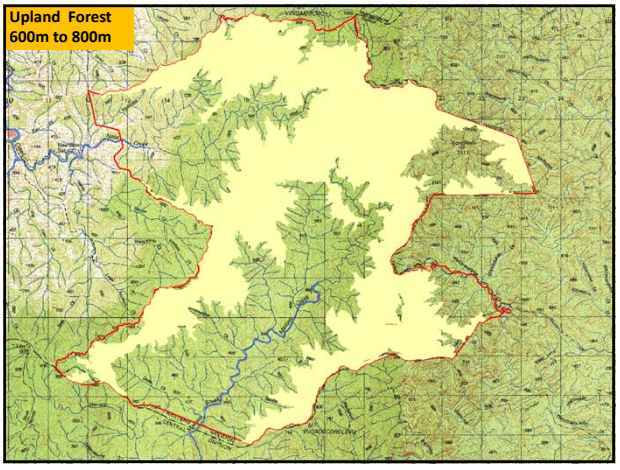
- **Lowland Forest 400m-600m**
- **Upland Forest 600m to 800m**
- **Cloud Forest Above 800m**

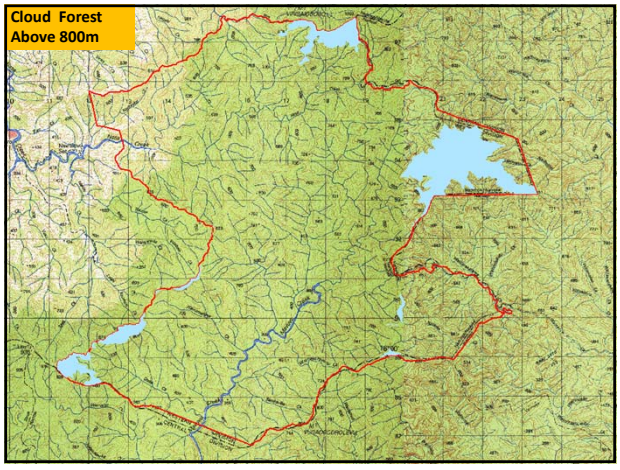
SYSTEMATIC SAMPLING

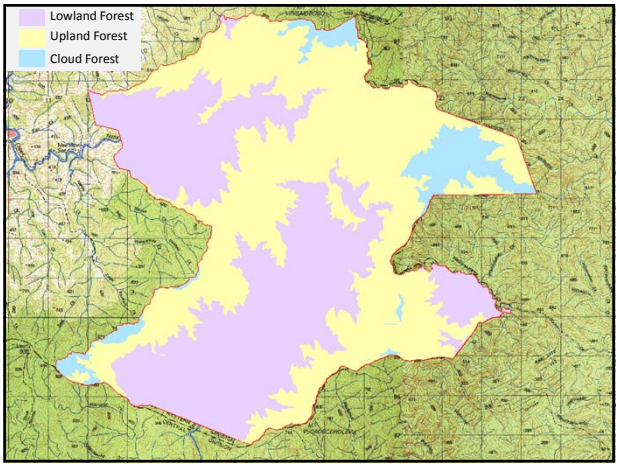


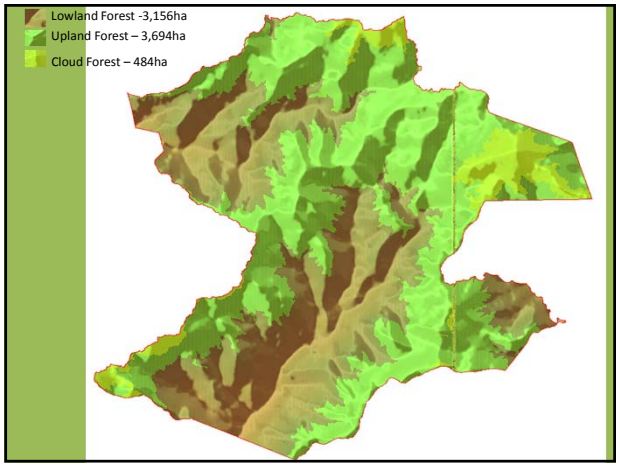

Mataqali Boundary

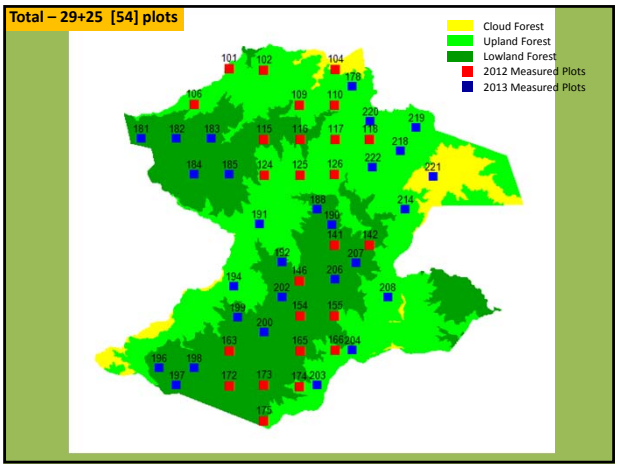

Lowland Forest
400m to 600m

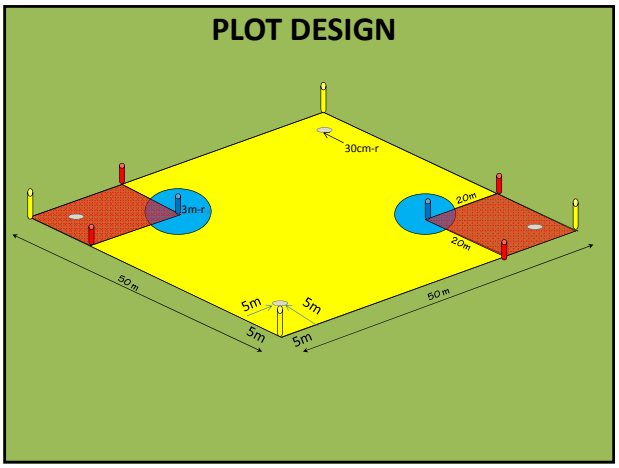

Upland Forest
600m to 800m


Cloud Forest
Above 800m


Lowland Forest
Upland Forest
Cloud Forest


Lowland Forest -3,156ha
Upland Forest – 3,694ha
Cloud Forest – 484ha





Measurement Parameters

50m x 50m	>= 25cm dbh (measure diameter & height)
20m x 20m	>= 10cm dbh <= 24.9cm dbh (measure diameter & height)
3m rad	>= 3cm dbh <= 9.9cm dbh (measure diameter & height) Count tally trees less than 3cm dbh
Biomass	Collect above ground litter
Deadwood	Measure length and dia at both end

COLLECTION OF BIOMASS DATA

Oecologia (2005) 145: 87–99
DOI 10.1007/s00442-005-0100-x

ECOSYSTEM ECOLOGY

J. Chave · C. Andalo · S. Brown · M. A. Cairns
J. Q. Chambers · D. Eamus · H. Fölster · F. Fromard
N. Higuchi · T. Kira · J.-P. Lescure · B. W. Nelson
H. Ogawa · H. Puig · B. Riéra · T. Yamakura

Tree allometry and improved estimation of carbon stocks and balance in tropical forests

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Abstract Tropical forests hold large stores of carbon, yet uncertainty remains regarding their quantitative contribution to the global carbon cycle. One approach to quantifying carbon biomass stores consists in inferring changes from long-term forest inventory plots. Regression models are used to convert inventory data into an estimate of aboveground biomass (AGB). We provide a critical reassessment of the quality and the robustness of these models across tropical forest types, using a large dataset of 2,410 trees ≥ 5 cm diameter, directly harvested in 27 study sites across the tropics. Proportional relationships between aboveground biomass and the product of wood density, trunk cross-sectional area, and total height are constructed. We also develop a regression model involving wood density and stem diameter only. Our models were tested for secondary and old-growth forests, for dry, moist and wet forests, for lowland and montane forests, and for mangrove forests. The most important predictors of AGB of a tree were, in decreasing order of importance, its trunk diameter, wood specific gravity, total height, and forest type (dry, moist, or wet). Overestimates prevailed, giving a bias of 0.5–6.5% when errors were averaged across all stands. Our regression models can be used reliably to predict aboveground tree biomass across a broad range of

Choice of the best predictive models

The overall best model, depending on whether total tree height H is available, was: Dry forest stands:

$$\langle AGB \rangle_{est} = \exp(-2.187 + 0.916 \times \ln(\rho D^2 H)) \equiv 0.112 \times (\rho D^2 H)^{0.916}$$

$$\langle AGB \rangle_{est} = \rho \times \exp(-0.667 + 1.784 \ln(D) + 0.207(\ln(D))^2 - 0.0281(\ln(D))^3)$$

Moist forest stands:

$$\langle AGB \rangle_{est} = \exp(-2.977 + \ln(\rho D^2 H)) \equiv 0.0509 \times \rho D^2 H$$

$$\langle AGB \rangle_{est} = \rho \times \exp(-1.499 + 2.148 \ln(D) + 0.207(\ln(D))^2 - 0.0281(\ln(D))^3)$$

FORMULA

- Dry Forest Stands: Forests with a pronounced dry season, during which the plants suffer serious water stresses and below 1,500mm/year of rainfall

  (AGB) = exp (-2.187+0.916 x ln(ρD²H)) =0.112 x (ρD²H)^0.916

- Moist Forest Stand - *Forest where evapotranspiration exceeds rainfall during more than a month but less than five months with 1,500 -3,500mm/year in rainfall*

  (AGB) = exp (-2.977+ ln(ρD²H)) = 0.0509 x ρD²H

- Wet Forest Stand – *Forest where evapotranspiration exceeds rainfall during less than a month with rainfall greater than 3500mm/year.*

  (AGB) = exp (-2.557+0.940 x ln(ρD²H)) = 0.0776 x ρD²H^0.940

Calculate the Above Ground Live Biomass using Chaves generic tropical moist & tropical rainforest equation which is ***AGL = 0.0509 x ρD²H***

Note that:

I. *Tree diameter in centimeters*
II. *Top height in meters*
III. *Density in g/cm3*

	C	D	E	F	G	H	I	M	N	O
1	Tree No	LocalName	DBH (cm)	Height (m)	Density(kg/cm³)	Density (g/cm³)	AGB			
2	1	Yasi vula	25.2	13	430	0.43	180.7	Calculate AGB using the formular: 0.0509*Density*DBH2*Height		
3	2	Salato	33.6	12.5	340	0.34	244.2			
4	3	Sasawira	46.4	15	490	0.49	805.5			
5	4	Dalovoci	31.1	10.54	430	0.43	223.1			

The Above Ground Live biomass for tree no. 1 is 180.7kg. Calculate the rest of tree within all the plots.

Step 5

	C	D	E	F	G	H	I	J	M
1	Tree No	LocalName	DBH (cm)	Height (m)	Density(kg/cm³)	Density (g/cm³)	AGB	BG	
2	1	Yasi vula	25.2	13	430	0.43	180.7	43.4	24% of AGL is BG BG = AGL * 24%
3	2	Salato	33.6	12.5	340	0.34	244.2	58.6	
4	3	Sasawira	46.4	15	490	0.49	805.5	193.3	
5	4	Dalovoci	31.1	10.54	430	0.43	223.1	53.5	

Carbon Content for Emalu Pilot Site

Tree Diameter greater than 25cm

VegetationType	Area (ha)	S Area(ha)	AG (kg)	BG (kg)	TOTAL (kg)	Carbon (kg)	Carbon (ton)	tonC/ha	Total Carbon Stock
Lowland	3,156	7.0	588,545.0	141,250.7	729,795.7	364,897.8	364.9	52.1	164,516.8
Upland	3,694	6.0	495,095.7	118,822.9	613,918.6	306,959.3	307.0	51.2	188,984.6
Cloud	484	0.5	43,838.0	10,521.2	54,359.2	27,179.6	27.2	54.4	26,331.6
	7,334	13.5	**1,127,478.6**	**270,594.7**	**1,398,073.4**	**699,036.7**	**699.0**	51.8	379,778.9

Tree Diameter from 10cm to 24.9cm

VegetationType	Area (ha)	S Area(ha)	AG (kg)	BG (kg)	TOTAL (kg)	Carbon (kg)	Carbon (ton)	tonC/ha	Total Carbon Stock
Lowland	3,156	2.2	50,428.9	12,102.8	62,531.7	31,265.8	31.3	14.0	44,051.3
Upland	3,694	1.8	42,106.9	10,105.5	52,212.4	26,106.2	26.1	14.2	52,411.1
Cloud	484	0.2	2,892.1	694.1	3,586.1	1,793.1	1.8	11.2	5,428.5
		4.2							

Tree Diameter from 3cm to 9.9cm

VegetationType	Area (ha)	S Area(ha)	AG (kg)	BG (kg)	TOTAL (kg)	Carbon (kg)	Carbon (ton)	tonC/ha	Total Carbon Stock
Lowland	3,156	0.1	771.2	185.1	956.4	478.2	0.5	3.9	12,249.7
Upland	3,694	0.1	935.2	224.5	1,159.7	579.8	0.6	5.4	20,130.4
Cloud	484	0.0	37.6	9.0	46.6	23.3	0.0	4.2	2,016.7

Conclusion

- Fiji is aligning itself to policies and also international obligations to assuring and enhancing Sustainable Forest Management.
- The Permanent Sample Plot will be measured for 25 years consequently whilst REDD+ sites will be measured after every 5 years.

3.Indonesia:Enhancing Forest and Watershed Condition for Climate Change Adaptation and Mitigation

ENHANCING FOREST AND WATERSHED CONDITION FOR CLIMATE CHANGE ADAPTATION AND MITIGATION

By. MR. SUHARDIJONO
Ministry of Forestry of The Republic of Indonesia

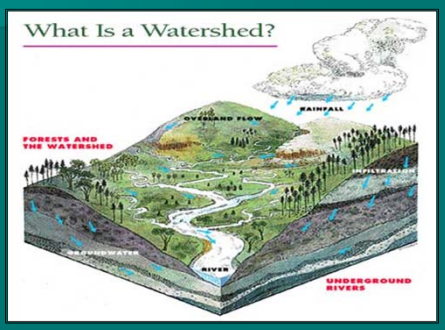
Overview of Indonesia

- PROVINCES 33, DISTRICTS > 500
- ISLANDS > 15,000
- POPULATION > 220 MILLION PEOPLE
- ECONOMY : AGRICULTURE, OIL & GAS, MINING, INDUSTRIES, TOURISM

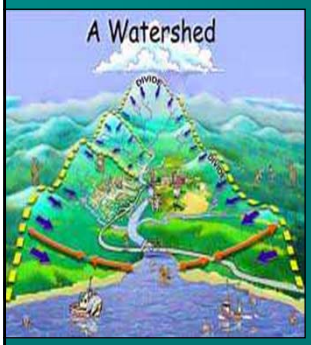
1. WATERSHED AND FOREST PROTECTION IN INDONESIA

- Forest and watershed becomes important natural resources for Indonesia
- The importance of watershed in Indonesia especially for forest management has clearly been stated in Forestry Law No. 41 year 1999
- The total watershed in Indonesia is 17.088 units
- Indonesia has about 68.4 % forest out of total land area

Watershed in Indonesia

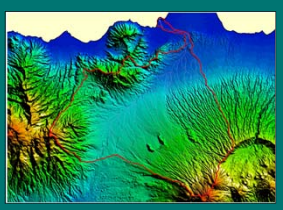


Definition

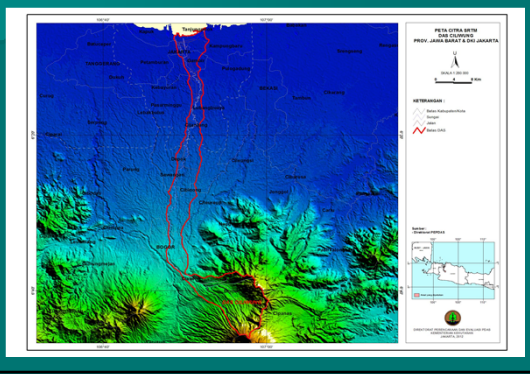


- A watershed is "that area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community."

- The total watershed in Indonesia is 17.088 units,
- Priority watershed is 350 units,
- Watershed becomes planning basis for forest management



Ciliwung watershed



Objectives of forestry development

- To ensure adequate forest area scattered through out watersheds or islands
- To optimize forest functions
- To increase the welfare of people living surrounding the forest area.
- To increase carrying capacity of watershed to support livelihood of the people
- To guarantee the distribution of forest benefit equally to the whole community

2. OVERVIEW OF FOREST MANAGEMENT

Forest in Indonesia contains :

✓ National/State Forest

✓ Private Forest : 8.07 million hectare

✓ National Forest area about 130.68 million hectare

✓ Approximately 68.4 % of total land

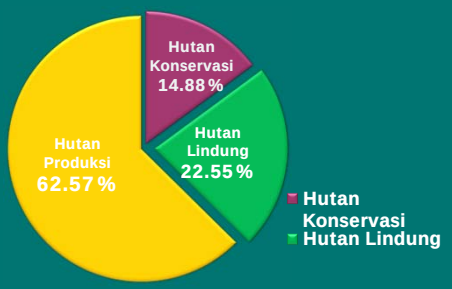
✓ NATURAL FOREST

✓ MAN-MADE FOREST

Forest functions

- PRODUCTION FOREST (timber and non timber)
- PROTECTION FOREST (water balance, erosion, soil fertility)
- CONSERVATION FOREST (biodiversity, flora, fauna)

FOREST FUNCTIONS

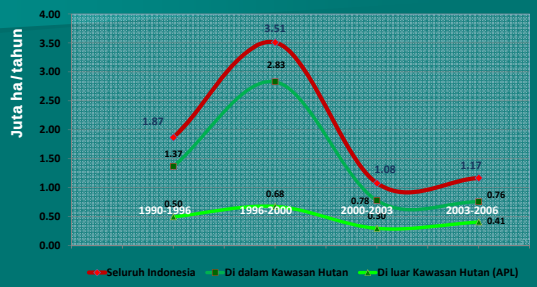


Sumber : Ditjen Planologi, Kementerian Kehutanan th 2009

The condition of forest cover

- Primary or virgin forest about 41.26 million hectare
- Secondary or log over area about 45.55 million hectar
- Plantation forest about 2.82 million hectare
- Degraded forest about 41.05 million hectare

DEGRADATION RATE



Management of forest and watershed

- Nature conservation and Forest protection
- Forest harvesting
- Forest and land rehabilitation

3. Historical Bacground

- Before independence/Netherland colony
  Established teak plantation in Java island
- Harvesting Periode (early 1970-late 1990) :
  Heavy forest felling, increased forest industries, a lot of forest degradation
- Rehabilitation period (early 2000 – now) :
  Reduced forest harvesting, increased forest protection and rehabilitation, promote more community involvement and other stakeholders for forest rehabilitation and management

4. Development commitment

- The national constitution called UUD 1945 in article 33 states that land, water and all of the natural resources are managed by government to increase the welfare of people's livelihood.
- The Law no. 41 year 1999 regarding Forestry states that implementation of forest resource management is conducted to increase the welfare of people and to rise the quality of watershed condition.

Mid Term Forestry Development Planning Year 2010-2014 :

a. Strengthening forest boundary and inventory
b. Rehabilitation of degraded forest and strengthening watershed condition
c. Forest fire prevention
d. Protection of biodiversity
e. Revitalization of forest harvesting and industry
f. Community empowerment surrounding forest area

Programs of forest rehabilitation :

a. Rehabilitation of degraded forest and land including mangrove, coastal forest and peat swamp forest.
b. Establishment of community forestry
c. Development of private forest
d. Development of seed source stand
e. Establishsement of village forest
f. Establihment of integrated watershed management planning

5. POLICY AND STRATEGY ON CLIMATE CHANGE MITIGATION AND ADAPTATION

- Commitment on climate change mitigation when attended G 20 Conference in Pittsburg and COP 15. By year 2020 Indonesia will reduce carbon emission up to 46 %,
- Reduce 26 % through Indonesian effort and 15 % through international suppor

Presidential Decree No. 61 year 2011 regarding National Action Plan on Climate Change Mitigation.

SECTOR	26% (Gton CO2 e)	41% (Gton CO2 e)
Forestry and peat land	0.672	1.039
Agriculture	0.008	0.011
Energy and transportation	0.036	0.056
Industry	0.001	0.005
Waste	0.048	0.078
Total	0.767	1.189

Strategies for forestry and peat land sector

- to reduce deforestation and degradation rate
- to increase planting to raise carbon absorption
- to protect forest from fire and illegal logging
- to manage drainage in peat land area
- to stabilize water level in drainage system
- to optimize forest and water resource without deforestation
- to implement appropriate technology for land and agriculture management with minimum carbon emission.

6. Problems

- Vast area of degraded forest
- Difficult accessibility
- Very expensive transportation cost
- Lack of human resource condition
- Limited budget
- Lack of coordination among the level of government
- Very small standard cost of implementation
- A lot of forest encroachment by community, etc.

7. FOREST AND LAND REHABILITATION TO SUPPORT CLIMATE CHANGE MITIGATION

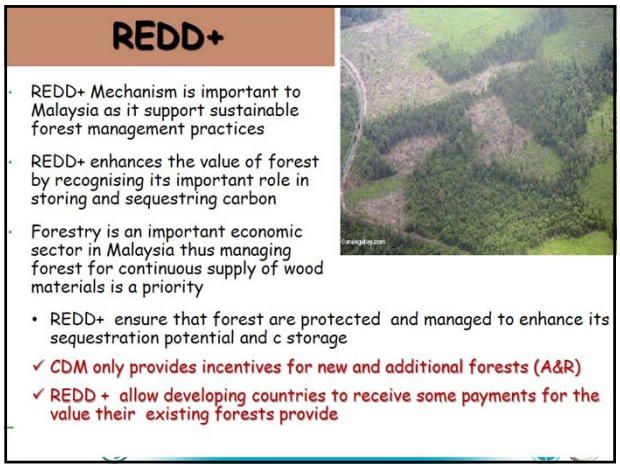
- Rehabilitation of degraded forest and land including mangrove, coastal forest and peat swamp forest about 2.5 million hectare
- Establishment of community forestry about 2 million hectare
- Development of private forest about 250.000 hectare
- Development of seed source stand about 10.000 hectare
- Establishsement of village forest 500.000 hectare
- Establihment of integrated watershed management planning targeted for 108 critical watershed.

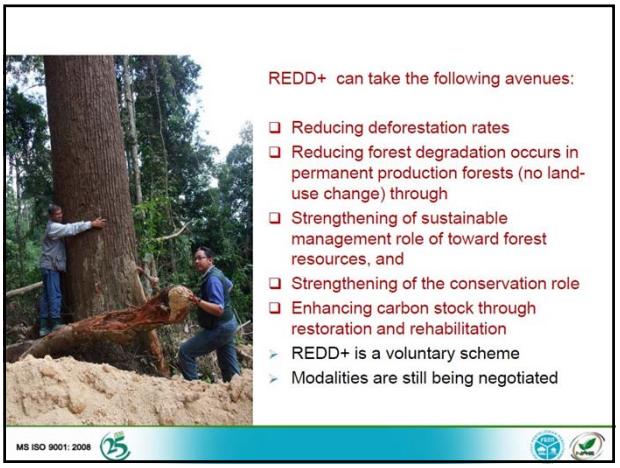
8. Closing

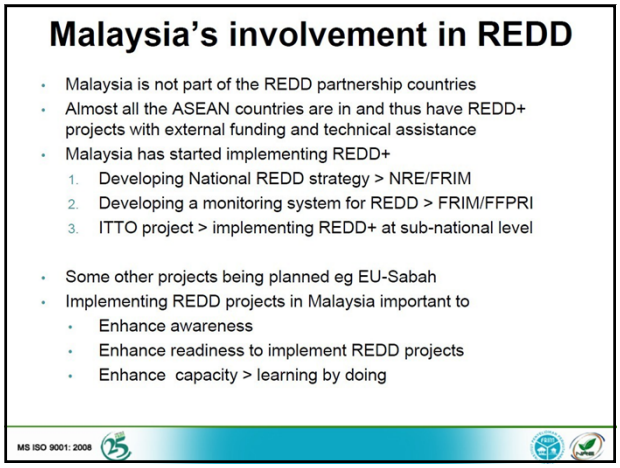
- The existence of forest and watershed is very important. Forest count about 68.4% of total land. It means forest relatively dominant land cover within the watershed. If the forest is degraded, the watershed will be very critical.
- Indonesia has high commitment on climate change mitigation and adaptation. The government has established National Action Plan , in which forestry sector becomes an important parts of the program.

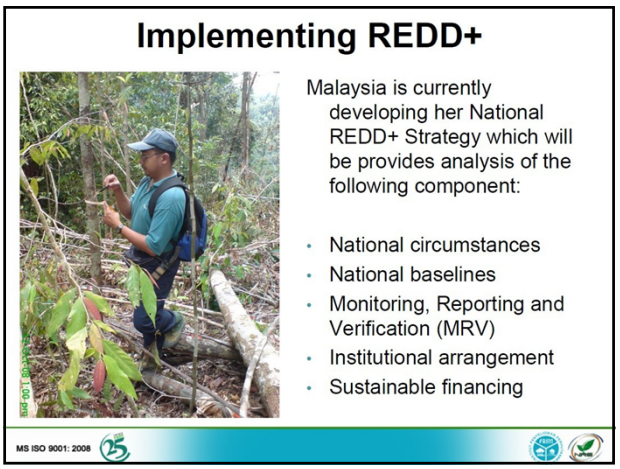
THANK YOU

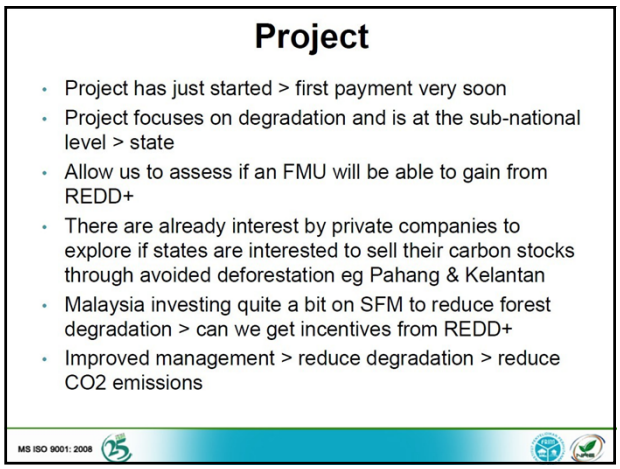
4.Malaysia: Reducing Forest Degradation and Emissions through Sustainable Forest Management(SFM) in PENINSULAR











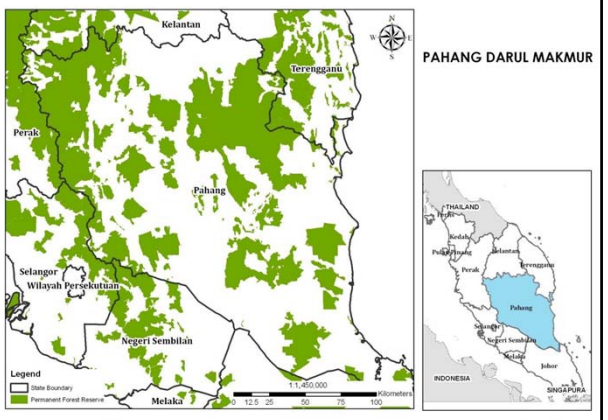
Objectives

- General objective > to utilize Sustainable Forest Management (SFM) as a mitigation tool in combating climate change.
  - As deforestation rate is stable in Malaysia, the emissions to be accounted for REDD mechanism would probably come from the reduction of forest degradation
- Specific Objectives
  - To improve knowledge on reduction of forest degradation and enhance payments for ecosystem services (non-carbon benefits)

Project location

- Project will to be conducted in Pahang
  - forestry an important economic sector
  - Has orang asli/local communities
  - Large protected forests > national parks, watersheds etc
  - Various forest type> inland, peat and mangroves

	Extent (ha)	%
Total land area	3,595,585	
Total Forested land	2,024,236	56.3
Permanent Reserved Forest	1,562,902	43.5
National Park	461,334	12.8



Component 1

- **Output : National forest degradation estimated**

Activities

- Assessment of forest degradation drivers
  - Stakeholder consultations
- Develop tools/guidelines to account, monitor and report forest degradation

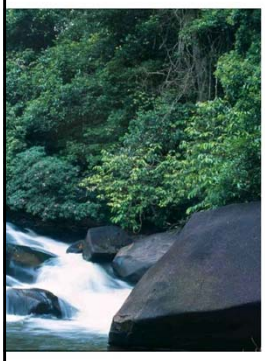
Component 2

- **Output 2: Forest degradation reduced at the forest management unit**

Activities

- Forest degradation at the forest management unit assessed
  - Assessment made using remote sensing and ground inventories
  - Baselines establsihed
- Methods for reducing forest degradation implemented
  - Improve harvesting prescriptions assessed > log fisher, RIL, Max volume control, protection of fruit trees, etc

Component 3



- **Output 3: Incentives for carbon and ecosystems services established**

Activities

- Assessment of cost and benefits of improving forest management and reducing degradation
- Valuing Non-carbon benefits eg water, recreation,
- Develop a scheme for payment under REDD or PES (co benefits beside C)

Outputs and Activities

- **Output 4: Capacity of major stakeholders and communities where relevant is strengthened**

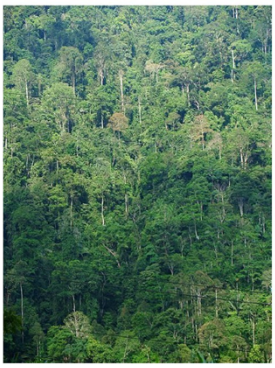
Activities

- Developing awareness programmes amongst policy makers and forest managers
  - Particularly at the state level > workshops, consultations etc.
- Develop capacity in REDD+ and carbon accounting
  - Assessment of different C pools > training local and international
- Cross sharing of experience and knowledge with other REDD projects in the region
  - Visits and study tours to assess REDD+ projects

MS ISO 9001: 2008

Implementation approaches and methods

- Major players > FRIM, NRE, FDHQ, Pahang State FD
- Project Steering Committee > governing body to ensure project implemented accordingly based on national circumstances
- Technical Working Group – address technical aspects of the project



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Conclusion

- Project is exciting as it provides opportunities to enhance value of forests at the FMU
- It promotes SFM and supports Malaysia's commitment under the UNFCCC
- Again REDD is voluntary > if benefits are not attractive > states may not be interested
- The project allows such assessment > cost and benefits
- Project's success depends on the support of key stakeholders > FDHQ and State FD

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5.Mongolia: Climate Change and Adaptation Measures in Mongolia

Climate Change and Adaptation Measures in Mongolia

P. Battulga
Institute of Geoecology
Mongolian Academy of Sciences, Mongolia

Context

- Introduction
- Climate Change in Mongolia
- Impact of Desertification
- Deforestation and reforestation
- Some results in case our study
- Forest management plan and NEAP
- Policies and measures on adaptation to climate change
- Adaptation measures in forestry
- Recommendation

Temperature and Precipitation Changes in Mongolia

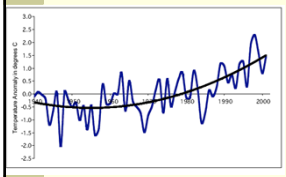


Fig 1. Trend of average year temperature

Fig 1. Continuous change in Mongolia's climate has been observed in recent years: between 1940-2007, the air temperature rose by 2.1^{0}C , by 1.9-2.28^{0}C in the mountain region and by 1.6^0 -1.7^0 C in the Gobi and steppe regions.

Fig 2. Mongolia's total annual rainfall has d ecreased by 1.7-12.5% in the Gobi region w ithin the last 68 years, and increased by 3.5-9.3% in the eastern and western regions.

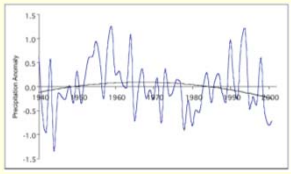
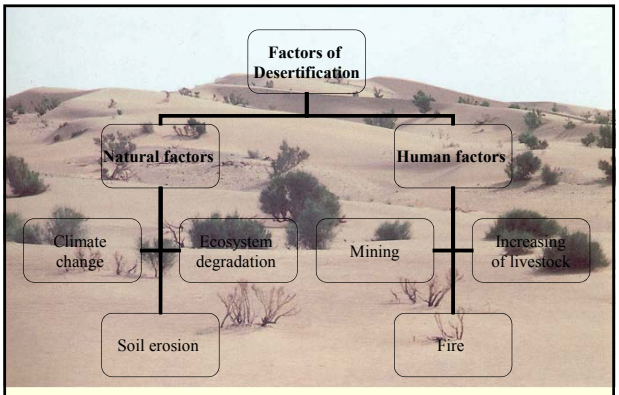


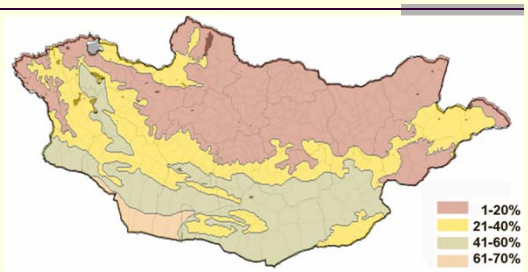
Fig 2. Trend of total annual precipitation



Gobi desert zone of Mongolia

Gobi desert area is homeland of Mongolian nomadic herders

Frequency of Drought

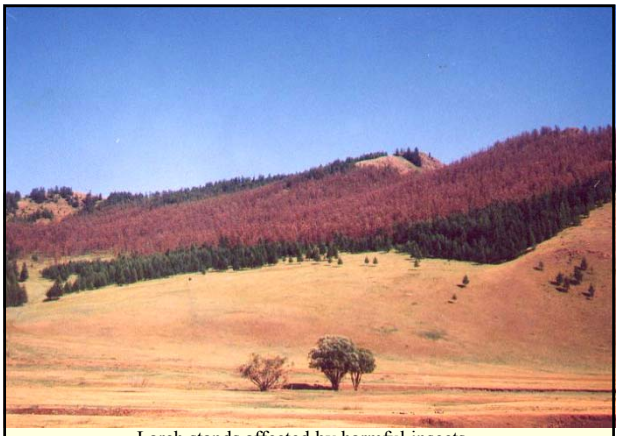


Soil erosion

Soil erosion type	1990-1999		2000-2005	
	000' ha	%	000' ha	%
Water erosion	21.8	14.0	21.8	14.0
Wind erosion	7.8	5.0	12.5	8.0
Water and Wind erosion	91.6	58.6	93.8	60.0
Other type	2.0	1.2	3.0	1.9

Forest logging

- Specially illegal tree logging is main factor of ecosystem disturbance in northern Mongolia. Negative impact of deforestation is cooperated with land degradation, water resource depletion etc.,



Larch stands affected by harmful insects

Gold mining and Desertification

30% of the degraded land due to mining, and geological exploration is rehabilitated at some level.

Surface mining (Gold) in forest area

Land degradation and Dust Storm

Due to climate change almost half million hectares of land has eroded, which has been used for agriculture during the last more than 40 years. Also 70% of Mongolian territory is degraded.

Yield from severely degraded pasture has decreased by 5 times.

Number of days with dust and sandstorms in the steppe and Gobi desert zones has increased by 3 and 4 times by the beginning of the 21st Century in comparison with 1960's.

Desertification impact on herders

- Number of wealthy households who have thousand and more animals increased and productivity from animals increased

Water resource and desertification

Changes of herding ways

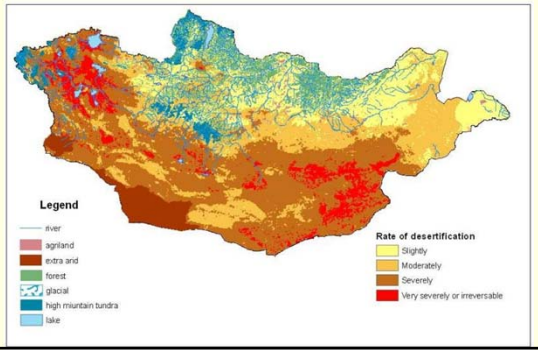
- The traditional herding way of Mongolian people which was adapted in past thousand years has been changed under impact of desertification and drought.

Changes of composition of animals

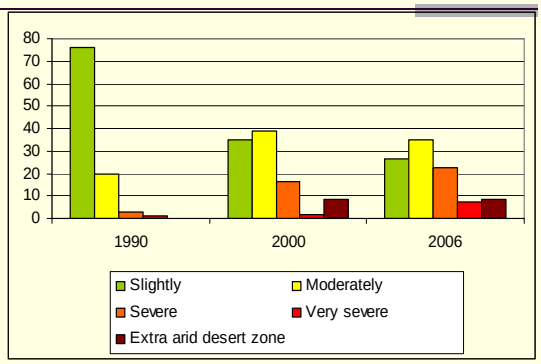
- The composition of domestic animal's flock has changed and number of cattle specially cows decreased and the number of small livestock specially goats prevailed.
- Since 1990s total number of animals has increased up to 40.0 million and the carrying capacity of pastureland has changed drastically.

During the last 40 years the desert areas of Mongolia has increased by some 38,000 ha. 70% of the total pasture land in the country has degraded due to inappropriate management of land use.

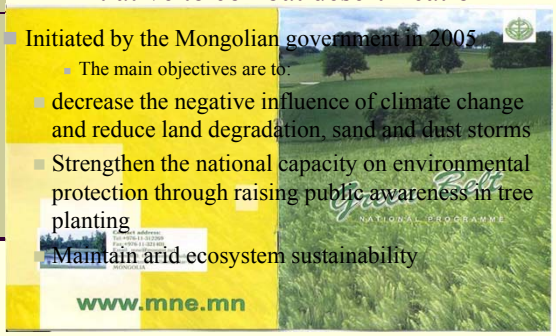
Desertification map, 2007



Desertification rate



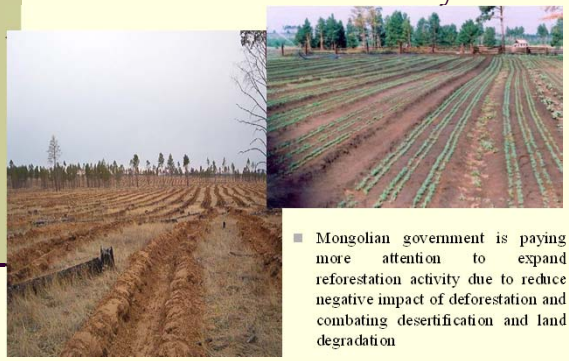
The 'Green belt' program National initiative to combat desertification



- Initiated by the Mongolian government in 2005
  - The main objectives are to:
- decrease the negative influence of climate change and reduce land degradation, sand and dust storms
- Strengthen the national capacity on environmental protection through raising public awareness in tree planting
- Maintain arid ecosystem sustainability

Deforestation and reforestation

Reforestation activity



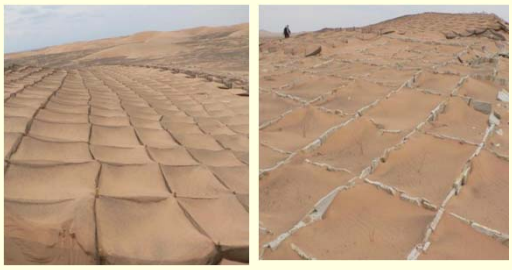
- Mongolian government is paying more attention to expand reforestation activity due to reduce negative impact of deforestation and combating desertification and land degradation

Public participation in tree planting

Afforestation in Gobi region

Nursery Development in Gobi region

Demonstration for Sand fixation



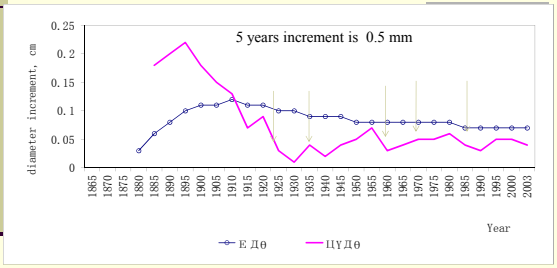
Straw used fixation work

- Straw used sand fixation method is more suitable and efficient but it is difficult to protect from animal grazing during the the winter time.

Implementing project

- Desertification dynamics and its trend 2004-2008 (MG)
- Desertification in settlement area in Mongolia (MG 2007-2010)
- Sustainable land management for combating desertification (promoting of UNDP, by finance Nederland Government)
- WOCAT (Swiss Cooperation Agency)
- Rehabilitating desert zone ecosystems and promoting sustainable alternative livelihood in Gobi protected areas buffer zones and peripheral communities in Mongolia (Institute for Global Environmental Strategies, Japan)
- Since 2003 Korean Government Agencies, research institutions, NGOs and private organizations are supporting for combating desertification and reforestation in Mongolia.

Drought impact on diameter and height increment of *Larix sibirica* Ldb



Droughts occurred in 1941, 1944, 1945, 1949, 1951, 1957, 1960, 1962, 1964, 1965, 1970, 1972, 1974, 1975, 1978, 1981 in Gobi Altai province (Mijiddorj et all, 1985).

Allometric regression models and index for estimating the above-ground biomass

(Hosoda and Iehara, 2010)

$W=aD^b$ (1)

$W=a(D^2H)^b$ (2)

$W=aD^bH^c$ (3)

$W=(D^2H)/(a+bD)$ (4)

There are:

W- *weight of biomass (kg),*

D-*Diameter at Breast height(in cm),*

H- *Height (in m),*

a,b,c- *coefficient*

$$RMSE = \sqrt{\sum_{i=1}^{n}(y_i - \bar{y}_i)^2 / n} \quad (5)$$

$$RMSE(\%) = \sqrt{\sum_{i=1}^{n}((y_i - \bar{y}_i)^2 / y_i) / n} \cdot 100 \quad (6)$$

$$Bias = \sum_{i=1}^{n}(y_i - \bar{y}_i) / n \quad (7)$$

$$FI = 1 - \frac{\sum_{i=1}^{n}(y_i - \bar{y}_i)^2}{\sum_{i=1}^{n}(y_i - \bar{y})^2} \quad (8)$$

Total amount and percentage of above ground larch stand biomass in Altai, Mongolia

No	Total biomass, kg	Stem		Branch		Needle	
1	11.64	9.13	(78 %)	2.07	(18 %)	0.44	(4 %)
2	38.73	26.84	(69 %)	9.34	(24 %)	2.56	(7 %)
3	11.57	8.06	(70 %)	2.94	(25 %)	0.56	(5 %)
4	22.68	20.12	(89 %)	2.04	(9 %)	0.52	(2 %)
5	90.61	73.28	(81 %)	12.84	(14 %)	4.84	(5 %)
6	47.96	37.78	(79 %)	8.30	(17 %)	1.88	(4 %)
7	109.64	94.00	(86 %)	12.38	(11 %)	3.26	(3 %)
8	42.78	26.73	(62 %)	12.10	(28 %)	3.94	(9 %)
9	45.61	35.03	(77 %)	7.49	(16 %)	3.09	(7 %)
10	22.82	18.41	(81 %)	3.44	(15 %)	0.97	(4 %)
11	147.33	101.10	(69 %)	39.12	(27 %)	7.10	(5 %)
12	26.89	18.48	(69 %)	6.95	(26 %)	1.45	(5 %)
13	57.23	46.70	(82 %)	8.10	(14 %)	2.43	(4 %)
14	87.27	59.30	(68 %)	22.81	(26 %)	5.68	(7 %)
15	39.90	25.93	(65 %)	10.75	(27 %)	3.22	(8 %)
16	40.12	31.61	(79 %)	6.85	(17 %)	1.66	(4 %)
17	154.15	128.72	(84 %)	21.67	(14 %)	3.76	(2 %)
18	129.92	96.09	(74 %)	27.42	(21 %)	6.41	(5 %)

Stem (76±2%), Branches (19±1.0%), Needles (5±0%),

Regression model for estimation biomass and parameters, examination

No	Model	Type	Coefficient	SE	R^2	BP
Stem:						
1	$y=aD^b$	N	a=0.1142, b=2.2672	a: 0.07, b: 0.20	0.94	0.01
		W	a=0.1264, b=2.2255	a: 0.04, b: 0.12	0.96	**0.06**
2	$y=a(D^2 H)^b$	N	a=0.0348, b=0.9202	a: 0.01, b: 0.04	0.99	0.008
		W	a=0.0387, b=0.9073	a: 0.01, b: 0.02	0.99	**0.08**
3	$y=aD^b H^c$	N	a=0.0270, b=1.6585, c=1.2143	a: 0.01, b: 0.11, c: 0.14	0.99	0.001
		W	a=0.0320, b=1.7242, c=1.0786	a: 0.01, b: 0.08, c: 0.13	0.99	**0.06**
4	$y=(D^2 H)/(a+bD)$	N	a=40.984, b=0.8401	a: 5.25, b: 0.28	0.99	0.006
		W	a=39.908, b=0.9081	a: 2.99, b: 0.18	0.99	**0.06**
Branches:						
1	$y=aD^b$	N	a=0.0180, b=2.4268	a: 0.02, b: 0.43	0.78	0.008
		W	a=0.0431, b=2.1211	a: 0.04, b: 0.29	0.79	**0.07**
2	$y=a(D^2 H)^b$	N	a=0.0197, b=0.8200	a: 0.03, b: 0.18	0.68	0.002
		W	a=0.0225, b=0.8011	a: 0.02, b: 0.13	0.72	0.03
3	$y=aD^b H^c$	N	a=0.0447, b=3.1777, c=-1.1761	a: 0.06, b: 0.55, c: 0.62	0.83	**0.21**
		W	a=0.1226, b=2.5532, c=-0.8742	a: 0.14, b: 0.43, c: 0.65	0.81	0.25
4	$y=(D^2 H)/(a+bD)$	N	a=243.1, b=-0.5086	a: 159, b: 8.38	0.66	0.002
		W	a=133.0, b=5.6032	a: 82.7, b: 5.11	0.70	0.02
Needles:						
1	$y=aD^b$	N	a=0.0412, b=1.6331	a: 0.04, b: 0.33	0.70	0.04
		W	a=0.0282, b=1.7692	a: 0.02, b: 0.30	0.72	**0.87**
2	$y=a(D^2 H)^b$	N	a=0.0311, b=0.5911	a: 0.04, b: 0.14	0.62	0.008
		W	a=0.0148, b=0.6810	a: 0.02, b: 0.13	0.66	**0.76**
3	$y=aD^b H^c$	N	a=0.1262, b=2.1798, c=-1.0294	a: 0.14, b: 0.45, c: 0.61	0.76	0.46
		W	a=0.0955, b=2.2050, c=-0.9464	a: 0.12, b: 0.45, c: 0.73	0.75	**0.98**
4	$y=(D^2 H)/(a+bD)$	N	a=116.2, b=49.50	a: 334, b: 20.5	0.56	0.008
		W	a=244.3, b=41.09	a: 284, b: 19.8	0.63	**0.49**

[1] N, ordinary least square regression; W, weighted least square regression; [2] Standard error (SE) of parameter estimates a, b, c; [3] Results (*P* value) of Breusch-Pagan test for homoscedasticity (data are heteroscedastic at $P \leq 0.05$); test results which pivotal for the selection of the [illegible] regression model for further examination are printed in bold.

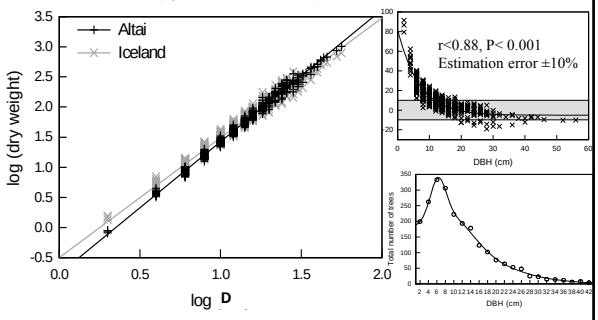
Index and error for estimating models of above ground biomass of *Larix sibirica* Ldb

Model	RMSE (kg)	RMSE (%)	Bias(kg)	FI
Stem:				
1 (W)	8.9	11.8	0.761	0.936
2 (W)	4.1	5.0	0.046	0.987
3 (W)	3.6	5.1	-0.051	0.989
4 (W)	3.8	4.8	0.001	0.988
Branches:				
1 (W)	4.6	36.3	0.008	0.985
2 (W)	5.4	39.3	0.270	0.979
3 (N)	4.0	56.2	0.529	0.988
4 (W)	5.6	40.7	0.348	0.977
Foliage:				
1 (W)	1.1	44.1	0.003	0.999
2 (W)	1.2	45.6	0.049	0.999
3 (N)	1.0	42.6	-0.004	1.000
4 (W)	1.3	47.6	0.008	0.999

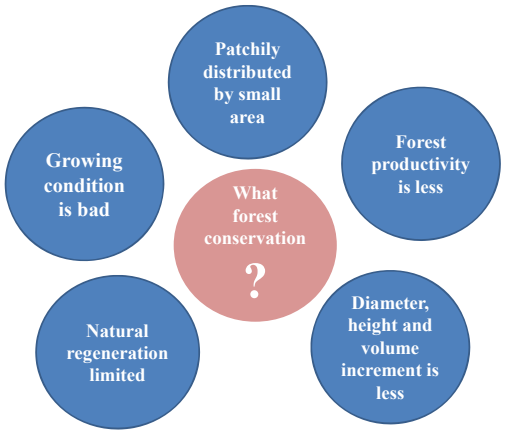
For branch biomass $W=aD^b$ (1)

For stem and needles biomass $W=aD^bH^c$ (3)

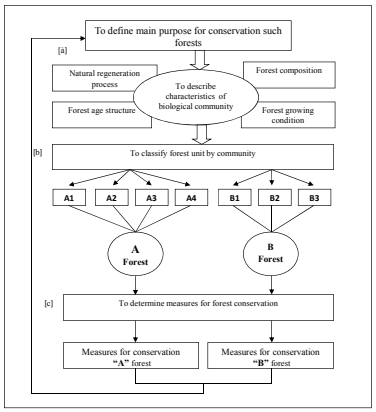
- Mongol Altai (Battulga et all. 2013)
- Iceland (Bjarnadottir et al. 2007)



Total above-ground biomass versus stem diameter at breast height (dbh) in *Larix sibirica* calculated with the regression model $y = aD^b H^c$ with parameters a, b, c determined with trees sampled in the the Altai Mountains, Mongolia (this study) or Iceland (Bjarnadottir et al. 2007).



Model for conservation forests in Mongol Altai mountain ranges



A forest

A1 unit
Larch (>100)
Larch (<40)

A2 unit
Larch (>100)
Larch (41-100)
Larch (<40)

A3 unit
Larch (>100)
Larch (>100)
Larch (<40)

A4 unit
Larch (>100)
Larch (>100)
Larch (41-100)+larch (<40)

B forest

B1 unit
Larch (>100)
+ Larch (41-100)

B2 unit
Larch (>100)
Larch (>100)

B3 unit
Larch (41-100)
Larch (>100)

Forest Management Plan and NEAP

- In 2010, Forest management plan 2011-2015 of Mongolia developed clearly including forest utilization, rehabilitation and protection and funded by Mongolian Government.
- In 2011, the draft National Environmental Action Plan-2011-2021 (NEAP) of Mongolia has been developed through the initiative of the Ministry of Nature, Environment and Tourism, with the assistance and close coordination of the World Bank within the activity of the "Environmental reform ("NEMO2 /Netherland-Mongolia Trust Fund) project.

Policies and measures on adaptation to climate change

a. Improve forest management

The following major mitigation options have been identified for the forestry sector. 1) Natural regeneration; 2) Plantation forestry; 3) Agro-forestry; 4) Shelter belts; and 5) Bioelectricity;

b. Reduce emissions from deforestation and forest degradation, improve sustainable management of forests and enhance forest carbon stocks in Mongolian forest sector

There are a certain amount of potential for the reduction of GHG emission from deforestation and forest degradation in Mongolia. Therefore, it is possible to initiate and implement a REDD project in Mongolia through reforestation activities by community based forest management improvement and sustainable use of forest resources.

Adaptation measures in forestry

- Organizing afforestation activities in at least 12 thousand ha areas in a year and implementation of the Government 'Green Belt' programme on land of at least 200 ha.
- Ensuring tree and bush seed production of at least 5 tons and plant 30 million seedlings per year
- Conducting a forest insects and diseases distribution survey in 1,200 thousand ha and implement actions against harmful forest insects and diseases in 68.5 thousand hectares of land in a year.
- Regulation of the limit of annual logging. Logging areas can be established as 20-30 thousand hectares per year in relation to tree types, their number and capacity.
- Strengthening forest fire prevention and fighting system.
- Introduction of enhanced forestry management methods. Community ownership on 20 percent of the total forest fund by local communities and forestry groups should be established in order to ensure forest protection restoration and proper utilization of forest resources, etc.

Recommendations

- To restructure and strength forestry institutions at central and local level (The feasibility of establishing an autonomous forestry board, and how it can be established and structured, is a matter for consideration).
- To formulate an appropriately phased and structured long term National Forestry Program for Mongolia to guide the sustainable forestry development of the country.
- To consider the linkage of policy, legislation, programs and their implementing mechanisms.
- The present system of forestland use should be reviewed in connection with forest conservation and protection in the country and to establish effective and efficient participation of local community organizations in forestry development, through rational resource allocation and appropriate arrangements.
- To establish an appropriately developed, structured and balanced enterprise system, financial system, social protection system and environmental protection system.
- To enhance the country's capability in the field of forestry development, including the need to strengthen and restructure institutions engaged in forestry research and the need to improve facilities for forestry education and training.

6.Nepal: Assessment of Regional Climate Models and Selection of Appropriate Model Suitable for Mountainous Region

Study on : Assessment of Regional Climate Models and Selection of Appropriate Model Suitable for Mountainous Region of Nepal

Presented by:
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Multi Stake Holder Forestry Program(MSFP)
IDS Nepal

Objective of the study

The primary objective of this study was "Assessment of Regional Climate Models and Selection of Appropriate Model Suitable for Mountainous Region" for research and systematic observation in Nepal.

Scope of the Study

- Review of the available documents related to climate models.
- Assess the climate models that are used in Nepal to assess the climatic scenario.
- Suggest the appropriate climate model suitable for mountainous region of Nepal.
- Based on the gathered information, prepare a final report on regional climate models and selection of appropriate model suitable for mountainous region.

Methodology

- This study was based on literature review and consultation with climate change experts and related stakeholder like research institutions, GOs, Bilateral and multilateral agencies like ADB, IFC, WB Group, INGOs and NGOs.
- The articles and journals were collected in electronic as well as hard copy from internet and library. The secondary information was also collected by discussion with climate change modeling experts.

Current Climate Vulnerability in Nepal

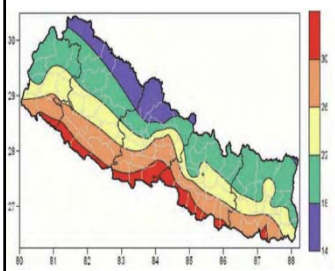

Figure 1. Spatial variation of mean maximum temperature. Source PAC, 2009

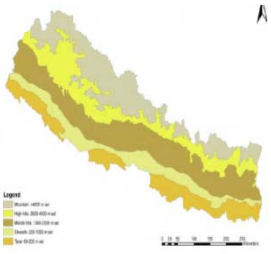

Figure 2. Elevation. Source PAC

Current Climate Vulnerability in Nepal

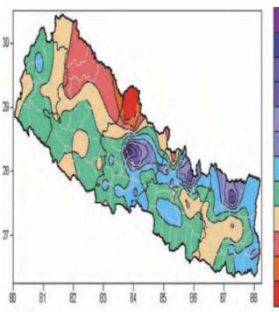

Figure 3. Annual mean rainfall. Source PAC, 2009

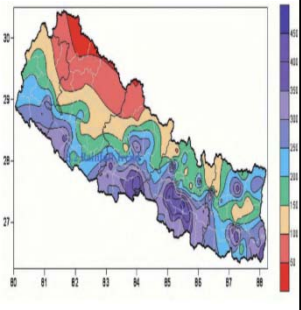

Figure 4. 24 hours highest rainfall (mm). Source PAC (2009)

Emerging Climate Trends

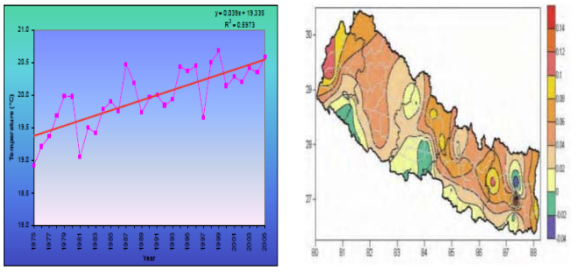

Figure 5. Annual mean temperature trend Nepal (Baidya et al (2007) and spatial pattern (PAC, 2009)

Climate Model Data and Projections for Nepal (Based on Literature review)

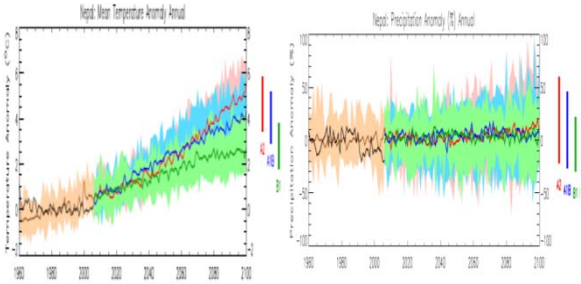

Figure 7. Trends in annual mean temperature for the recent past and projected future simulated by 15 models for each emissions scenario (McSweeney et al)

Figure 8. Trends in annual mean rainfall for the recent past and projected future simulated by 15 models for each emissions scenario % anomaly (McSweeney et al)

Downscaled Projections

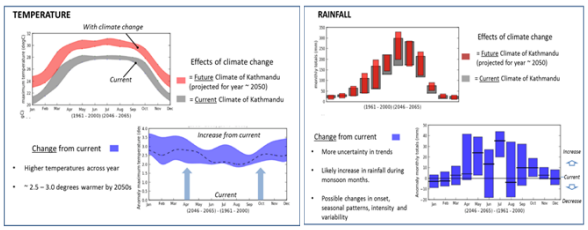

Figure 9. Temperature and Precipitation Projections for Kathmandu (A2, 2050)
Source of data: Climate Systems Analysis Group (CSAG), University of Cape Town, UCT (2012)

Downscaled Projections

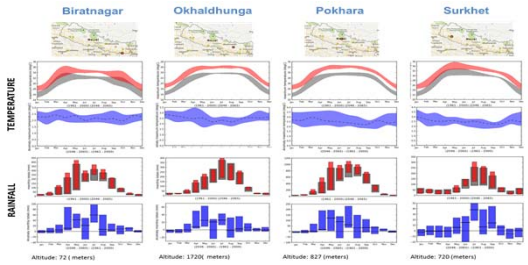

Figure 10. Monthly daily maximum temperature and monthly rainfall for the mid-century projections (A2) for different sites in the country (Source: Climate Systems Analysis Group (CSAG), University of Cape Town, UCT, 2012)

Downscaled Projections

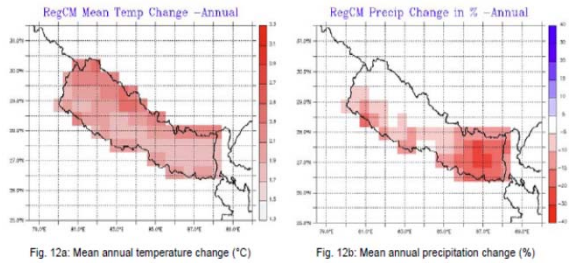

Fig. 12a: Mean annual temperature change (°C)

Fig. 12b: Mean annual precipitation change (%)

Figure 11. RCM output for Nepal. Source: Karmacharya et al., 2007

Downscaled Projections

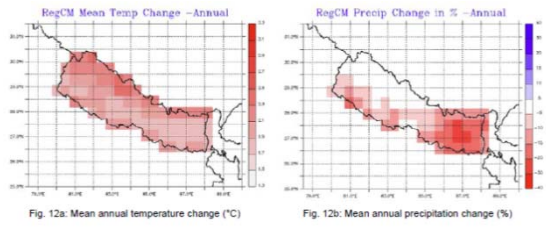

Fig. 12a: Mean annual temperature change (°C)

Fig. 12b: Mean annual precipitation change (%)

Figure 11. RCM output for Nepal. Source: Karmacharya et al., 2007

Downscaled Projections

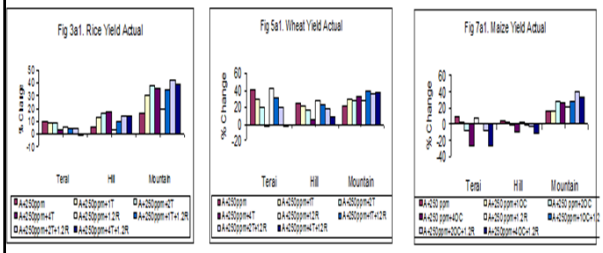

Figure 22. Rice, wheat and maize yield at different altitude regimes as influenced by climatic variability.Source Sherchand et al (2007)

Use the PRECIS Model on RCM framework in Nepal

- In 2010 the ICIMOD conducted one research on climate change impact on eastern Himalayan region of Nepal through PRECIS model on RCM framework.
- The study focuses mainly on analysis of contemporary trends in temperature and precipitation in the region and on analyzing the scenarios of future climate change.
- Economic impact assessment of climate change impact on different key sectors of Nepal through PRESIS, DSSAT and LEAP model. (Ministry of Environment science and IDS Nepal).

Conclusion and Suitable Climate Model Recommendation for Mountain Region of Nepal.

- Due to complex geographical structure, data availability and based on literature review the PRECIS model with RCM framework is suitable for climate change impact study in Nepal.
- The present version of PRECIS has an option to downscale to a horizontal resolution of 25 km with A1B scenario.
- In Agriculture DSSAT crop models (agronomic models) to assess the soil-plant-atmosphere components relevant for plant growth and yield, and the effects of future climate change on crop productivity.
- There are models (BIOME 3, FAO) to project the extent and nature of future ecosystem changes in the geographical distribution of species, and these models can be effective partially to quantify effects of climate change in a country like Nepal where adequate data are not available.
- Empirical Glacier Mass Balance Model to calculate the mass balance
- Water Balance model for climate impact assessment of river basin runoff

7.PNG: Case Study of Forest Adaptation

CASE STUDY OF FOREST ADAPTATION
– Papua New Guinea (PNG)

Approaches to Forest Adaptation
Seminar Workshop, Hungian, China
01st – 12th July 2013

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Outline

(I) INTRODUCTION ON FOREST MANAGEMENT IN PNG/ FOREST POLICIES/ ACTION PLAN FOR CLIMATE CHANGE ADAPTATION
- Forest management in PNG
  - 1.1 Forest resource of PNG
  - 1.2 Forest policies of PNG
  - 1.3 Framework of planning
  - 1.4 Forestry & Climate change Framework for Action 2009-2015

(II) KEY ISSUES TO BE RESOLVED/ MAIN CHALLENGES FROM CLIMATE CHANGE AND WHAT SHOULD BE DONE TO PROTECT OUR FOREST TO ENHANCE ITS SOCIO-ECONOMIC & ENVIRONMENTAL VALUES
- Impacts of climate change
- What should be done to protect forest

(III) TOOLS & METHODS
- Data analysis & modeling application
- Data sources
- Tools use in PNG
- New techniques learned from previous training & its application

(IV) RESULTS AND DISCUSSION
- Modeling
- Scenarios
- Policies & strategies for climate change adaptation

(V) LOOKING AHEAD
- Challenges & Opportunities

Location of Papua New Guinea

(I) FOREST MANAGEMENT IN PNG AND FOREST POLICIES/ ACTION PLANS FOR CLIMATE CHANGE ADAPTATION

1.0 Forest Management in PNG

- Forests and forest resources in PNG – manage by PNG Forest Authority (PNGFA) as mandated by the PNG Government.
- PNGFA's mission statement is in harmony with PNG's Constitution and aims to: *"Promote the management and wise utilization of the forest resources of PNG as a renewable asset for the wellbeing of present and future generations."*
- PNGFA is responsible for managing and developing the nation's;
  - natural forests and state-owned forest plantations,
  - negotiation of timber industries activities, and
  - other forest related activities in the country.

Cont'd…

1.0 Forest Management in PNG

1.1 Forest and forest resources of PNG

Land Cover Type	Area (million ha)
Total Land Area of PNG	46.284
Forest cover	29.28 (63.6%)
<> Production forest	15.0
<> Reserved forest	13.08
<> Protection forest	1.2
Other wooded lands	4.474
Grassland & savannah	3.241
Inland water bodies	0.998
Other land	8.134

Source: PNGFA Corporate Plan

Cont'd…

1.0 Forest Management in PNG

1.2 Forest policies of Papua New Guinea

- PNGFA - govt's mandated body responsible to manage acquired forest resources of PNG.
- It's operations are governed by the following policies/ guidelines;
  - National Forest Policy
  - Forest Act 1991 (as amended)
  - PNGFA Corporate Plan
  - The National Forest Development Guidelines 2009.
  - Forest Regulations
  - National Forest Plans (19 Provincial Forest Plans)
  - PNG Logging Code of Practice
  - 24 Key Standards, and the
  - Forestry and Climate Change Framework for Action 2009-2015.

Cont'd…

1.0 Forest Management in PNG

1.3 Framework of Planning

- National Forest Plan
  - provides a detailed statement on how the govt intends to manage, develop and utilize natural forest resources.
  - Outlines a program of forest acquisition & identification of areas that are considered to be suitable for commercial logging.
  - Areas suitable for logging are acquired by the state under a Forest Management Agreement (FMA) signed btwn landowners' rep identified under an Incorporated Land Group (ILG) and PNGFA.
  - Operations of all major timber concession areas are processed and operated in accordance with the National Forest Plan and the respective Provincial Forest Plans and regulated by the Forestry Act.

Cont'd…

1.0 Forest Management in PNG

1.4 Forestry & climate change Framework for Action 2009-2015

- Targets development and strengthening of partners for implementation of national, provincial and community initiatives.
- It's consistent with timeframes of national development strategies of PNG (e.g. MTDS, MDG's) and others (Kyoto Protocol).
- Significantly, it addresses the issues of forestry and climate change that requires a national multi-stakeholder approach.
- Especially with sectors link to;
  - Weather and climate including water;
  - Agriculture and Fisheries; Energy; Mining and Petroleum;
  - Landuse; Health coastal zone management; Forest soil management; Marine Ecosystem; Tourism and Transport.

Cont'd…

1.4 Forestry & climate change Framework for Action 2009-2015

Vision and Goal of the Framework

- Vision: *"That Papua New Guinea people, their forests, environment and livelihoods are resilient to the risks and impacts of climate change."*
- Goals:
  - To ensure that PNG people build capacity to be resilient to the risks and impacts of climate change thru implementing adaptation measures;
  - Contributing to mitigation of greenhouse gas (GHG) emissions;
  - Improving decision making and good governance;
  - Improving understanding of climate change and its effects;
  - Promoting education and awareness; and
  - Developing and strengthening partnerships and cooperation.
- There are 7 principles in this Framework. Principle # 2 directly focuses on "Adaptation and implementation of strategies to address the impacts of climate change."

Implementing Adaptation Measures

- Building resilience thru adaptation to climate change has been identified as the key priority for all provinces and communities.
- The govt agreed with FAR of IPCC that adverse effects of climate change are already being witnessed in PNG.
- New Guinea Islands, highlands and coastal areas of PNG believe their survival is threatened.
- The ecological fragility, economic vulnerability and remoteness of PNG makes recovery from extreme weather and climatic events very difficult.
- National adaptation policies and measures reflecting the whole of country approach need to be integrated into national sustainable development strategies and plans.
- Adaptation measures based on the precautionary approach and principles of risk management with a focus on improving the livelihoods of its people are encouraged.
- Such an approach require the implementation of resilience building measures that have multiple benefits including disaster risk reduction.

Expected Outcomes by 2015

1. Adaptation measures to climate change developed and implemented at all levels.
2. ARCDM and REDD+ projects on forestry initiatives facilitated and developed with adaptation funds or from Gov't and donor funding.
3. Highly vulnerable forestry priority areas identified through site-specific baseline data, collection and interpretation and adaptive actions developed.
4. Integrated approaches to adaptation embedded in national sustainable development plans and budgeting process.
5. Research and development into forest types and climate impacts.
6. Restoration and rehabilitation: forest enrichment and plantation development with soil protecting species in highly degraded areas.
7. Main streaming of climate change into forest management plans and policies.
8. Methodologies and research initiatives incorporated into school curriculum.
9. Integrated food and wood production (agroforestry) for environmental, economic and social services that improve local communities capacity to cope with adverse climatic events.
10. Improved and effective coastal mangrove and littoral forest management to minimize effects of heavy storms and rising sea-level on coastal communities.
11. Improve and effective urban forestry management to maintain and improve shade cover to keep towns and cities in PNG cooler.

Implementing Strategies

- PNGFA recognizes that the implementation of this framework, its forestry policy & development strategies (MTDS, LTDS, MDG's and Vision 2050) are mutually reinforcing.
- This will require more focus and increase efforts both by PNGFA, the PNG Govt and international community .
- PNGFA with necessary support from donor partners and international community, including facilitation and improvement of access to the existing resources and, where appropriate through allocation of dedicated financial resources , will seek to improve actions identified in the framework nationally with the support of the landowners and their communities, as necessary.
- Harmonized implementation of this 5-year framework is essential.

Monitoring the Framework

- Evaluating progress against vision, goals, principles, outcomes and priority activities of this framework will be undertaken at all levels, following establishment of appropriate baseline and mechanism.
- UN organizations, NGO's and the private sector will, where necessary, provide support and coordinating role, for regional and international reporting.
- Targets and indicators will be established within the action plan linked to the framework and set at the appropriate levels.
- Mid-term review is now currently being done (2013) to determine its overall success.
- Key stakeholder meeting – done biennially to review progress on implementation of framework and its action plan.
  - This requires stakeholders to indentify progress and emerging gaps that require priority action and adjustment of priorities in future.
- Key stakeholders: PNGFA, OCCD, the Govt, local communities and NGO's.

(II) KEY ISSUES/ CHANGES TO BE RESOLVED, MAIN CHALLENGES FROM CLIMATE CHANGE AND WHAT SHOULD BE DONE TO PROTECT OUR FOREST AND ENHANCE ITS SOCIAL, ECONOMIC AND ENVIRONMENTAL VALUES.

1.0 Background

- The IPCC FAR provides and reaffirms strong evidence that global, regional and national changes due to climate change, variability and sea level rise are caused by human and natural activities (IPCC, 2007).
- Climate change in PNG is real and its impacts on terrestrial ecosystems are becoming more evident especially with;
  - increasing surface and air temperatures,
  - changes in distribution and intensity of rainfalls,
  - alteration of hydrological regimes,
  - changes in wind patterns and intensity,
  - altering fire frequencies and intensities,
  - flooding and erosion regimes and
  - changes in frequency and intensity of extreme weather events

(Saulei, S., et al. 2011).

2.0 Impacts of climate change

Impacts of climate change in the forestry sector of PNG are very obvious, examples are tabulated below;

Impacts of climate change	Description of Impact
Prolonged and intense droughts // Increase fire frequency and intensities	E.g. 1997 El Nino effect: Severe droughts and extensive fire occurrence in PNG destroying vast forests areas around the country.
Increased temp. leading to reduce soil MC	Affects soil physical structures & increased seedling mortality, reduced tree growth/ yield e.g. Bulolo forest plantation)
Changes in phenology; seed quality & physiology of trees	Occurs due to increased temperature
Occurrence of Invasive species	Occurrence of invasive species (weeds) not known to occur in the area before.
Insects and pathogens	E.g. increase termite attack on trees in forest plantation (Bulolo) - the attack was related to vulnerable trees exposed to increasing temp. and changed soil physical conditions.
Increase incidences of pests and diseases	Trees stressed due to injuries sustain during logging were vulnerable to insect and pathogenic attacks. Exposure to new extreme micro-climatic conditions may only promote pest and diseases and thus mortality (Saulei *et al* .2010.)

Cont'd...

2.0 Impacts of climate change

Impacts of climate change	Description of Impact
Tree mortality in natural forest	Trees dying at altitude 250-550m due to logging injuries and "edge effect" – lead to decrease in productivity in terms of volume/ha. (e.g. Asengseng FMA, West New Britain Prov.). Impact on socio-economic benefit of the developer, landowners and the state will be enormous. Impacts on the forest ecosystem e.g. pests and diseases are of concerns.
Flooding, landslips and erosion	Increase precipitation resulting in flooding, soil erosion, landslips and increased seedling mortality (especially in forest plantations).
Sea level rise	Trees were dying along low lying coastal areas and on low lying atolls due to rising sea level or subsiding land enabling the sea to submerse the area. Mangroves dying in some areas due to lack of substrate which have been eroded over past years (as in Siasi Is.). Islanders plant mangroves behind constructed sea walls along the coastline to protect their islands.
Food and freshwater security	Rise in sea level has allowed sea water to move inland through surface wash and intrusion through the soil thus affecting freshwater sources and food crop yields (e.g. Siasi Island, Duke of York Islands and outlying islands and atolls).

Table 1: Summary of elements of climatic vulnerability and their impacts

Exposure & Sensitivity	*Impacts*
Increase temperature	Changes to soil physical characteristics including moisture holding capacity; increase vulnerability of plant matter susceptible to fire; change in phenological behavior of trees.
Increase in extreme events	Droughts, floods; landslips, soil erosion, soil compaction due to flushing out actions of flowing water
Increases in forest fires	Reduction in wood supplies; follow up infestations by insects and pathogens
Increases in insect, fungal, etc outbreaks	Reduction in wood supply both in terms of quantity and quality
Changes in forest productivity	Changes to wood supply and carbon sequestration
Shifts in species composition	Changes to technology and markets; changes to other values
Genetic erosion through selection and breeding especially for species selected for seed orchards	Reduction of resilience or adaptation mechanisms to impacts of climate change

3.0 What should be done to protect forest and enhance its social, economic and environmental values

Table 2: Impacts of climatic changes and what needs to be done in PNG

Key Issues /Main challenges from climate change	What should be done to protect forest and enhance its social, economic and environmental values
Droughts/ forest fires	- Reduce non-climatic threats (e.g. logging, hunting, burning, gardening) to forest ecosystem and its biodiversity. - Set up climate (weather) monitoring systems at strategic locations e.g. near forest plantation, and warning signs or fire indicator to warn people to be wary and not ignite fire; Improve capacity to combat fires (fire fighting)// impose tough penalties on arsonists.
Natural forest mortality	- Conserve intact ecosystems, avoid habitat fragmentation and create biological corridors; rehabilitation of affected areas; determine cause of mortality through research; weigh out adaptation options & implementation (Action Plan).
Plantation mortality	- Follow strict nursery practices, improve seedling handling and planting techniques, and management during early stages after planting. - Conserve and promote genetically diverse tree populations with genetic potential to acclimatize to climate change; ex situ conservation or relocation of vulnerable plantation tree species. - Maintain natural processes (e.g., migration, predation, pollination, seed dispersal) in the plantations which are necessary for ecosystem function;

Cont'd...

Table 2: Impacts of climatic changes and what needs to be done in PNG

Reduced tree growth	- Assessment of potential genetic erosion within species of plantation trees be addressed so that work on characteristic selection be considered and make way for possible backcrossing to be conducted (Saulei, S,. et al. 2010.)
Increase incidences of pests and diseases// invasive species	- Determine the species, their points of entry and population size of major insect and pathogenic infestations causing forest trees mortality and establish strategies for eradicating and monitoring them over a period of time (Saulei, S,. et al. 2010.)
Degradation of areas	- Rehabilitation of degraded and exposed areas by planting trees that would meet the set objectives, e.g. SRC trees for firewood/ posts/ charcoal production or commercial timber trees for timber/ post; Carbon sequestration, etc.
Sea level rise	- Building sea walls; Protection of shoreline by planting mangroves and other non-mangal trees where mangroves cannot grow.
Freshwater security	- Enhance water storage and conservation; improve management of forest watershed areas & water-use efficiency.
Food security	- Promote Agroforestry (MPTS) through inter-planting of food crops with trees.
Capacity building	- Build capacity for research, planning and implementation of adaptive measure. Conduct awareness to villages so they are able to make inform decisions.

(III) TOOLS AND METHODS

(a) Data analysis and modeling application

- Forest inventory data and other non-climatic data including socio-economic data collated for V&A baseline studies on impacts of climate change are analyzed by PNGFA .
- Modeling application using baseline data for climate change impacts is rare.
- Climatic data analysis and modeling application used by PNGFA are sourced from IPCC's Assessment Reports and other sources (e.g. PNG National Weather Service).

Cont'd...

(III) TOOLS AND METHODS

(b) Data sources

- Models depend on a lot of quality data and information.
- PNGFA conduct V&A assessments, amongst other activities, to collate useful baseline data and information.
- PNGFA is also building capacity on GIS & Remote Sensing which is a very useful tool to provide up-to-date forest data/ information – useful for monitoring purposes.
- Climatic data for PNG and Pacific region are still scarce and there is a need for better modeling for future projections is essential (Saulei, 2011).
- Climate data and information is collated by PNG National Weather Service and PNG Maritime Authority, but there are more data and information that can be sourced from published reports by IPCC (e.g. FAR4, IPCC 2007).
- In order to implement effective adaptation policies, plans and programmes, climatic and non-climatic information and data is required, in and across sectors at local, regional, national and global scales, supported by 'local knowledge and experience'.

Cont'd...

(III) TOOLS AND METHODS

(c) Tools use in your region (PNG)

- Tool - is a means or instrument by which a specific task is accomplished.
  - E.g., RCMs, impact models, decision tools (cost-benefit analysis, MCA, TEAM, ADM, etc), stakeholder tools (vulnerability indexes, Livelihood Sensitivity Exercise, etc.).
- A method - is a set of steps or tasks that can be implemented through using a number of tools, i.e. means or instrument used for accomplishing a specific task (UNFCCC 2005b).
- Availability of different tools and methods to use is not a limitation (UNFCCC, 2005).
- PNGFA uses tools that are suitable to achieve set goals and objectives of a particular assessment and also based on its capabilities to use them.
- Generic methods and tools used in recent V&A assessments in PNG include; *cognitive mapping and expert judgment* (see Giupponi et al, 2008 and Locatelli, B., *et al.*, 2008) and *Rapid Vulnerability & Adaptation Assessment* method (Santoso, 2007).

Cont'd...

(III) TOOLS AND METHODS

(c) Tools use in your region (PNG)

These three methods are detailed briefly as follows:

- ***Cognitive mapping*** (or concept mapping or mental model) - is a structured process that enables researchers to produce a map of the concepts or ideas behind a topic of discussions and to describe how these ideas are interrelated. It assists the researchers to define problems and structure their mental model.

  For the V&A assessment, cognitive mapping can start with;
  - identifying the different elements relating to vulnerability.
  - the second step involves clustering of the identified elements into groups or initiating events, intermediate events, outcome and consequences.
  - the third step aims at representing casual links between the elements, and
  - the last step consists of explanations of these links.
- ***Expert judgment*** – a method used for eliciting informed opinions from experts of a specific topic (see Meyer and Booker, 1991).
  - It is a useful method when resources are limited for conducting an in-depth analysis of scientific literature, collecting data or modeling.

Cont'd...

(III) TOOLS AND METHODS

(c) Tools use in your region (PNG)

- ***Rapid Vulnerability & Adaptation Assessment*** – a method for designing national strategies and plans of adaptation to climate change.
  - V&A assessments in PNG: A number of coastal and small island communities in PNG were assessed using the rapid assessment method designed for use in Indonesia (Santoso, 2007) with particular emphasis on the following parameters: *Exposure; Sensitivity*, and the *Adaptation* capacity in regard to transport, communication, finance, manpower and health for the island communities.
  - For this exercise, both the national and sectoral development goals were used against potential short and long-term impacts of varying climate change scenarios (especially for issues relating to exposures and sensitivity). Of particular sectoral importance were agriculture, health and social services. While for adaptation capacity, the assessment was based on observations and discussions with local authorities and communities on the islands.

Cont'd…

(III) TOOLS AND METHODS

(d) New techniques learned from previous trainings and their application

- No (external) training attended in the past regarding V&A .
- PNGFA does conduct workshops on climate change issues and through such workshops, issues of V&A are discussed and ideas shared.
- Access to information via the internet – very useful.

Cont'd…

(III) TOOLS AND METHODS

(e) Forest adaptation strategies under different potential climate change scenarios and forest management scenarios

- National adaptation policies and measures reflecting the whole of country approach need to be mainstreamed into national sustainable development strategies and plans.
- A national plan of adaptation needs to be prepared.
  - The plan is best to be mainstream and incorporated into national long-term dev. strategy.
  - Forest adaptation strategies should be tailored to address identified site-specific potential climate change scenarios and to suit specific forest management scenarios, taking into consideration existing forest policies and forest development plans of the country .
- The extent of vulnerability to climate change and climate variability of forests ecosystems in PNG is not fully understood. There are few vulnerability and adaptation baseline assessments done in PNG (e.g. Saulei, S & Nagari, T., 1998; Saulei, S., *et al.* 2010; Saulei, S., *et al.* 2011).
- Currently, adaptation strategies resulting from thorough vulnerability assessments are very few, and much less at the national level. This is due to the fact that research on V&A started only recently within PNGFA (Organization re-restructure - 2009).
- Capacity to undertake such activities also needs to be address effectively.

(IV) RESULTS AND DISCUSSION

1. Modeling

- Modeling of impacts of climate change on forests and other ecosystems for vulnerability and adaptation is very limited in PNG.
- Much of what PNGFA has done mainly focused on site-specific baseline assessments to determine impacts of climate change and vulnerability issues and determining adaptation options.
- What is being discussed below are information that is generated from modeling by IPCC and others on climate change and its potential impacts.

Cont'd…

(IV) RESULTS AND DISCUSSION

1.1 Climate Change

- There is very little being done in the area of climate models in PNG and the region, but this is needed to improve our understanding of climate change, variability and sea level rise (Saulei, *et al.* 2011).
- The improved scientific understanding of climate change and natural variability has challenged all to appreciate the contributions, especially the impacts of climate change as a global, regional and national issue:
  - The observed increase in global average temperature since the mid 20th century is likely due to the observed increase in anthropogenic GHG concentrations.
  - FAR (IPCC 2007) is more advanced information than TAR (IPCC, 2001).
  - Apparent human influence now extends to other aspects of climate, ocean warming, extreme temperatures and wind patterns.
  - Warming of the climate system has been detected in the changes on surface and atmospheric temperatures, temperatures in the upper several hundred meter of the oceans and its contribution to sea level rise;
  - It is understood that anthropogenic forcing is likely to have contributed to changes in wind patterns, affecting extra-tropical storm tracks and temp. patterns in both hemispheres.

Cont'd…

(IV) RESULTS AND DISCUSSION

1.2 Climate impacts on PNG

- It's now a challenge for PNG and the rest of the world to seriously reduce their levels of emissions by developing and applying national climate change and mitigation policies:
  - The impacts of climate change is extended to oceans, extreme temperatures and wind patterns,
  - PNG GHG levels continue to increase due to the Petroleum, Gas and Mining activities, Forestry, waste, energy and technology contributions,
  - Risk assessment and monitoring on climate change, variability and extreme events in PNG should be a priority.

Cont'd…

(IV) RESULTS AND DISCUSSION

1.3 Projections of future changes in Climate

- The models used in the FAR have suggested that in the next two decades a warming of about 0.2° C per decade is projected for the emission scenarios.
- If the concentrations of all GHGs and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1°C per decade could be expected:
  - Advancement in models for GHG emission at or above current rates would cause further warming and induce many changes in global climate system during the 21st century and that could likely be larger than those presently observed.
  - The models for temperature changes compare very well with the sea level rise measurements at global level.
  - Most models do not include uncertainties in climate-carbon cycle feedback or include the full effects of changes in ice sheet flow due to lack of data.
  - Increase in atmospheric CO_2 concentrations leads to increasing acidification of the ocean. Average global pH level in the oceans was recorded to be between 0.14 and 0.35 units over the 21st century

Cont'd...

(IV) RESULTS AND DISCUSSION

1.3 Projections of future changes in Climate

- Both past and future anthropogenic CO_2 emissions will continue to contribute to warming and sea level rise for more than a millennium, even if steps are taken now to greatly reduce or stop all emissions due to the timescales required to removal of this gas from the atmosphere.
- There is now higher confidence in projected patterns of warming and other regional-scale features, including changes in wind patterns, precipitation and some aspects of extremes and melting of the ice. Warming is expected to be greatest over land and at high altitudes and northern latitudes and at least over southern oceans.
- The range of models have indicated that there is likely future tropical cyclones will become more intense, with large wind speed and more heavy precipitation with ongoing increases of tropical Sea Surface Temperature.
- With confidence in modeling temperatures are likely to increase by approximately 5°C by 2100
- Anthropogenic warming and sea level rise would continue for centuries due to the timescales associated with climate processes and feedback, even if the GHG concentrations were to be stabilized in 2100.

(IV) RESULTS AND DISCUSSION

1.4 Potential impacts on PNG

Below are important potential projections regarding climate change in PNG;

- The level of GHG in the atmosphere will continue to increase in the next 100 years as developing countries like PNG will contribute to meet its economic and social aspirations thru development of its natural resources of oil/gas, forest and land change;
- Melting of ice cap and thermal expansion of the oceans are the main sources contributing to the sea level rise in PNG and the pacific region. Some coastal provinces with their outlying small islands are now being impacted;
- Climatic data for PNG and pacific region are still scarce and there is an urgent need for better modeling for future projections is essential;
- The range of models have indicated that there is likely future tropical cyclones will become more intense, with large wind speed and more heavy precipitation with ongoing increases of tropical Sea Surface Temperature in the country and neighbors.
- The climate change and variability will impact the whole country but will be heavily felt by New Guinea Islands, Milne Bay, Gulf, Central, Sepik Provinces, and Fly provinces.

Such information would assist PNG make informed decisions regarding forest Adaptation strategies in light of climate changes.

2.0 Scenarios

2.1 Potential Impacts to PNG

The following are some results of recent assessments of potential climate change impacts:

- In the last 10-15 years, there is strong evidence of increase in temperature of the atmosphere and oceans, sea level rise in PNG provinces and the Pacific;
- Sea level changes will adversely affect the atoll islands in New Guinea Islands and low lying coastal areas of the country;
- EL Nino and La Nina signals will continue to increase its frequency and intensity and its impacts on the entire country especially on food and freshwater security.
- There will be major climatic influences in the country and the region and will greatly have an impact on economic, social and environmental sectors of the densely populated parts of the country, especially the vulnerable remote and isolated communities.
- More intense and longer droughts in PNG
- The frequency and intensity of cyclones, heat waves, flooding and extreme climatic conditions will be experienced;
- Highland provinces will be impacted severely in light of long- and short-term droughts especially for populated areas and malaria/health will be a challenge.

3. Policies and strategies for climate change adaptation

- There is need for climate change, variability and sea level rise policy as it is important for the country.
- There is a need for a National Action Plan for Adaptation of vulnerable forest ecosystems for PNG to compliment the broad framework 2009-2015.

V. LOOKING AHEAD

A. Challenges:

- Capacity:
  - In terms of personals and financial resources to carryout V&A baseline studies and initiatives especially in vulnerable ecosystems.
  - Capacity building is needed to enable developing countries such as PNG to develop adaptation programmes and strategies.
- Uncertainties in institutional arrangements in terms of infrastructure, capacity building, policy and new practices to carry out V&A initiatives.

B. Opportunities:

- Policies and measures are currently in place.
- There is strong leadership and coordination of V&A related activities.

"THANK YOU!!"

8.Thailand : Forest Management and Biodiversity Conservation under a Changing Climate

Forest Management and Biodiversity Conservation under a Changing Climate A Case Study of Ban Sam Kha, Lumpang Province, Thailand

AREEYAPAT PETCHARAT
THE ROYAL FOREST DEPARTMENT, THAILAND

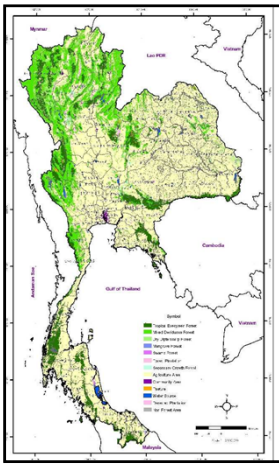
Outlines

- Forest management in Thailand
- Forest policies and action plans for climate change adaptation
- Biodiversity conservation under a changing climate in Ban Sam Kla, Lumpang Province, Thailand
- Challenges and opportunities

Forest Management in Thailand

- Forest cover
- Policy frameworks
- Legal frameworks
- Responsibilities
- Strategies

Forest Cover



Area of the country:	51.3 m ha
Forest area (defined by law):	22.4 m ha
Forest area (remaining)	17.2 m ha (33.4%)
Deforestation rate	-0.57%
Forest area need to be rehabilitated (In natural reserved forest)	2.3 m ha
Total forest carbon (30% crown cover)	1,897 Mt C
Average carbon density	130 t C/ha

National Forest Policy (1985) targeting 40 % (20.5 m ha)
Conservation Forest 25 %
Economical Forest 15 %

Logging concession was banned in 1989

Natural Reserve Forest (10.6m ha)
Protected forest (11.8 m ha)
148 national parks
111 forest parks
60 wildlife sanctuaries
65 non-hunting areas
16 botanical gardens and 55 arboreta

Policy Frameworks for Forest Management

- The National Economic and Social Development Plan (NESDP)
- The National Forest Policy
- The 1997 Constitution

Legal Frameworks for Forest Management

- Forest Act, B.E. 2448 (1941)
- National Park Act, B.E. 2504 (1961)
- National Forest Reserve Act, B.E. 2507 (1964)
- Wildlife Conservation and Protection Act, B.E. 2535 (1992)
- Forest Plantation Act, B.E. 2535 (1941) The 1997 Constitution

Forest Management Responsibility

- The National Park, Wildlife and Plant Conservation Department(DNP)
- The Royal Forest Department (RFD)
- The Department of Marine and Coastal Resources and Environment (MNRE)

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Forest Management Strategies

- Expansion of designated protected areas
- Expansion of the forest resource base by plantation
- Community Forestry

8

Forest Policies and Action Plans for Climate Change Adaptation

- The Initial National Communication (INC)-2000
- The Second National Communication (SNC)-2006
- Thailand's National Strategy on Climate Change, 2008-2012

9

Biodiversity Conservation under a Changing Climate

- Biodiversity and climate change
- A case study of Ban Sam Kla Village, Lumpang Province, Thailand
- Role of the community in climate change mitigation and adaptation
  - Mitigation actions
  - Adaptation actions

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Biodiversity and Changing Climate

- Global climate change is having significant effect on biodiversity.
- Ecosystems and their biodiversity have a role to pay in securing the substantial carbon stocks held within the atmosphere.
- Actions for conserving biodiversity under a changing climate
  - Mitigation actions (controlling and reducing emissions of greenhouse gases)
  - Adaptation actions (increasing the ability of natural systems to absorb and respond to change)


A case study of Ban Sam Kla Village, Lumpang Province, Thailand

- Overview of the study site

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Role of the community in biodiversity conservation under a changing climate

- Mitigation actions
  - Reforestation and rehabilitation of deforested areas
  - Reduce crop residue burning

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Role of the community in biodiversity conservation under a changing climate

- Adaptation actions
  - Developing biodiversity data bases systems
  - Water management and wildfire prevention
  - Create habitat linkages

http://biodiversity.forest.go.th/

Challenges and Opportunities

- How best to plan and adapt for an uncertain future.
- Strategies include:
  - Sequestering carbon through new forests
  - Substituting energy derived from fossil fuels
  - Avoiding emissions from forest loss and degradation
  - Multi-purpose resource management
  - Minimizing conflict to building partnerships,
  - Public participation and international collaboration
- Research and evaluation of the long-term impacts of climate change
- Good governance in national administration
- Community forestry is the key measure to achieve forest governance

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Thank you!!!

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